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"JAMES YOUNG, SCOTTISH INDUSTRIALIST AND PHILANTHROPIST"

THESIS

SUBMITTED TO

THE UNIVERSITY OF GLASGOW

in fulfilment of the requirements of the

DEGREE OF DOCTOR OF PHILOSOPHY

by JOHN BUTT

Department of Economic History

December, 1963

The story of Mr. Young's life and labours is as interesting as almost anything to be found in the whole range of industrial biography.

David Bremner

The Industries of Scotland,

Edinburgh, 1869. p. 491.

JAMES YOUNG, SCOTTISH INDUSTRIALIST AND PHILANTHROPIST (1811-1883)

This biographical study examines the character and career of a significant Victorian entrepreneur, James Young, the founder of the Scottish shale-oil industry. His early career, the transition from carpenter to industrialist, is described against the background of his talents, training and interests.

Before discussing his own business activities, his place in the history of oil technology is reviewed, but the main significance of this work is the consideration of Young as an exponent of a new type of business economics, normally associated with the large-scale public company, untypical of most Victorian business enterprises. Young's place in his first partnership with E.W. Binney and E. Meldrum is discussed, as are the contributions of his partners, the conditions of production, the state of the market and the extent of competition, investment in research, technical development, commercial organisation, publicity and advertisement. The extent of integration of operations is also described.

The general attack on Young's patent produced classic patent litigation which required particular analysis, since the viability of his main British patent of 17 October, 1850 explains the degree of his success. The court actions - Gillespies v. Russels, (1853) in the Court of Session, Young and Others v. White and Others, (1854) in the Court of Queen's Bench, E.W. Binney and Company v. The Clydesdale Chemical Company, (1860) in the Court of Session and Young

Others v. Fernie and Others, (1862-66) in Chancery and the House of Lords - are separately examined and related to Young's success in business. Similarly, Young's visit to the United States of America in 1860 to enforce his American patent is described, together with the influence of the infant American petroleum industry on the early history of the Scottish shale-oil industry. The general expansion of the Scottish industry after 1860 is described and so are the operations of Young's limited liability company (1866-70).

Although the main emphasis is placed upon James Young's significance as an entrepreneur, attention is also directed to his philanthropic activities. He was a Trustee and benefactor of Anderson's University, Glasgow from 1858 to 1883 and dominated its administration and development during his Presidency (1868-1877). This period of Young's direct involvement with higher scientific, technical and general education for working men in Glasgow coincided with a mood of national re-examination of education. His philanthropy and policies are, therefore, set against this wider background. He governed the institution with a radical spirit but in a paternalistic fashion in much the same way as he attempted to control his business.

Young also supported the work of David Livingstone and acted as his Trustee from 1857 to 1875. This activity - arranging for the care and education of Livingstone's children, lobbying the Government on Livingstone's behalf, financing out of his own pocket, expeditions to find Livingstone and helping to perpetuate his memory - is described. Finally, the threads

of Young's character are drawn together and his achievements and wider significance assessed.

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PREFACE

The purpose of this biography is not to sit in judgment on the dead or to provide a stereotyped supply of motives or excuses for James Young's actions. Yet some assessment of his significance has long been needed, especially since his energies were so wide-ranging. As a scientist and as an engineer, as a business man and as a philanthropist, I have tried to contemplate and evaluate him. Mindful that irony and paradox are forces in human action, aware that the depths of a man's mind are not neatly compartmented for all to behold, convinced that a man's character is constantly subject to pressures and changes, I have judged without being satisfied that I have finally reconstructed a personality and its environment.

My debts to friends, acquaintances and colleagues are many. I have been greatly helped by Miss A.M. Thom, the grand-daughter of James Young, who not only placed most of his private papers in the Andersonian Library but also allowed me free and hospitable access to those that she retained. Dr. H. Wilson, the grandson of David Livingstone, generously waived his copyright over the relevant Livingstone papers. Mr. G. Thomson, Secretary of the Royal College of Science and Technology, kindly placed his office at my disposal while I examined the Minute Books of the Trustees and Managers of Anderson's University. The staff of Scottish Oils Ltd. - in particular, Dr. Peutherer, Dr. Stewart and Mr. W.G. Thomson -

were most helpful and not only showed an enlightened interest in the history of the shale-oil industry but also in the preservation of their business records. But perhaps, this was only to be expected of the business enterprise which sponsored the pioneer studies of the late E.M. Bailey and the late H.R.J. Conacher.

I would like to express my gratitude for all the help and encouragement I received from the staff of the Mitchell Library, Stirling's Library (Patent and Commercial Section), Mr. John Imrie of the Scottish Record Office, G.C. Wood and the staff of the Andersonian Library, Dr. A.J. Hyde, Mr. G. Maxwell, Professor G. Hibberd, Professor S.G.E. Lythe, Mr. H.M. Elder, Mr. C. Fulton and others.

I owe a special debt to my supervisors, Professor S.G. Checkland and Dr. R.H. Campbell who were always politely and constructively critical. Mrs. R.A.L. Barr enthusiastically performed the hardest task of all : typing so many drafts from barely legible manuscripts.

J.B.

JAMES YOUNG : CARPENTER TO INDUSTRIALIST (1830-1851)

"... most inventors have found that making the invention is the easiest and pleasantest part of the work ..."

James Young, M.S. notes for a lecture on the life and achievements of James Watt. (no date.)

1. Young, the Carpenter

Born in Glasgow on 11 July, 1811, James Young was the eldest son of John Young and Jean Wilson who had married on 9 February, 1809.[1] John Young whose genealogical roots were in Clydesdale and who was described as "Wright in Glasgow" was, in fact, a working carpenter and coffin-maker in his own business. The business was very small and did not even absorb the labour force of Young's other brothers, one of whom was a painter and another, a mill-worker. Young appears to have had a great manual dexterity and skill - as soon as he was able he worked for his father.

Throughout his twentieth year James Young kept a journal[2] of his daily activities, the earliest record of his life. This is not so full as one would have liked, but it provides some illumination. It lists his daily activities but rarely his opinions or feelings; it gives his habits but not his version of how he formed them; it is factual more than subjective.

1. M.S. Letter, Peter Shaw to James Young, 19 December, 1862.
2. Thom Collection of the Private Papers of James Young: Journal, May 1830 - April 1831, no pagination.

Young's day started early, normally at 5 a.m. or 4.30, even on Sundays. In his working week he did all the jobs that one would expect of the carpenter working in a small business: repairs to property and shops, designing and making furniture, shop-fittings, notice-boards, cabinets, chests, coffins, snuff-boxes, looking after tools, sharpening planes and chisels and glazing windows. Occasionally, he went out to work at the customer's house or business premises.[2] There he gained experience in estimating costs, fixing a price for a particular job and making up accounts:

> "I was employed the whole day in making out Polloks and howies accounts We got the money for Polloks but mr howie wanted everything desected so I had to let him know the price of every pane and avery small article."[3]

Now and then, he became his own commercial traveller and went looking for work. Generally, he was very busy, often working ten or twelve hours a day, although there was little to do in February and March, 1831.

Young's journal contains many valuable clues to his interests and hobbies. It may well have been kept to give him practice in writing, for his formal education, especially in English, seems to have been slight. This is revealed not only by his lack of attention to spelling, punctuation and grammar but also by the irregularities in his handwriting. He was

1. Ibid.
2. For example, "went to Mr thompsons distelery." Ibid., 23 June 1830
3. Ibid., 23 August 1830

certainly a "late developer" in Science. On 5th May, 1830, he proudly records: "I am now in vulgar frattions."[1] Few first-class chemists, or indeed scientists, have started with such a back-log in mathematics to be made up. It is some indication of Young's perseverance that he was able to overcome this lack of knowledge in an indispensable service subject. His enthusiasm for education was outstanding. His father was ambitious for him and provided him with encouragement and support. At the age of nineteen Young was attending school on Sundays[2] and from there he moved on to the Mechanics' Institute and Anderson's University,[3] although he still continued to attend some classes on Sundays.

Most Sundays Young walked with his friends around Glasgow:

> "went with James Wilson up the side of the river as far as the glasgow water works crosed it there at a temprarey bridge and came down the oposet side til we came to rutherglen when we went on to the road ..." [4]

Young's interest in the spectacular was typical of any young man:

> "... I went with Mcfarlan to see two men execute ..." [5]
> "... I went to see mr greens baloon which was to go of at three ... I went to duke street near the head of bellgrove the day being wet with a good deal of wind some began to tire waiting however a few mineuts before five he asended in a short time we lost sight of him in a cloud but he apeared in a little and again went out of sight and I came home ..." [6]

1. Ibid., 5 May 1830
2. "on this night the school broke up." Ibid., 24 September 1830
3. Ibid., 9 November 1830, passim.
4. Ibid., 4 July 1830
5. Ibid., 12 May 1830
6. Ibid., 8 July 1830

"... I went in the evning to see an exhibition at the foot of the saltmarket I saw 2 crocidles from the nile and an alagater from st domingo with 2 serpents the crocidles were 3 feet long as I gessed and the alagator 4 ..." 1

"... I went this day about 5 o'clock to a colection of wild beasts I wated til about half past 8 when I agred with the keeper for a ride on an elifant so I got mounted on its nek it kneeled down til I got on and to let me of it took the bonet of my head and put it on the keper fired a blunder bush showed its foot and did other tricks at the word of the keper ..." 2

"... at night I went to se a ventriloquist ..." 3

Young's training as a carpenter in a small business was invaluable personal experience; it was an important formative influence on his later career and success. He was trained to work hard, to use his own initiative and ingenuity, to be meticulous about standards of workmanship, the cost of raw materials, selling price and profit margin, to act as his own designer and middleman, to put a value on his own activities, to develop the capacity for organisation and method-study. These were all necessary attributes of the successful industrialist-to-be. Young was more than the typical entrepreneur; he was essentially a designer who made a fortune from chemical engineering. Careful and conscientious application to a craft with an eighteenth century tradition of exquisite workmanship and design could do nothing but good for such a man. Perhaps, it explains his later precision.

1. Ibid., 10 July 1830
2. Ibid., 16 July 1830
3. Ibid., 6 August 1830

Like Henry Maudslay,[1] of the machine tool industry, James Young began with a training in carpentry and moved on to other materials.

At Anderson's University he attended lectures regularly, often on four out of the five weekday evenings. James was following his father's example, for John Young had attended George Birkbeck's lectures for working men, thirty years before.[2] The whole range of science took his interest - Natural Philosophy, Anatomy, Mathematics and Chemistry - and his teachers were Mr. Mackie, Dr. Heron, Mr. Wilson and Mr. Graham. He had bought a thermometer before attending classes and may have aspired to becoming a doctor since the first lecture he attended was one given by Mr. Hunter on anatomy,[3] and Anderson's University Medical School was well-established as the Glasgow working man's entrée into the profession. His devotion to religion and his regular attendances at church may indicate that he may have had ambition to become a medical missionary, as David Livingstone did later. In May, 1830, he was reading Paly's Evidences of Christianity and Murray's Africa.[4] On 22nd October he paid 1/7½ for Guy's Geography and Pinoch's Catechism.[5]

1. L.T.C. Rolt, Great Engineers, London 1962, p. 90.
2. Royal Commission on Scientific Instruction and the Advancement of Science, 1872/1876, Q. 10,022, Evidence of James Young.
3. Journal, 1830-1831, 29 July 1830
4. Ibid., 15 May 1830
5. Ibid., 22 October 1830

Gradually, Natural Philosophy and Chemistry absorbed him, and later, the new penumbral study of Electro-Chemistry.

Electricity first attracted him: "... I was trying to mak a lectifying machine ..."[1] By 18th January, 1831, Young had made a galvanic pile from one and a half pounds of zinc - and the pile worked.[2] Later, he tried to make equipment for electrolysis.[3] From Natural Philosophy he was turning to Chemistry: "... I was producing hydrogen gas by the galvanic pile and by the action of sulphuric acid with iron and water ..."[4] In December, 1830, Young had begun to attend regularly the lectures of Professor Thomas Graham; he was given a class ticket by a Mr. Garner.[5] He also took an interest in the affairs of the Mechanics' Institute:

> "... it was agreed by the mechanics institution that they shoul leave the hall that they now occupied and the managers were impored to direct the building af a new place ..." 6

> "... was at Andersonian university in the evning at the chusing of the committe ..." 7

1. Ibid., 23 November 1830
2. Ibid., 7-18 January 1831
3. Ibid., 22 January 1831
4. Ibid., 5 February 1831
5. Ibid., 11 and 13 December 1830
6. Ibid., 21 January 1831
7. Ibid., 25 April 1831

2. Young as Assistant to Thomas Graham (1832-1838)

From February, 1831, James Young was actively searching for another job, but his first attempts were unsuccessful.[1] Eventually, he became laboratory and lecture assistant to Thomas Graham,[2] Professor of Chemistry in Anderson's University from 1830 to 1837. The exact date of Young's change of occupation is a mystery, but the last academic session for which he paid for admission to Graham's Chemistry class was 1831-1832[3] - as Graham's assistant, it is unlikely that Young would have been asked to pay fees.[4] Young's notebook for the period 1832-1834 clearly indicated that sometime during this period he had become Graham's assistant.

It seems likely that Young's enthusiasm for Chemistry and his manual dexterity commended him to Graham; Graham, himself,[5] reveals that Young did carpentry work for him, and there can be no doubt that, since Graham's laboratory was scantily equipped, and there was no salary attached to the

1. "I went to seek a job but did not get it." Journal 1830-1831, 20 April 1831
2. Thomas Graham (1805-1869) was the son of a Glasgow textile manufacturer who made money in the West Indian trade; student at the University of Glasgow; M.A. in 1826; post-graduate at Edinburgh where he first began to lecture in Chemistry 1826-1828; industrial consultant in Glasgow 1828-1830; Professor of Chemistry in Anderson's University 1830-1837; Professor of Chemistry in University College, London, 1837-1855; Master of the Mint 1855-1869. c.f. H.H. Browning, The Andersonian Professors of Chemistry, Glasgow, 1894, pp. 15-28, and T.E. Thorpe, Essays in Historical Chemistry, London, 1894, pp. 160-235.
3. This admission card in among the Andersonian Library MSS.
4. Thom Collection: Note-Book of James Young, 1832-1834.
5. R. Angus Smith, Life and Works of Thomas Graham, Glasgow 1884, p. 44, Thomas Graham to his sister, Margaret, 29 April 1839.

Chair, he had need of a versatile and skilled laboratory technician able to make and assemble apparatus.[1] This, Young was capable of doing. In turn, Young had much to gain from his association with Graham, for Graham in the 1830s made probably the outstanding contributions to Chemical theory and teaching practice of any British Chemist.[2] He instituted compulsory laboratory practical classes for his students when this was unusual outside Germany;[3] he did the groundwork during his tenure of the Glasgow post for his "Elements of Chemistry"[4] which, with revision, remained a standard text-book for students in Britain and even in Germany for much of the nineteenth century.

Young was associated with Graham during the most prolific period in Graham's life; 29 research papers written during this period are listed under Graham's name in the Royal Society's Catalogue of Scientific Papers. This is an indication of quantity and method, not necessarily of quality. But it was at this stage of his career that Graham began the investigation of liquids which made him the father of colloid chemistry. He was a thorough-going atomist, taught by Thomas Thomson, F.R.S., the first Regius Professor of Chemistry in

1. Ibid., p. 66
2. T.E. Thorpe, Journal of Chemical Society, 1900, vol. 77., p. 575.
3. R. Angus Smith, op. cit., p. 36, 2 August 1831
4. Thomas Graham, Elements of Chemistry, London, 1842, contained well over 1,000 pages and was translated into German by a Professor Otto. In Germany it became known as "Graham-Otto". Sir William Ramsay, Essays, Biographical and Chemical, London 1908, p. 59.

the University of Glasgow and the man who published Dalton's views on atomism before Dalton put them into print.[1] Graham was not so much interested in the structure of the atom or matter; his main interest was the effect of the motion of atoms in gases and liquids. He was an admirable director of research, always ahead of his time, capable of careful, meticulous experiments, but also able to make the necessary generalisations.[2] He, it was, who selected the subjects which his students and assistants investigated; he thought out what apparatus was needed; Young made it if he could, and assembled it; then followed a series of detailed experiments, and this provided the range of data which Graham used totest existing chemical laws or to suggest new ones. Two papers, the result of careful research, provided Graham with an international reputation in the early 1830s. The first, "On the law of the diffusion of gases,"[3] was read before the Royal Society of Edinburgh in December, 1831, and published in the Philosophical Magazine in 1833. This won for Graham the highest award of the Royal Society of Edinburgh, the Keith medal in May, 1833. The second, "Researches on the arseniates,

1. Ibid., p. 58.
2. C.f. also the judgment of:
   a. A.W. Hofmann: "... Graham was one of those singular minds which create and open new roads of science." Nature, 1869, vol. i., p. 59.
   b. J. Norman Collie: "... In many respects he was much ahead of his time. Capable of the most careful and painstaking work, at the same time, he was able to make the widest generalisations ..." 'A Century of Chemistry at University College,' Centenary Addresses, London 1927; p. 12.
3. Transactions, Royal Society of Edinburgh, xii, 1834 pp. 222-258.

phosphates and modifications of phosphoric acid,"[1] published in 1833, made him a great reputation immediately and won for him the Royal Medal of the Royal Society in 1838. He had been elected a Fellow in 1836.[2] In 1841 he became the first President of the Chemical Society.[3]

If Graham was at his most fruitful period, it was not always because of his own industry. He believed that his work should be done by his students as part of their experience as analytical chemists. During these years, Angus Smith suggests that financial worries and lack of physical energy made Graham less capable of concentrated effort than at any period in his life![4] His students did not find him a good lecturer; many of them found his lectures obscure and boring because of his inability to present his material well. As Lyon Playfair, one of his great admirers, put it:

> "... As a professor, he was unable to keep discipline among his students, and his expository powers were not of a high order ..."[5]

But Graham was a good experimentalist and at his best with the small tutorial group in the laboratory. This explains why so many of his more earnest students revered him. Apart

1. Philosophical Transactions, 1833, pp. 253-284.
2. R. Angus Smith, op. cit., p. 67.
3. T.E. Thorpe, Essays in Historical Chemistry, London 1894, p. 163.
4. R. Angus Smith, op. cit., p. 66
5. T. Wemyss Reid, Memoirs and Correspondence of Lyon Playfair, London 1899, p. 38. This was also the opinion of H.E. Roscoe, later Professor of Chemistry in Owen's College. H.E. Roscoe, The Life and Experience of H.E. Roscoe, p. 28.

from Lyon Playfair and Young himself, the classes of Anderson's University in the 1830s were full of talent: Walter Crum, recognised in Germany as one of Europe's outstanding textile printers, David Livingstone, the missionary-explorer, J.H. Gilbert, an outstanding pioneer of agricultural chemistry, Sheridan Muspratt, educationist-scientist, and many men who later made their names in industry and commerce.[1] Graham, as a former industrial consultant, was au fait with most of the latest chemical developments in industry; he attached great significance to the practical applications of his science;[2] Young could not have had a better academic training for his future career as a chemical engineer.

Graham was a founder member of the British Association, and one of James Young's earlier expeditions was his visit to Dublin in August, 1835, when the British Association held its meetings in Trinity College. Young sailed by the steamer, "Eclipse", from the Broomielaw to Belfast and then went on to Dublin by horse-drawn coach. The journey was quite eventful and interesting for the insight which Young's account of it gives us. He spent much of the sea voyage down in the engine room talking and noting:

> "... our vessel is driven by 2 engines of 35 horsepower each which require 25 tons of coal to belfast and back ..."[3]

1. R. Angus Smith, op. cit., p. 36 and pp. 66 sq., c.f. also A London Barrister-at-Law, Biography of Dr. Sheridan Muspratt, London, 1852, p. 8.
2. T.E. Thorpe, op. cit., p. 216.
3. Thom Collection: Notebook of James Young, 1835, no pagination, "Irish".

He found the engineers "... fine fellows had two bottles of porter with them ..."[1] And the chemist-aesthete in him made him remark on "... curious thing the phosphoresnz of the sea ..."[2] Traffic in Belfast amazed him: "... theres lots of cars in belfast flyin in all directions but no coaches or noddys ..."[3] From Belfast to Dublin Young was greatly entertained:

> "... we had plenty of fun and jokes the whole way and two beuglers who playid nothing but scotch tunes auld lang-sine rob roy and some others ..."[4]

An outside passenger, an Irish surgeon, kept the party amused as did the odd bottle for Young freely admits: "... I drank rather much Irish whiskey with them."[5] Apart from the sickness which this activity induced, the only cause of concern was the obvious poverty of Ireland:

> "... we were always atacked by beggers when the coach stoped and they are very persevereing in there calling 'leave me one hapeny and the blessing of god go with ye: oh leave me one hapeny to a poor creature for the love of god' ..."[6]

Young was both amused and impressed by Dublin, although one suspects that he was staggered by the price-levels, that he disliked the Irish and particularly for their failure to observe the Sabbath in the Scottish fashion:

1. Ibid.
2. Ibid.
3. Ibid.
4. Ibid.
5. Ibid.
6. Ibid.

"... dublin is a good looking town but built of brick it seems to contain no long closes like those in the high St. glasgow the natives are odd beings all the men wear either surtouts or great coats they are good speakers there is some fine shops and the streets are covered with cars plying in all directions we were often asked: do you want a car sir: we had some fun laghing at the great coats and strange signs there is one sign in (blank) : everything necessary for the alter wher they sell crosses and other toys and next door there are cofins in the window ... we have found everything very dear and of course we are not pleased ..."

Later Young notes:

"... coals 15/- per ton in Dublin ..."

"... there are a great many bridges across the river and the streets are very clean ... we went to some library at night to get a book but we could not be taken in for less than a week which cost 1/5 so that would not do no peny a week here ..."

"... On Sunday the first thing we saw when we got out of doors was a man fishing in the river cars were plying in still shops open women crying things for sale a boy was sitting pulling in a ferry boat ..." 1

"... soda water seems in voge and we saw soda water laboratory on a sign ..." 2

During his stay in Dublin, Young went to Kingston by train, a scientific adventure which took nineteen minutes for the six miles; he also visited Phoenix Park and the Zoological Gardens. He was startled by the pace of life:

"... every beast of burden in Dublin must trot if it does not gallop coal carters horses cuddys and car horses are all the same ..." 3

Yet there were "... plenty of fellows who were lying sleeping on the pavement very soundly ..." 4

1. Ibid.
2. Ibid.
3. Ibid
4. Ibid.

The gathering of the British Association in Trinity College impressed Young by its gloominess, cliqueishness and confusion: "... there apeared to be few strangers ..."[1] The subjects which Young noted in detail generally had connections with industry or future industrial applications. During the discussions on the Miner's Safety Lamp, invented by Sir Humphrey Davy, Graham suggested that the gauze should be treated with a weak alkaline solution to improve the chances of detecting gases, but Young notes:

> "... the meting generaly thought the lamp of Davy quite safe if rightly used ..." [2]

There was also much discussion about protecting tin and iron from corrosion which Young carefully noted.

His notebook reveals his interest in the controversy about chemical notation systems:

> "Dalton gave his view of the atomic constitution of bodies especiely of gases and gave a lithographed coppy of some symbols which he proposed ... he stood up for the arrangement of the atoms which he proposed long ago ..." [3]

Graham favoured the system of the Swedish chemist, Berzelius, and this is, in fact, the one now used.[4] Steam dominated the final session:

1. Ibid.
2. Ibid.
3. Ibid.
4. A.E. McKenzie, The Major Achievements of Science, Cambridge, 1960, vol. i., p. 139., c.f. also J.G. Feinberg, The Story of Atomic Theory and Atomic Energy, New York, 1960, pp. 39 sqq.

> "... We went to the Rotunda at night and heard Dr. Lardner on the application of steam the house was crowded with fashion ..." [1]

Young's position with Graham was a combination of student, assistant and teacher. This is made clear by his own note-books and Graham's letters during this period and also by the reminiscences of his contemporaries. Lyon Playfair remembered Young as one of Graham's favourite pupils in Glasgow and as Graham's lecture-assistant in London.[2] Livingstone and several other students were taught to use tools and assemble apparatus by Young.[3] Young's own recollection was definite enough:

> "I was his class assistant for about 7 years and he depended upon me to give his lectures when he was absent or when he was ill." [4]

In a letter to his brother, William, Graham specifies this:

> "... In case I remain here, would you make a point of seeing Mr. Young and request him to begin the Practical Course, and get on with it till the end of the week, assuring the students of my return at the beginning of the week following ..." [5]

In addition to assisting Graham, Young was experimental assistant to the Professor of Natural Philosophy. The curriculum of experiments and lectures with the apparatus required each week is given in a Notebook drawn up by Young.[6]

1. Note-Book of James Young, 1835
2. T. Wemyss Reid, op. cit., p. 38 and p. 42.
3. W.G. Blaikie, The Personal Life of David Livingstone, London 1880, p. 21.
4. Chancery, Young and Others against Fdrnie and Others, 1864, Fourth Day, p. 16.
5. R. Angus Smith, op. cit., p. 41.
6. Thom Collection: Notebook of James Young, 1834, "Apparatus used in Class".

This makes it obvious that Young himself was exceedingly versatile as an experimentalist although, of course, it is well-known that the divergence between Physics and Chemistry was very small in the first half of the nineteenth century. Young was teaching the Mechanics' Class Practical Chemistry and Experimental Physics - and the class and its committee thought sufficiently highly of him to give him a glowing testimonial when he left with Graham:

> "... The experiments illustrative of the lectures on Chemistry and Natural Philosophy have, for several sessions, been almost entirely conducted by Mr. Young; and this Committee scarcely think it possible that he can be surpassed as an experimenter ..."

The session previously, Young was presented with an inscribed silver watch with a centre second hand as a mark of his students' appreciation. He made pencil notes for a formal reply:

> "I have endevored to do my duty and science expects every man to do his duty I am happy sir to see the labours of you and your Commitee crowned with such amazing success ..."
>
> "... but now sir through the exertions of an active com a class has been formed the like of which I often wished but seldom dared to hope for but now Sir I must say my dreams have been realised you have formed a mecanicks class which for numbers has seldom been eqaaled and what is far better for dilligence stands unrivaled ..."

1. Andersonian Library MSS. Testimonial from his students on James Young's excellence as a teacher, 28th June 1837.
2. The inscription was:
"Presented to Mr. James Young, Assistant in the Natural Philosophy Department in the Andersonian University by the Students attending the Mechanics Class, for his diligence and ability in facilitating their studies. Glasgow, 26 April, 1836."
3. In Notebook of James Young, 1835, "Irish".

If his students were well-pleased with Young, he was equally impressed by them:

> "... many who now attend the Mecanicks class will soon shine forth by applying there knowledge for the benefit and comfort of there species ..." [1]

Apart from his income from teaching and assisting Graham, Young also gained from his practical ingenuity. He was making amd selling electrical apparatus and vacuum flasks. For example, he had commercial contacts with the Gorbals Popular Institution.[2]

One early example of Young's practical ability was his construction in February, 1836, of a miniature galvanic battery consisting of a dozen small double zinc plates.[3] This was the model for a larger battery - Young's first invention - which was made for Professor Graham who demonstrated it to the Glasgow Philosophical Society.[4] One of Britain's greatest scientists, Dr. Michael Faraday had been experimenting with a new type of battery from the summer of 1834;[5] Graham intended to write to him about Young's design which was an improvement on Faraday's model. However, Young, on 11th March, 1836, wrote directly to Faraday because Graham was "... at present confined to bed by an attack of inflamation of the eyes."[6]

1. Ibid.
2. Ibid.
3. Notebook of James Young, 1834-42, 8 February, 1836.
4. Ibid., 10 February 1836
5. Bence Jones, Life and Letters of Michael Faraday, vol. ii., p. 44, London 1870.
6. Notebook of James Young, 1834-42, 11 March 1836.

One of Young's friends took this letter and a copy of Young's battery to Faraday. Not that Young expected much from this:

> "... the improvement, if there any such be, may seem unworthy of notice by you but as you know every one is partial to the child of his own imagination ..." [1]

However, Faraday wrote a reply which reached Young on 22nd April, 1836[2]; its exact terms are not known, but it was sufficiently encouraging for Young to continue his series of comparative experiments which became the basis for a paper in the Philosophical Magazine. In particular, Young compared the operation of his battery with that of Faraday:

> "... the disinge ... is to find out the exact relation of my battery to other forms ..." [3]

The episode is not merely significant for demonstrating Young's practical ingenuity, although this attribute is undoubtedly of prime significance in the character of an industrial entrepreneur. Young's care in comparing his own work with others, in detecting the resemblances and differences between his own battery and that of others was indicative of his whole character and future success, for the viability of of any future patent was dependent upon this kind of conscientious application, upon the recognition of the work of others and the ability to state objectively the specific improvement made.

1. Ibid.
2. Ibid.
3. Ibid.

Young had developed the necessary personal attributes and techniques of the would-be successful patentee.

When Young moved to London with Thomas Graham he met Michael Faraday at the Royal Institution. Faraday was interested in Young's use of Thilorier's apparatus for producing liquid and solid carbonic acid and asked Young to give him a practical lesson in preparing liquid carbonic acid. During a visit to University College laboratory in 1838 Faraday had asked Graham for the loan of this apparatus and on that occasion Young must have offered to show Faraday how it worked.[1] According to Young, Faraday was testing a theory that all metals would become magnetic if their temperatures were low enough - carbonic acid was a useful cooling agent. Young, therefore:

> "... spent a long evening at the Royal Institute laboratory, "

but Faraday's experiments with cobalt and manganese were not successful.[2]

Young's experience in the Andersonian and at University College, London, was valuable because it enabled him to complete his own education. He acquired a thorough theoretical knowledge of the modern trends in chemistry and physics; he was becoming an experienced experimentalist as his notebook

1. J.H. Gladstone, Michael Faraday, London, 1873, pp. 132 sq. c.f. also T. Martin, (ed.) Faraday's Diary, 1820-62, vol. iii, 1836-39, London, 1933, p. 280, 17 May1838; "Graham has lent me Thilorier's Carb. acid apparatus..."
2. Ibid., c.f. also M. Faraday, Experimental Researches in Electricity, vol. ii., London, 1844, pp. 223 sq.

on practical chemistry (1834) reveals - but he had no related industrial experience. However, he did not lack interest in practical applications of science, bub merely opportunities for applying his talents.

Gradually, he became dissatisfied with his position under Graham and eventually, he decided to go into industry. This course was not suggested to him by Graham, as has been stated elsewhere.[1] On 19th October, 1838, he made the decision to leave Graham and to join James Muspratt's chemical firm.[2] One can be firm about the details of this because the same day Young wrote a letter to his mother in which he outlined the main course of events:[3]

> "... I sit down to write this very much excited Mr. Graham and I have almost jarred I am going to leave him and he seems not pleased at it ..." [4]

Apparently, Muspratt had earlier attempted to woo Young from Graham without success. His sons, Sheridan, who had been with Graham and Young in Glasgow, and James, were laboratory students in University College. It was through James Muspratt junior that the offer was made: £140 per annum and a house. The promise of a job with a house must have been particularly attractive to Young since he had only just married.[5]

1. R.J. Forbes, Studies in Early Petroleum History, p. 186; quoting E.M. Bailey, The Young Memorial Lecture, 1948, printed in parts in Institute of Petroleum Review, London, 1948, II, pp. 180-183, 216-221, 249-252, 357-360.
2. For the career of James Muspratt (1793-1886) see J. Fenwick Allen, Some Founders of the Chemical Industry, London, 1906, pp. 69-100.
3. Andersonian Library MSS, Letter from James Young to his mother, 19 October 1838.
4. Ibid.
5. Young married his cousin, Mary Young on 21st August 1838.

However, when Young told Graham of this offer he said that Young should hold out for £200 a year "... and made out of the door rather fast ..." [1] On 19th October, 1838, Muspratt Senior arrived in London and heard from his son what Graham had said. Muspratt, generously offered to allow Graham to fix Young's starting salary and said:

> "... he would wait till Mr. Graham could conveniently let me away ..." [2]

Graham, however, was most loth to lose Young and refused to take any part in these negotiations. But Young pressed him for a definite reply without success. Muspratt senior interviewed Young later that day and was clearly impressed:

> "... he said I was the very person that he wanted ..." [3]

He intended Young to be manager of his new Newton chemical works; he wanted an experienced scientist because he thought it:

> "...would have saved him five thousand pounds that had been spent on a bad patent while he was away ..." [4]

Young agreed to leave Graham and join Muspratt at the end of the academic session 1838/9 i.e. about the beginning of May, 1839. Muspratt agreed:

> "... to wait any time for me ..." [5]

But Young was fearful:

> "... I hope Mr. Graham wont try to spoil it ..." [6]

1. M.S. Letter, James Young to his mother, 19 October 1838
2. Ibid.
3. Ibid.
4. Ibid.
5. Ibid.
6. Ibid.

Apparently, Graham became reconciled to Young's departure:

> "... he (Graham) was boasting at the dinner last night that I was going to the largest Chemical work in the World so I supose all is right ..." [1]

It was not that Young could not have obtained promotion in academic life. The new college for Civil Engineers being mooted in 1839 - and later settled at Putney - had a vacancy for a Professor of Chemistry; but Young sent the prospectus to his friend Dr. Robert Campbel of Kent Street, Glasgow, and enjoined him to apply for the post, assuring him that Young and his acquaintances would forward his application with every means in their power.[2] Young was not merely leaving Graham; he was leaving academic life. Unlike many academics - Michael Faraday, for example - who disliked the whole idea of an industrial career, Young seems to have welcomed the opportunity; "Trade" was not for him,

> "... vicious and selfish ..." [3]

Young left London a few days after 16th April, 1839, when his letter to Campbel was written.

1. Ibid.
2. Andersonian Library MSS, Letter from James Young to Dr. Robert Campbel, 16 April, 1839, written on the reverse of the "Synopsis of the Course of instruction at the College for Civil Engineers."
3. This was Michael Faraday's view.

3. James Young in Lancashire (1839-1851)

James Young spent four and a half years as manager of Muspratt's chemical works[1] and lived for most of this time in the appropriately named Alkali Cottage,[2] Newton-le-Willows, on the outskirts of St. Helens. There James Muspratt had moved after he had fought and lost a legal action regarding pollution with the Corporation of Liverpool in 1838.[3] Muspratt's firm was in the early stages of reorganisation, for his soda-making works at Newton had to be greatly enlarged as a consequence of the move from Liverpool. Young, therefore, was able to avail himself of the opportunity to become an expert on plant lay-out, an experience likely to be of great value to him later. He undertook responsibility for designing large acid tanks, kilns and even the new chimney, over 300 feet high, containing three and a half million bricks and, according to newspaper reports, costing about £7,000.[4]

The St. Helens area provided a steady market for the products of the alkali works: there were local glassworks and copper smelting shops; in Liverpool there were soap firms;

1. Binney and Company against The Clydesdale Chemical Company, Edinburgh 1860, Evidence of James Young, p. 83.
2. Young's pocket book and diaries of the period 1840-1843 bear this address.
3. T.C. Baker and J.R. Harris, A Merseyside Town in the Industrial Revolution, St. Helens, 1750-1950, Liverpool 1954, p. 231.
4. A cutting dated 1857 in Young's Scrapbook gives these details. Muspratt was again sued by local landowners in St. Helens for damage to trees, fields, and crops caused by chemical effluents. In 1857 the works - and the chimney - was finally demolished. C.f. also L.F. Haber, The Chemical Industry during the Nineteenth Century, Oxford, 1958, p. 20, and J. Fenwick Allen, op. cit., p. 87.

throughout the area - but especially near Manchester - there were textile finishers, dyers and printers. Young was able to learn the business from an outstanding entrepreneur for Muspratt had virtually founded the Lancashire soda industry. Muspratt employed Young to perform a variety of functions now normally highly specialised. Apart from plant design, Young's duties at Newton included responsibility for production, costing, sales and marketing, stores and raw materials, labour relations and wages, research and pilot plant inspection. The financial responsibility was very great - the wage-bill alone in the spring and summer of 1841 was averaging £70 per week.[1] James Muspratt used Young as a watch-dog for new processes and technical developments: when, in 1838-40, Harrison Grey Dyar and John Hemming began their pilot-plant in Whitechapel for the ammonia-soda process, Young and Sheridan Muspratt went to inspect it.[2] But although James Muspratt spent £8,000 on this project and Young superintended the work, the Leblanc process was not superseded.[3]

Young also continued his interest in electrolysis and did research into the manufacture of ammonia and salts of ammonia. In 1841 he took out a patent for the production of[4] ammonia, an industrial application of his earlier work with carbonic acid in Graham's laboratory. Whether this earned Young much financial return is not known, but it certainly

1. Thom Collection: Pocket Book of James Young, 1841, Wages paid 17 April to 23 July.
2. L.F. Haber, op. cit., p. 88 and J. Fenwick Allen, op. cit., p. 88.
3. J. Fenwick Allen, op. cit., pp. 169-170.
4. British Patent No. 9156, 11 November 1841.

provided him with valuable experience in patent formulation. Young became more and more familiar with bleaching liquors containing ammonia, although he probably was not directly acquainted with those produced in gasworks by dry distillation of coal. Yet he would find few problems in turning his attention to the by-products of coal. He also learned much about the refining uses of sulphuric acid; this was to be very useful to him later.

James Muspratt was not an easy master to serve. James L. Gibb, one of Young's correspondents, thought:

> "... It will certainly be difficult for you to bear his whims and ebullitions of temper much longer ..." [1]

Young thought it best to seek an opening elsewhere, if possible as an independent manufacturer or industrial consultant. But he wanted "... to have all scores cleared up ..." with Muspratt before taking his departure.[2] Young has the qualities of success, according to Gibb:

> "... I have not the slightest doubts of your success, for without flattery I reckon you in complete possession of the two principal requisites, caution and perseverence. The want of either would be alike fatal to anyone about to take the proposed step ..." [3]

1. M.S. Letter, James L. Gibb to James Young, (no date, but probably December 1843)
2. Ibid.
3. Ibid.

From Gibb, Young gained more than encouragement. He received very valuable information from time to time about the prevailing prices of dyestuffs and bleaching agents and new processes.[1] Young was clearly able to make useful contacts.

Young also learned the importance of considering labour relations during his time with Muspratts. The infant chemical industry, for the most part, had many labour problems especially among unskilled labourers required to handle bleaching powders and liquors in bulk. Young knew that:

> "The liquor gives less trouble to the workmen therefore they wish to use it in preference to powder ..."[2]

What the workmen wanted was also what was economically desirable since, although bleaching liquors were not so concentrated as powders, their selling prices were relatively higher. Young thought it best to establish a new plant to specialise on bleaching liquors and acids.[3]

In fact, he joined Tennants, Clow and Company on 12th January, 1844.[4] From December, 1838, there was close liaison between all the soda-makers in Britain and Tennants and Muspratts were the leaders of the ring in Lancashire.[5] These two firms had their main contact via the Liverpool office of

1. There are several letters from Gibb in the Thom Collection. Unfortunately, few are dated.
2. Thom Collection: M.S. Memorandum on Advantages of bleaching liquor over powder, (in Young's hand).
3. Ibid.
4. Thom Collection: Pocket Book, 1844-45, inside fly leaf. Young's later statement, that he joined Tennants in 1843, was not made with any certainty (c.f. Binney and Company against the Clydesdale Chemical Company, 1860, Evidence of James Young, p. 84.)
5. T.C. Barker and J.R. Harris, op. cit., pp. 253 sq.

TABLE 1

JAMES YOUNG'S INCOME FROM TENNANTS, CLOW AND COMPANY 1844-52

	Time Interval	Income
1	31 January 1844 - 31 January 1845	£306
1	31 January 1845 - 31 January 1846	£331. 15. 9.
2	31 July 1849 - 31 July 1850	£1,241. 7. 9.
2	21 July 1850 31 July 1851	£1,052. 3. 2.
2	31 July 1851 31 January 1852	£337. 17. 6.

Sources:

1. Pocket Book 1844
2. M.S. Balance Sheet, 1850-1852

Tennants.[1] Young, therefore, probably, had opportunities for making contacts with Tennants before he left Muspratts. Tennants, Clow and Company was the Lancashire subsidiary of Tennants of Glasgow. In 1837 Tennants had leased the works at Ardwick Bridge, Manchester, and bought the business of Edward P. Thomson and this was the basis, together with their sales office in Liverpool, of the Lancashire subsidiary.[2] With their main works at St. Rollox alone producing 10,000 tons of various alkalis per annum in the 1840s, the Tennant group of companies was an outstanding European chemical firm.[3] Theirs was a rapidly expanding enterprise with progressive policies: they were prepared to make heavy capital investments in research and production; they had foreign as well as home sales offices; they employed commercial travellers whom they assisted by judicious advertising.[4] The managerial and executive staff of the Tennant Companies were generally well-paid even by the standards of their most affluent contemporaries in the chemical industry. They were often allowed to patent any processes devised by them but worked by the firm; the selected few also shared in any rise in profits by a bonus system.[5] Young certainly gained financially, and in many other ways, when he left Muspratts.

1. L.F. Haber, op. cit., p. 16.
2. E.W.D. Tennant, One Hundred and Forty Years of the Tennant Companies, 1797-1937, pp. 55 sq.
3. L.F. Haber, op. cit., p. 15
4. E.W.D. Tennant, op. cit., passim.
5. See Tables of Young's Income, 1844-1851.

Young was works manager at Ardwick Bridge until August, 1851,[1] but he travelled throughout Britain as a consulting chemical engineer for all the Tennant companies. Tennant, Clow and Company concentrated on dyestuffs and bleaching agents although they:

> "... were general chemical manufacturers ..." [2]

However, the main products were sulphuric, nitric and hydrochloric acids, caustic soda, chlorine, saltcake, and colouring agents, such as Prussian blue and green, red, yellow and orange dyes.[3] Young, himself, also undertook business consultancy mainly for customers of Tennants. From the beginning he seems to have belonged to a privileged "sub-contracting" group; the transition from this group to independent entrepreneurial status was not really an occasion for surprise. Young's assistant, William Gossage, for instance, also established his own firm in Widnes,[4] just after Young left Tennants.

Young's experience with Tennants was valuable to him for many different reasons. He learned the importance of sound investment in production, the value of economies of scale, the importance of initiative and drive in sales promotion and the need for personal contact with agents and customers. He lived well within his income and was able to accumulate capital.[5]

1. Binney and Company against The Clydesdale Chemical Company, 1860, Evidence of James Young, p. 223
2. Fernie and Others against Young and Others, (House of Lords), 1864, Evidence of James Young, p. 223.
3. E.W.D. Tennant, op. cit., p. 57.
4. Ibid., p. 58.
5. His Household Expense Book, 1844, for instance, reveals that he was spending about £2 per week when his basic salary was £300 p.a.

He was not parsimonious - indeed, he lived well - but he had a fetish for accounting for small sums, the cost of a paper or even a shave! This attitude of frugality and thrift was to serve Young well, for it enabled him to establish a credit-worthy reputation, the most vital attribute of the budding entrepreneur. It is some sign of his financial status that, just after he joined Tennants, Young took out an insurance policy for £999. 19. -. with an annual premium of £28. 9. 9d.[1] The significance of this investment was its security value to would-be partners or investors.

Young in the period 1844-48 gained valuable experience on the Stock Exchange in Liverpool and Manchester playing the share market for himself and acting in consort with senior members of Tennants. On 30th September, 1845, Young put out £300 in shares of the Manchester-Birmingham Railway Company,[2] possibly in the hope of gain in the likely event of a take-over. In October, 1845, Young was buying shares for J.C. Tennant - and they cost him more than he expected. Nonetheless, his client was satisfied:

> "... I wish to God the shares had only cost you the 200£ but as you have got poked into the high prices we must just make the best of it & stick to the devils like a burr. There are hundreds with you in the same boat ..."[3]

1. I am grateful to Miss A. Thom for allowing me access to this and many other items. This insurance policy, taken out with the Scottish Widows' Fund and Life Assurance Society on 6 November, 1844, was altered on 16 December, 1844, because Young, unwittingly, had given the wrong date of birth.
2. M.S. Letter, C.C. Tennant to James Young, 30 September 1845
3. M.S. Letter, J.C. Tennant to James Young, 10 p.m. 14 October, 1845.

These dabblings in railway shares increased Young's capital and the value of his financial security, but more than this, he gained additional business experience.

Of course, Tennants thought of James Young as an outstanding chemical engineer not as a financier. He was given very much a free hand in the experimental work which he undertook. However, he was asked to design improvements in the plant at St. Rollox;[1] he did sample analyses of a variety of industrial chemicals; he was constantly engaged in the hurly-burly of plant management. This led him to cost existing processes and compare his results with those of competitors. Such cost accountancy was usually the stimulus to new processes or improvements in existing methods of production. For instance, in 1844, he produced a new indigo dye at 4¼d per lb after costing the existing dye.[2] Later, in 1847-48, he improved the process for the production of copper sulphate after doing the costing arithmetic of existing processes.[3] He tried to interest dyers and printers in the firm's old and new products. He noted in his pocket book at the end of 1844 that when he was in Glasgow he must "... try the Turkey-red dyers with bichloride of tin ..."[4] He also surveyed districts of the British Isles likely to be suitable as potential sites for new chemical works or possible sources of raw materials. In particular, in 1848,

1. M.S. Letter, C.T. Dunlop to James Young, 6 October 1845
2. Thom Collection: Pocket Book of James Young, 1844
3. Thom Collection: Pocket Diary of James Young, 1847-49
4. Thom Collection: Pocket Book of James Young, 1844

he surveyed South Durham and North East Yorkshire, taking into account the cost of labour, fuel, transport, and local raw materials.[1] He reported in favour of the Middlesbrough area, where there has been great expansion of the chemical industry in the twentieth century.

Young produced several processes particularly valuable to Tennants. In 1847 he produced red and yellow prussiate of potash and soda by roasting horns and hooves on red-hot iron plates. This process was only superseded when cyanide extraction became commonplace at gasworks.[2] In 1848 he patented a process for improving the manufacture of stannate of soda and potash.[3] This process was worked by Tennants, and Young received one third of the profits as his royalty.[4] In drawing up his patent - and its specification - he was careful to engage professional assistance: J.C. Robertson and Company, a Patent and Design Registration Office, of 166 Fleet Street, London, did the main work while Young and Lyon Playfair revised their drafts.[5] Thus, the wording of the patent was exactly precise:

> "... the materials used in dyeing and printing to which my said Invention relates are the stannate and stannite of soda, the stannate and stannite of potash and other analogous preparations of tin ..."[6]

1. Thom Collection: Pocket Diary of James Young, 1847-49
2. E.D.W. Tennant, op. cit., p. 59.
3. British Patent No. 12,359, 9 December 1848
4. M.S. Balance Sheet: James Young in account with Tennants, Clow and Company, 1 July 1850 - 3 May 1852.
5. Thom Collection: Draft of the specification, "Improvements in the preparation of certain materials used in dyeing and printing," endorsed "Dr. Playfair & Revise £3. 3."
6. Ibid.

The market for these products was likely to be extensive. In the Glasgow district Young was assured that, provided the price was right, there would be considerable sale; what was wanted was a definite pricing policy and a few tons available in the area to be used for samples.[1] On the continent there were even better prospects since Tennants had a works in Rouen. By October 1849 Young's "Prepare", as it was called, had been subject to trials and been proved successful in Mulhouse, the main centre of the Alsatian cotton industry. The Swiss printers in Basle, where ribbon weaving and dyeing were specialities, were also likely to use Young's "Prepare", if he were to arrange delivery of samples to Tennants' "... correspondant there ..."[2]

In Lancashire there were problems involving patent rights. Several others had made improvements similar to Young's - but their patents did not stand. One of them, Thomas Rowlandson, a Liverpool chemist, had assigned part of his letters patent to Young on 22 November, 1849,[3] and this strengthened Young's hand against the others. Tennants were being sued by John Greenwood, John Mercer, and John Barnes conjointly; on 8 November, 1849, their solicitor, G.B. Withington, complained that Tennants, Clow and Company had infringed his clients' patent rights:

1. M.S. Letter, Charles Maclean to James Young, Glasgow, 20 July, 1849.
2. M.S. Letter, Rudolph Heilman to James Young, Mulhouse, 14 October 1849
3. Thom Collection: Draft Assignment from Thomas Rowlandson to James Young, 22 November 1849

> "... by manufacturing and selling Stannate of Soda in a dry state or in crystals which you call Young's Patent Prepare ..." [1]

In 1845, Greenwood, Mercer and Barnes had taken out a patent,[2]

> "for certain improvements in the manufacture of certain chemical agents used in dyeing and printing cottons, woollens and other fabrics,"

and this was the basis for an action in Chancery in November, 1849. In fact, this action failed, and Young's Patent Prepare was produced and sold until the patent expired.

Young had secured a French patent[3] in August, 1849, but there was considerable evasion which he found it impossible to stop. After some effort the major part of his patent specification was accepted in the United States in August, 1850, but some parts of it had to be abandoned

> "... partly on account of a portion ... being old or the principles well understood, and partly by reason of the imcompleteness of a part ..." [4]

Despite these difficulties, Young's experience with this minor patent was exceedingly useful. The practical value of employing experts to formulate and register his patent was proved beyond all doubt. Young had gained valuable insight into patent law and its evasion. His legalistic sense of caution could not but become more and more pronounced. Rather that he should first have these problems posed with stannate of soda than with his major paraffin patent. His later success

1. M.S. Letter, G.B. Withington to Tennant, Clow and Company, 8 November 1849
2. British Patent No. 10,757, 8 July 1845
3. Brevet d'Invention, No. 8738, 8 August 1849
4. M.S. Copy of letter from I.P. Prisson to J. C. Robertson and Company, New York, 31 August, 1850.

TABLE 2

INCOME FROM STANNATE OF SODA

	Time Interval	Income
1	July 1849 - July 1850	£941. 7. 9.
1	July 1850 - July 1851	£712. 1. 6.
1	July 1851 - January 1852	£267. 5. 8.
2	July 1852 - January 1853	£596

Sources:

1. M.S. Balance Sheet, 1850-1852
2. M.S. Letter, R. Heilmann to James Young, 23 February 1853

at law must be seen against this early background of patent problems. Economically, Young gained in two ways. First, this minor patent provided the opportunity for useful experience in managing and marketing the product of a small process. Secondly, it was a source of income and capital which could be used to float other entrepreneurial activities.[1] Thus, he became less and less dependent upon his basic salary from Tennants and more and more capable of establishing his own business.

Young gained more than industrial and financial experience in Lancashire. He took an active part in the political, social and intellectual life of the area. Like his first employer, James Muspratt, like Thomas Graham, his teacher, like his life-long friend, Lyon Playfair, like his future partners, Edward Meldrum and E.W. Binney, Young was, and remained, a radical, a left-wing Liberal. His experiences in Newton-le-Willows, in Liverpool and in Manchester - not to mention his early life in Glasgow - led him to consider the condition and welfare of the working classes. His view was that public health was the most important social problem of these rapidly growing urban communities. Well before the germ theory of disease had any wide following - or indeed, any following at all - Young recognised that:

1. See tables of Young's Income, 1844-52

TABLE 3

YOUNG'S BALANCES WITH TENNANTS

Date	Balance
1 February 1850	£ 6. 4. 7.
31 July 1850	£942. 13. 2.
31 January 1851	£870. 11. 1.
31 July 1851	£955. 16. 3.
31 January 1852	£495. 13. -.
3 May 1852	£281. 18. -.

Source:

M.S. Balance Sheet 1850-1852

> "... Our great sanitory problem, the solution of which has occupied much attention, is the prevention of decomposition in organic accumulations in towns ..." 1

Costs were "a barrier to the adoption of any general plan." 2

Young was nothing if not practical. But he felt that science should be used to improve the condition of all men and not merely applied to develop the financial power of any single group. He produced a cheap deodoriser using chloride of manganese, a waste product of the chlorine process.

> "... Several cesspools, and other places which gave out the most putrid odour, having been almost instantaneously sweetened by its application, an effect heightened by a small quantity of free chlorine, which this liquor contains ..." 3

He described the chemical reaction of this waste product applied to urban cesspools:

> "I need scarcely describe to chemists the action of this salt, the principal effect being, that the chlorine combines with the ammonium of the sulphuret of ammonium, and the manganese combines with the sulphur, thus forming chloride of ammonium and sulphuret. The former being in a floculent state, will readily supply sulphur or sulphates to vegetables ..." 4

Young estimated that production of this waste product was not less than 150 tons per day or "5½ lbs per annum for each individual". Young was convinced from his experiments carried out in the summer of 1847 that this was

> "... more than sufficient to deodorize all the cesspools in Great Britain..." 5

1. James Young: "On the Deodorization of Manures," 14 December 1847, in Memoirs of Manchester Literary and Philosophical Society, vol. viii., Manchester 1848, p.446
2. Ibid.
3. Ibid., p. 447
4. Ibid., p. 448
5. Ibid.

Young was typical of many other young radicals in Lancashire when, in 1844, he joined the Anti-Corn Law League.[1] He was different, however, in that he became so dissatisfied with the milk and water liberalism of the Manchester Guardian that he helped found the Manchester Examiner[2] under the editorship of Thomas Ballantyne. He also joined the Manchester Mechanics Institute,[3] and later, became a member of the Literary and Philosophical Society.[4] He was a great believer in the social force of organisations and voluntary societies. According to Angus Smith,[5] before Young was elected to the Literary and Philosophical Society, he had formed a chemical society of about thirty members; in the summer they met in country places, had tea together and held their meetings in country inns. "... Some of the meetings were very pleasant ..." This society became the first section of the Literary and Philosophical Society; with Angus Smith as its first Secretary. After Young's departure from Manchester it seems that this chemical section fizzled out.[6]

1. In the Thom Collection there is a receipt for Young's subscription of £1 dated 2 September, 1844
2. R. Angus Smith, A centenary of Science in Manchester, London 1883, p. 348 n.
3. In the Thom Collection there are two subscriber's tickets in Young's name, the first dating from 29 September 1844
4. Complete list of the Members and Officers of the Manchester Literary and Philosophical Society, 1781-1896, Manchester 1896, p. 39.
5. R. Angus Smith, op. cit., p. 348
6. Ibid.

The most important episode in the life of Young's Manchester Chemical Society occurred during the Corn Law Crisis in November, 1845, when the potato blight was at its height and famine imminent not only in Ireland but also in industrial Lancashire. A sub-committee of the Literary and Philosophical Society was appointed to experiment:

> "for the purpose of ascertaining how far chemical agents could be used in averting the disease ..." 1

John Thom and James Young did the experiments, and Young compiled the report. They found that potato blight could be prevented by storing the crop in a dry place and burning sulphur so that the vapour passed through the piles of unaffected potatoes. Thom had thought that sulphuric acid could be used to treat diseased potatoes, after they had been harvested; Young made a weak solution for this purpose:

> "... the committee had immersed diseased potatoes in sulphuric acid or oil of vitriol, mixed with 40 parts of water, and found that the disease had not progressed ..." 2

The scientific information was passed on to Peel, but Young's ambition was to save human beings, not to save the Corn Laws!

James Young's time in Lancashire was exceedingly creative in terms of the rest of his career. There his social and political attitudes became most definite; there he developed his concept of science as the solvent of man's environmental problems; there he took his first steps in industrial management; there he revealed his ingenuity and capacity for cal-

1. Ibid., p. 290
2. Ibid., p. 293

culating risks and taking investment decisions; there he produced his first practical improvements in chemical processes and patented them. In Lancashire existed the milieu from which the successful entrepreneur could emerge from the ranks of industrial management.

JAMES YOUNG AND THE DEVELOPMENT OF THE AGE OF OIL

"In his patent Mr. Young claims the manufacture of paraffine oil and paraffine from bituminous coals. He is the first person to obtain paraffine on the large scale and as a regular commercial operation and he is also the first to employ bituminous coals and to point out the particular advantage of using cannel or gas coal ..."

Professor Thomas Anderson :
Report on the Priority of Young's
Invention, 31 October, 1860.

James Young did not make an abrupt change from industrial management in Lancashire to business ownership in Scotland. He developed a pilot scheme in Derbyshire; this was the basis for his later partnership with Edward Meldrum and Edward William Binney to work his patent. Nor was the development of the age of oil abrupt. To understand Young's later commercial success and significance an explanation of earlier processes and uses of oil is essential. At the right time and in the right place a fortune could be made: an amalgamation of science, technology and economics would have occurred.

1. Prelude to the Development of the Age of Oil

The history of petroleum has attracted considerable attention in recent years, and the work of many eminent scholars has crystallized our knowledge. Petroleum has been used by man for thousands of years. In classical antiquity it was a basis for speculation, a curiosity, but not a fundamental source of power and light.[1] Prehistoric inhabitants in America worked oil wells, and Red Indian tribes used oils to annoint their bodies before battles.[2] In ancient China

1. R.J. Forbes, Bitumen and Petroleum in Antiquity, (Studies in Ancient Technology, vol. i., Leiden, 1955)
2. P.H. Giddens, The Birth of the Oil Industry, pp. 7 sq., New York 1938.

and in the Middle East the combustible qualities of oil made it an attractive adjunct to the art of warfare.[1]

During the centuries following the expansion of Islam natural oil seepages in the Middle East were exploited to provide fuels for light, greases and waxes for ointments and cosmetics, lubricants for primitive machinery, fluxes for cleaning silks and other textiles and for curing fine quality leather. Technical progress in refining techniques and apparatus also occurred, especially in Egypt and Syria.[2] Yet the age of oil did not occur because the commercial production of oil was not sufficiently based on science - nor did an adequate technology exist.

Important scientific and technological changes had to precede any vast expansion of oil production. Illiterate peasants in several parts of Europe - particularly in Russia, France, Alsace, Bavaria, Sicily, Northern Italy, the Tyrol, Galicia and Rumania - exploited natural seepages, tar wells and oil sands throughout the mediaeval period for cart grease, folk medicine and lamp oil.[3] But not until folk custom and usage had been rationalised as part of mineralogy and chemistry, not until the first scientific treatises on geology and min-

1. J. Needham, Science and Civilisation in China, vol. iii, pp. 608 sq., Cambridge 1959;
   J.R. Partington, A history of Greek Fire and Gunpowder, p. 28, Cambridge 1960;
   R.J. Forbes, More Studies in Early Petroleum History, pp. 70-90, Leiden 1959.
2. R.J. Forbes, A short history of the Art of Distillation, passim, Leiden 1950.
3. R.J. Forbes, Studies in Early Petroleum History, passim, Leiden 1958.

eralogy had been printed, would the opportunity occur for the advance beyond Classical or Arabic technology. The development of mechanical inventions, the evolution of scientific metallurgy based on coal and the passing of traditional societies with relatively fixed populations were all necessary prerequisites for the expansion of marketing opportunities and profit margins.

Before the nineteenth century the process of change was slow. Petroleum seepages became increasingly known both in Europe and in the New World.[1] But their uses were limited. They could inspire thoughts of other mineral wealth - encourage borings and sinkings for salt and coal;[2] they were used to impress visitors to Baku - but their economic value was slight. Oils were used as cart grease, as daub for cattle diseases, as ointment for human pains, as wood and metal preservatives, as lamp oils in local areas, as substitutes for wood-tar which was used in the dockyards for careening ships and for preventing the deterioration of cordage - and occasionally as a mollifier for the angry waters of the deep sea. But wood-tar provided for most of these purposes, and as long as charcoal remained the basis of metallurgy, wood-tar would be available in great quantities as a waste by-product of the carbonization

1. From the late eighteenth century barrels of crude oil were objects of trade between Red Indian tribes and white traders in America. P.H. Giddens, op. cit., p. 11.
2. Both in Europe and America oil was regarded as evidence of the existence of other - more important - minerals.

process. As coal was increasingly applied to industrial processes, a reflection of the shortage of timber in Western Europe and the inflation of timber prices, and as coking techniques in the eighteenth century became more efficient, charcoal was no longer a vital basic fuel except in a few, high-quality, finishing processes. Substitutes for wood-tar, particularly coal-tar and local "crudes" from oil seepages, became more and more important.

A practical interest in natural oils was well-established in Britain by the seventeenth century. Whale oil was the best of these for all purposes and the most expensive, largely because of the monopoly of the Greenland Company. Rapeseed oil, "rosin oil" made from pine resins and in the 1830s "camphene", a purified oil of turpentine, gradually developed as substitute lamp oils for the more expensive whale oil, but these were inferior in performance and occasionally dangerous if burned in some lamps. The interest in lubricants was slower to develop; the fear of corrosion of firearms and armour stimulated the first patent by John Casper Wolfen and John Miller in 1617.[1] But in the period 1630-1640 there were a number of patents for the production of lamp oils, candles, night-lights, clear-wax, and tallow from bones.[2]

1. British Patent No. 4, 1 July 1617.
2. C.f. British Patent No. 50, 21 January 1630: for making yellow wax white;
   British Patent No. 89, 18 March, 1636: for extracting tallow or other liquid substances from bones;
   British Patent No. 103, 10 February 1637: for mills for making oil for lamps;
   British Patent No. 124, 8 February 1640: for making candles and night-lights.

Artificial oils as substitutes for wood-tar were developed from 1681 onwards. In that year John Becher and Henry Serle[1] patented the manufacture of pitch and tar from coal. In 1694 Martin Eele, Thomas Hancock and William Portlock found a "way to extract and make great quantities of pitch, tarr and oyle out of a sort of stone"[2], and in 1697 Eele gave an account[3] of their operations in Shropshire, making it clear that oil-shale was their basic material. Talbot Edwards improved their techniques and in 1716 patented his destructive distillation process.[4] By that time native tar, equal or superior to Swedish wood-tars,[5] were being produced mainly for the naval dockyards. Henry Haskins, a chemist living in Northfleet, Kent, patented a process in 1746 by which a fine quality pitch was produced.[6] A strange volatile waste product, "a pale acid phlegm"[7], was also given off - and this may well have been a hydrocarbon oil like paraffin.

Prevailing scientific opinion gradually assisted the progress of invention, for the erroneous chemical theory of phlogiston concentrated scientific attention on the process of combustion and the production of gases. The volume of

1. British Patent No. 214, 19 August 1681.
2. British Patent No. 330, 29 January 1694
3. M. Eele, An account of the making of pitch, tar and oil out of a blackish stone in Shropshire, Philosophical Transactions, vol. xix., 1697, p. 544.
4. British Patent No. 405, 29 June 1716
5. Ibid., p. 1.
6. British Patent No. 619, 2 December 1746
7. Ibid., p. 2.

knowledge about oils, pitches and tars grew. Glauber in his Chemical Pharmacopeia, published in London in 1689, interested himself in the healing qualities of oils produced from coals.[1] Scientific cachet was ultimately bestowed when Diderot's Encyclopedie in 1765 carried a learned article on "pétrol".[2] The gradual replacement of the phlogiston theory by the development of quantitative chemistry in the eighteenth century,[3] the work of Stephen Hales, Joseph Black, Joseph Priestley, Henry Cavendish and Antoine Lavoisier, was even more significant for gas-making from coal was one of its many respectable applications, and from commercial gas-making the logical analysis of tars and mineral oils derived.

Before James Young's paraffin patent over 150 directly related inventions and improvements were recorded. The commercial motives of their patentees were diverse. Fewwere concerned directly with lamp oils. Some were concerned with the production of wood preservatives and careening materials such as Christian Wilhem, Baron von Haake, who, in 1772, patented his "new-invented secret art or mystery in extracting

1. J.R. Glauber, Chemical Pharmacopeia, London 1689, (translation by Packe), Third Part, p. 34.
2. This article by Chevalier de Jancourt is discussed by R.J. Forbes, op. cit., pp. 34 sqq.
3. C.C. Gillespie, The Edge of Objectivity, Princeton 1960, pp. 202 sqq.;
   A. Wolf, A History of Science, Technology and Philosophy in the Eighteenth Century, London 1938, Chapter 13 passim;
   C. Singer, A Short History of Scientific Ideas to 1900, Oxford 1959, pp. 332-341;
   For an interesting, if idiosyncratic, analysis of the work of these scientists, vide. J.D. Bernal, Science in History, London 1957 (2nd Edition), pp. 444-452.

and making from a certain mineral several compositions called Mineral Tar and Mineral Oil .."[1] These liquids were distilled from coal, and by-products such as vitriol and salt petre were also produced.[2] In Scotland the Earl of Dundonald in 1781 distilled coal at Muirkirk[3] and in 1785 he secured an Act of Extension of 20 years for his patent which was adjudged to be in the national interest.[4] Dundonald's efforts were noted and commended in the first Statistical Account of Scotland.[5] John Crooks, an Edinburgh chemist, patented a process in 1799[6] for distilling schists, similar materials to those used by Young at Bathgate and Addiewell in the 1860s. But Crooks was interested only in soap-making, bleaching solutions and insecticides - and not at all concerned with lamp oils or lubricants.

Most of the patents earlier than Young's only incidentally referred to oils and were mainly concerned with gas-making. Thus, oil's greatest competitor in the nineteenth century in the field of domestic lighting became an assistant to the emergence of the techniques of the oil industry. Typical of this tradition were the patents of Frederic Albert[7]

1. British Patent No. 1015, 28 August 1772.
2. Ibid., p. 1.
3. British Patent No. 1291, 20 August 1781.
4. Dundonald's extension dated 1 June 1785, was later added to British Patent No. 1291.
5. J. Sinclair, The first Statistical Account of Scotland, Edinburgh 1793, vol. ix., pp. 278-280.
6. British Patent No. 2342, 14 October 1799. Earlier in 1797 Crooks had patented a process for making soaps from fish waste.
7. British Patent No. 2764, 18 May 1804; British Patent No. 3200, 7 February 1809.

Winsor, a London merchant who, in 1804 and in 1809, patented "an improved oven, stove or apparatus" in which fuels were broken down into gas, oil, pitch, tar and acids, leaving coke. This process was used to provide gas-lighting for Pall Mall. Eventually, Young was to use a common gas retort in which he distilled coal to produce paraffin oil.[1]

Several gas engineers came close to Young's invention. In 1837 Jean Baptiste Mollerat patented "an improvement or improvements in the manufacture of gas for illumination" and this process used an oil-bearing schist.[2] Michel Antoine Bertin, Baron de Buisson drew up a specification in 1845[3] which was used by Young's opponents in their unsuccessful attempts to break his patent. At his extensive works in Autun where he was part-owner and plant-manager, du Buisson used bituminous schists which were broken up into "pieces not larger than half the size of a man's hand", allowed to dry before being put into a hopper and heated to a "very high temperature", when distillation, first of water and then of oil and water, began.[4] Several products were obtained: gas, part of which was used for lighting the works, a pure light lamp oil, and paraffin wax which was obtained "by crystallization"; but

1. Fernie and Others v. Young and Others, House of Lords, 1864, Evidence of James Young, p 231.
2. British Patent No. 7358, 2 May 1837.
3. British Patent No. 10726, 22 December 1845.
4. Ibid., p. 9.

> "... the presence of this substance is scarcely perceptible in raw oil of petroleum, bituminous stone, asphalte or other bituminous substances; it is in schistus that it is contained in the largest proportion. I always leave the parrafine in the fat oil ... in order to render it of better quality ..." [1]

The fine oils were used as lamp oil while the heavier oils were sold as lubricants. Tar, soap, sulphate of ammonia, and "manure" (i.e. fertilisers) were also produced.[2] Paraffin crystals could be obtained if desired - du Buisson did not normally separate the paraffin - and these could be processed for candle-making.[3] Du Buisson's patent was the basis for the establishment of a short-lived oil company at Wareham in the 1840's.[4] His patent did not, however, specify 'coal' as a raw material; Richard Butler's earlier patent of 1833 was similarly invalidated at law;[5] upon this point Young's later patent stood firm.

Before anyone could make a fortune from lamp oil, lamps had to be improved. Lamp design until the end of the eighteenth century was primitive. Vegetable and fish oils were the normal fuels, and these supported poor unstable and smoky flames. Domestic accidents were very common. The process of combustion

1. Ibid., pp. 11 sq.
2. Ibid., p. 13.
3. Ibid., pp. 18 sq.
4. Young v. Fernie, House of Lords 1864, Appellants' Appendix, pp. 100 sq.
5. British Patent No. 6375, 1833.

and the nature of gases were not generally understood, although in 1775 Priestley had isolated oxygen, and five years later Lavoisier had named it and thoroughly explained its part in the combustion process. Practical men with scientific training in this new knowledge of the properties of oxygen were able to begin the solution of the problem of lamp design. Significantly, it was an acquaintance of Lavoisier and the Montgolfiers who made the break-through. His name was Francois Pierre Ami Argand,[1] who, in 1782, demonstrated a lamp that had an adequate, adjustable air supply. He realised that the weaknesses of existing lamps could be solved by providing a cylindrical adjustable wick with a central air supply, thus allowing an adequate flow of air to the flame and eliminating the tendency of existing lamps to smoke. The Argand lamp was patented in Britain in 1784,[2] but both in France and Britain many pirate designs appeared, and Argand's patent rights were disregarded. He died a bankrupt in 1803.[3]

The most outstanding lamp of the eighteenth century was the Carcel lamp invented in 1800 by Guillaume Carcel (1750-1812).[4] This lamp had a pump mechanism which pumped oil from the reservoir below the wick into the basin where the wick rested

1. The best short account of Argand's life is to be found in S.T. McCloy, French Inventions of the Eighteenth Century, University of Kentucky 1952, pp. 52-56.
2. British Patent No. 1425, 3 July 1784.
3. R.J. Forbes, More Studies in Early Petroleum History, Leiden 1959, p. 111.
4. S.T. McCloy, op. cit., p. 56.

so that a small pool of oil always lay about the wick. The regularity of the oil supply ensured an intense light and a complete absence of wick carbonization. The brothers Girard improved this lamp in 1807, but since all such lamps were expensive there was no great sale. Further improvements occurred in English lamps which adapted these erstwhile French principles. John Barton patented a lamp "with wick constantly supplied with oil from a reservoir below the frame" in 1809;[1] his design was a pirate version of the Carcel and Girard lamps. After the Napoleonic Wars there were several attempts to produce a cheap lamp. Thomas Allingham in 1818 turned out "the economical and universal lamp"[2] which sold well, but was really a less expensive, modified Argand lamp.

From 1820 onwards Read Holliday, a Huddersfield chemist, was making and selling lamps but with no great success until the 1850s. The Holliday lamp had a conical reservoir and a remarkably efficient burner.[3] This lamp and the Argand lamp were both used in experiments by James Young.[4] On the continent Franchot's "Moderator" lamp was introduced in 1836;[5] this lamp had a movable rod which rigorously controlled the flow of oil to the wick and was the subject of many improvements, espec-

1. British Patent No. 3272, 2 November 1809
2. British Patent No. 4228, 19 February 1818
3. Holliday patented his lamp by British Patents No. 12015, 5 January 1848; and No. 12965, 11 February 1850
4. Thom Collection: Pocket Book of James Young, 1851-2
5. R.J. Forbes, op. cit., p. 111.

ially by Neuberger in 1854.[1] Indeed, the 1850s was the first decade of cheap efficient lamps. This was a fortunate accident for James Young.

The development of a scientific candle-making industry was also an aid to Young's success. Hand-made candles were very expensive and inclined to lose their shape; their wicks required regular snuffing; this was a common source of irritation. As early as 1787 William Cooper, a Sheffield tallow chandler, patented a machine for making twisted cotton wicks[2] - but Cooper had no great commercial success for the mass production of candles needed to develop first. However, in 1801, a water closet maker in Marylebone, Thomas Binns, invented a casting process for candles,[3] the important beginning of a series of improvements which, by 1855, had thoroughly mechanised the candle industry.[4] In 1823 Chevreul obtained stearine by removing the glycerine from tallow, and within ten years Edward Price and Company of Battersea were marketing stearine candles.[5] Paraffin wax was an improvement on stearine, if it could be produced cheaply. Yet another opportunity for diversification of production was occurring to James Young.

1. Ibid., pp. 111 sq.
2. British Patent No. 1619, 11 August 1787
3. British Patent No 2488, 23 April 1801
4. R.J. Forbes, op. cit., p. 145
5. Ibid., p. 146.

The field with the largest immediate rewards was that produced by the development of a European machine tool industry, a necessary consequence of the "Industrial Revolution". Animal fats, fish and vegetable oils were acquiring a scarcity value - experiments[1] with palm oil lubricants for cotton spinning machinery were not successful. Both in Britain and France there was general recognition that new types of lubricants were necessary. Natural oils were satisfactory for slow-moving machinery but tended to be broken down by the heat of increased friction as machinery became faster moving. One obvious consequence of the mechanisation of the textile industries and of transport was the expansion of the market for lubricating oils. The study of lubrication problems and of the forces of friction was longstanding but not until the invention of the viscometer by Charles Dolfuss in 1831 was there a satisfactory instrument in common use for the testing of lubricants.[2]

James Young was preceded by many pioneers in lubrication problems, generally practical men prepared to try any likely substance. One of the most outstanding was the Prussian Count de Hompsech who in 1841 took out a British patent for making lubricating oils and purifying them; his raw materials

1. The first two British patents for palm oils were taken out in the early 1830s.
   a. British Patent No. 6121, 2 June 1831, Nidola Hegisippi Manicler, chemist, and James Collier, civil engineer;
   b. British Patent No. 6256, 13 April 1832, John Demeur
2. R.J. Forbes, op. cit., p. 179.

were "... bituminous schists, shales, or slates, or other rocks or minerals containing bitumen or bituminous substances ..."[1] This invention included a screw or poker used to ensure the effective carbonization of the charge. This screw was later included by Young in his process but not claimed as part of his invention.

Young was not the first man to think of refining lamp oils. From the 1790s onwards there were many improvements beginning with the use of sulphuric acid in refining. Young was to use sulphuric acid as the basic chemical in his refining process. Nor was he the first man to make hydro-carbon oils. Recently, Abraham Gesner, 1797-1864, has had his champions[2] as the founder of the kerosene oil industry. The first of the man-made hydro-carbon oils was not paraffin nor kerosene but benzene discovered by Michael Faraday in 1825 and applied successfully for industrial and domestic purposes by Charles Blachford Mansfield[3] in 1847.

Nor was Young the inventor of the term, 'paraffin', with which his surname has been constantly associated. The term, 'paraffin', was coined by Carl Reichenbach of Blansko, Moravia. Reichenbach managed mines, iron foundries, chemical works and

1. British Patent No. 9060, 4 September 1841; and Memorandum of Alterations, 5 July 1842.
2. Vide Kendall Beaton, "Dr. Gesner's Kerosene: The Start of American Oil Refining" in Business History Review, vol. xxiv., March 1955, pp. 28-53.
3. British Patent No. 11960, 11 November 1847.

workshops on the estates of the Count of Salm; he was also an experimental chemist of some ability. In 1830 he discovered in beech wood tar - and named - paraffin wax, but no commercial process was patented.[1] He sent a sample to the eminent French chemist, Gay Lussac, who was the first but not the only man in France to analyse Reichenbach's paraffin wax.[2] The flourishing Autun shale oil industry in the late 1830s took an active interest in this experimental work, and one of its leaders, Selligue, patented the first process for the production of paraffin wax in 1838.[3] In Britain Young's student acquaintances took an interest in the scientific controversy surrounding paraffin wax. John Thom, working in Graham's laboratory in Glasgow, was the first Briton to check Reichenbach's experiments.[4] Young must have known of Thom's experiments, but they had no commercial significance - in any event, paraffin wax had not been produced from coal.

From what has gone before, it must be clear that James Young did not invent the lamp oil industry. He was one of several men who attempted to make fortunes from new processes. As the market was widening the profitability of ventures in oils increased. But often the area of exploitation lacked

1. R.J. Forbes, op. cit., pp. 147 sq.
2. J. Gay-Lussac, Analyse de la paraffine, (Ann. Chem. Phys. vol. 49, 1832, pp. 78-80). Dumas, the doyen of French chemistry, was the leader of the controversy which followed the publication of Gay Lussac's paper.
3. Brevet d'Invention, No. 9467, 14 November 1838.
4. Fernie and Others v. Young and Others, House of Lords, Evidence of James Young, p. 232, 1864.

critical advantages or the entrepreneurs themselves were deficient in personal qualities necessary for success. For instance, in 1810, William Speer of Dublin and London patented a process for making oil for lamps, but it depended upon the supply of existing tarry oils from coal and other bituminous substances.[1] Supply was often irregular, and Speer certainly did not make a fortune. In Galicia, Joseph Hecker and Johann Mitis worked oil seepages from 1810 to 1817; Hecker actually produced a lamp oil that was sold in the local towns, but transport costs crippled the venture - and in 1815 the most profitable seepage gave out..[2] Sir Thomas Cochrane, one of the least responsible of the Dundonalds, had a grandiose scheme in 1813,[3] for lighting the cities, towns and villages of England which never got beyond the confines of one, small, Westminster parish.[4] In 1823, the mineral wax, hatchettite, was discovered on the shores of Loch Fyne in Argyllshire and named after the English chemist, Charles Hatchett. But no industry grew up in the area; no one thought of commercial exploitation.[5] According to his own uncorroborated account, Abraham Gesner made oil from coal which he burned in lamps at public lectures given on Prince Edward's Island in August, 1846. In 1849

1. British Patent No. 3325, 6 April 1810.
2. R.J. Forbes, op. cit., pp. 93 sq.
3. British Patent No. 3657, 3 March 1813
4. Dundonald and Bourne, Life of Thomas Cochrane, tenth Earl of Dundonald, London 1869, vol. i., p. 50.
5. Abraham Gesner, Coal, Petroleum and Other Distilled Oils, New York 1861, pp. 8 sq.

Gesner began to act as chemical consultant to Sir Thomas Cochrane, tenth Earl of Dundonald and designed a retort suitable for the distillation of Trinidad pitch and for the production of "kerosene gas".[1] By 29 January, 1850, Gesner had an American patent[2] for the manufacture of illuminating gas from bitumen. He had beaten Young to the patent office, but his patent was so specific that Young's later patent could not be regarded as an infringement. Gesner had made the mistake of concentrating on gas when Young was working on several different oils.[3] Gesner's later patents[4] for kerosene or kerocene were attempts to put the clock back by bypassing Young's patent. But these attempts failed.

The entrepreneur likely to have outstanding success had to possess chemical knowledge, patent lore and access to capital. In addition, he had to have the opportunities: an expanding market in a rapidly industrialising society; a regular supply of basic raw materials, preferably obtainable at low costs; locational advantages of good transport facilities and proximity to large centres of population in which heavy engineering and textiles were predominant. His key patent had to maintain its force at law in the face of deter-

1. G.W. Gesner, Biographical Sketch of Abraham Gesner, in Bulletin of Natural History Society of New Brunswick, No. XIV., pp. 7 sq.;
   Abraham Gesner's work has been excellently assesed in a popular article by Owen Colverd, Pitch and Glass, Institute of Petroleum Review, March 1961, vol. 15, No. 171.
2. American Patent No 7052, 28 January 1850
3. Scientific American, 9 and 16 February 1850
4. American Patents 11203-11205, June 1854.
   In these patents the spelling given is kerocene.

TABLE 4

PATENTS RELATED TO DOMESTIC LIGHTING AND INDUSTRIAL LUBRICATION

(1840-50)

Number	Classification
66	For the production and distribution of artificial light (principally gas).
57	For improvements in candle manufacture
over 40	For treating, melting and cutting tallow
12	For improvements in wick manufacture
20	For lamps for burning oils
40	For other lamps
30	For making, refining and treating natural oils
20	For making or extracting oils from coal/peat/ coal tar.

Source:

Index of Patents (1840-50)

mined attempts to subvert it. Otherwise, the patent would have been lost in the multitude of the other 285 British patents for the production and distribution of gas, oils, lamps, candles and wicks, which were taken out in the 1840s. To prevent such a catastrophe the patent itself had to possess a fortuitous blend of precision, limitation and generalisation. It had to combine narrow chemical technology and wide commercial vision.

2. Young's Pilot Scheme in Derbyshire

James Young had the necessary personal qualities for entrepreneurial success in the chemical industry, but the circumstances of Young's entry into the oil industry have never been adequately explained. His experience with Muspratts and Tennants was essentially in textile dyestuffs and bleaching agents.[1] Perhaps he knew of the career of Charles Macintosh, the Scottish chemist, who first commercially used coal-tar as a cheap but effective solvent for rubber, a process essential to the development of the largescale manufacture of water-proof clothing. More likely it was a fortunate accident.

Ever since leaving Professor Graham, James Young had been in touch with Lyon Playfair. In 1845 they had been considering a partnership in business but were unable to secure a licence from the proprietors of a patent.[2] In addition, they were both interested in the commercial possibilities of potassium cyanide, and Young was anxious that Playfair should not announce the results of their joint work at the British Association in 1845:

> "... as I am sure that to say anything about it there would be considered in law as a publication and no patent taken after that would stand. So whatever you do keep that to yourself ..."[3]

1. W. Woodruff, The Rise of the British Rubber Industry during the Nineteenth century, Liverpool 1958, p.3.
2. M.S. Letter, James Young to Lyon Playfair, 18 July 1845
3. M.S. Letter, James Young to Lyon Playfair, 18 June 1845

When Playfair moved to become Professor of Chemistry at the South Kensington "Museum of Economic Geology", he continued to ask Young's advice on matters of experimental chemistry and in 1846 offered his assistance in getting Young's work on the specific gravity of gases published.[1] This connection with Playfair was the first important circumstance which led to Young's entry into the oil industry.

In his memoirs Lyon Playfair gave his version of what happened.[2] James Oakes, Playfair's future brother-in-law, had established himself at Riddings in Derbyshire, where he was the owner of several coal mines, quarries and an iron foundry. Playfair and the celebrated Bunsen had acted as industrial consultants for Oakes on several occasions, particularly on blast-furnace gases. Sometime in 1847, possibly in November or early December, Playfair had been asked to report on the natural oil spring which had been discovered down one of the Riddings mines He wrote to Young on 3 December, 1847:

> "You know that mineral naptha is a rare natural product, no spring of it occurring in this country, all being imported from the Continent or Persia. Lately a Spring of this valuable product has been discovered on an estate belonging to my brother-in-law (Mr. Oakes), near Alfreton, Derbyshire ..." [3]

1. M.S. Letter, Lyon Playfair to James Young, 9 October 1846
2. Wemyss Reid (ed.), Memoirs and Correspondence of Lyon Playfair, London 1899, pp. 37 sq.
3. Ibid., p. 102. Lyon Playfair to James Young, 3 December 1847

The flow from this spring yielded about 300 gallons a day, according to Playfair; the naptha was rather like treacle and after one distillation "... it gives a clear, colourless liquid of brilliant illuminating power ..."[1] From the first Playfair knew that this was a good lamp-oil and clearly told Young. Thus, it is clear that Young ought to be believed when he later stated that from the beginning of operations at Riddings he made two oils, one for lubrication and the other for burning in lamps.[2] Playfair, himself, had clearly tested the liquid and found also that "... it dissolves caoutchouc easily ..." May be, this was the piece of information which especially interested Young.

Apparently, Oakes had thought of establishing a refinery, but Playfair had advised him against such a course of action. He felt that chemical manufacture was not really a province into which iron-masters could safely enter.[3] If Young was interested, Playfair would send a specimen to Manchester and he added:

> "... Perhaps you could make a capital thing out of this new industry, and enable my friends to do the same ..."[4]

The naptha could be sold direct to the gas companies, for Playfair reminded Young that, it:

1. Ibid.
2. E.M. Bailey, The Young Memorial Lecture 1948, is the mistaken source giving 1856 as the date when Young began manufacturing paraffin lamp-oil.
3. Wemyss Reid, op. cit., p. 102.
4. Ibid.

> "... is now largely used for adding to the illuminating power of gas, and that the tar residue is a valuable product .." 1

Elsewhere, Playfair suggests that from the beginning he knew that:

> "... This oil, when cold, deposited shining crystals which I recognised to be the paraffin of Reichenbach ..." 2

Although this is possible, it seems unlikely that Playfair should not have mentioned this phenomenon in his letter to Young. More probably, the crystallization process was part of the later experiments conducted by Young and not part of the initial discovery at all. This was Young's recollection fourteen years later.[3]

Certainly, much of the credit for Young's departure into the oil industry must go to Lyon Playfair; Young, himself, did not seem to be in any hurry to go to Riddings. His Stannate of Soda process was occupying much of his time, and he was due to read a paper on the deodorization of sewage and manures to the Manchester Literary and Philosophical Society on 14 December. Playfair in a letter written from Riddings House on 19 December, 1847, advises Young to come immediately - for two reasons. First, Playfair was available himself to conduct Young round, and secondly,

> "... Dr. Ure is in negotiation about it for one of his large chemical manufacturers so unless it is looked after you might lose a very valuable thing ..." 4

1. Ibid.
2. Ibid., p. 38.
3. Fernie and Others v. Young and Others, House of Lords, 1864, Evidence of James Young, pp. 236 sq.
4. M.S. Letter, Lyon Playfair to James Young, 19 December 1847.

Playfair was right; Andrew Ure did make a report about this petroleum spring.[1]

Eventually, Young seems to have made up his mind. He went to Riddings on 22 December,[2] probably taking up Playfair's offer of accommodation. Playfair and Young talked of the petroleum spring, and Young left Playfair with a copy of the paper "read at Manchester on Manures".[3] On the following day Young went down the pit:

> "... I found the petroleum dropping from the roof over the coal ... The coal was being worked out, and the roof over the coal was sandstone; and as the coal was taken away the sandstone broke, and out of the crack oozed and dropped this petroleum. This petroleum was about the thickness of olive-oil, and on a cold day it became nearly solid as olive-oil would do; and it was of a dark coffee colour ..."[4]

There was a laboratory at Riddings, and on Christmas Eve Young began his first experiments with 925 c.c. of crude petroleum which he distilled in a glass retort:

> "... a little water came first then some Naptha not much then an oil ..."[5]

The naphtha just filled a 1,000 grain bottle, and the oil more than filled a bottle of the same size. Young was optimistic; "... this looks hopefull ..."[6]

1. Pharmaceutical Journal, vol. 7, London 1848, p. 485
2. Thom Collection: Pocket Diary of James Young, 1847-1849, mainly in pencil, (no pagination) 22 December 1847. Young, with his customary care, listed his expenses as 49/3d.
3. Ibid.
4. Binney and Company v. The Clydesdale Chemical Company, Court of Session, 1860, p. 84.
5. Pocket Diary, 1847-1849, 24 December 1847.
6. Ibid.

Despite the Christmas party at Riddings House - Young probably stayed at the George Hotel, Alfreton - Christmas Day was spent on similar experiments. There were, naturally, one or two minor disappointments. On one occasion, the retort broke "when Naptha was coming quick."[1] On 30 December Young absent-mindedly left the gas burning all night under the retort with the result that "... a quantity of Naptha had been lost ..."[2] when the retort overflowed. But on 1 January, 1848, Young found that the pitch which he had purified:

> "... had a crystalline appearance on top fluid with small grains as if it had little crystals in it ..."[3]

These were tiny flakes of Reichenbach's paraffin wax! This seems likely to have been the first occasion when Playfair noticed the crystals.

Young then decided to approach his employers. He suggested that they should work the spring or take charge of marketing the oils. But Tennants considered that the likely scale of operations was too small for them to consider Young's suggestion.[4] There was a time-lag and then James Oakes suggested to Young that he should go ahead without Tennants' support.[5] Young asked Tennants' permission if it would be possible to remain

1. Ibid., 25 December 1847, 7.20 p.m.
2. Ibid., 30-31 December 1847
3. Ibid., 1 January 1848
4. Binney and Company v. The Clydesdale Chemical Company, Court of Session, 1860, p. 85, Evidence of James Young.
5. Thom Collection: M.S. Copy of Proof of Mr. James Young, Young v. Fernie, In Chancery, 11 February 1864.

in their employment and yet act as an independent entrepreneur at Riddings.[1] They agreed. The willingness of Tennants to agree to such a bizarre arrangement is some indication of the value that they placed on Young. It may have been not merely a result of a benevolent attitude to their senior employees but also a deliberate attempt to mollify Young. For Young was irked by not being made a director, particularly since J.B. Statham, formerly Thomson's chief clerk, was given a place on the board.[2] Young felt that he was worth a great deal to Tennants:

> "St. Rollox made £40,000 in 1847 the year my experiment was tried this is disected into 9 parts of which
>
> | | | | |
> |---|---|---|---|
> | John Tennant takes | 5 | | |
> | Charles Tennant | 2 | | |
> | George Brown | 1 | | |
> | Charles Tennant, Dunlop | 1 | " | 3 |

Tennants were, in fact, delaying the inevitable. A formal deed of covenant was signed on 20 September 1848 by which Oakes agreed to provide the land and to pay for the construction of the refinery. Young was to pay for the costs of refining and in addition 10% per annum of the capital costs incurred by Oakes. Returns were to be divided: Young was to receive 15% commission on the sum received from the sale of products;

1. Binney and Company v. The Clydesdale Chemical Company, Court of Session, 1860, p. 85. Evidence of James Young. Vide also p. 109, Evidence of Lyon Playfair.
2. E.W.D. Tennant, One Hundred and Forty Years of the Tennant Companies, 1797-1837, p. 56
3. Pocket Diary, 1847-1849, February 1848

the products were, however, to be divided in a ratio of 5 to 3 in favour of Oakes. James Young took out a seven year lease of Oakes' petroleum spring;[1] his solicitor was Edward William Binney;[2] "... and Mr. Meldrum and I started ..."[3]

A small pilot plant was established at Riddings with the minimum of equipment. There were two 18 cwt. lead pans or tanks, eight cast-iron pans, eight glass retorts and three enamel pans, which, with cartage, installation charges and cost of coals, and purifying agents, cost Young over £140.[4] Young, then, sent for Edward Meldrum, who was working as a chemical consultant in a works near Wakefield, Yorkshire.[5] Meldrum took over the Riddings plant in Derbyshire as manager while James Young continued to work for Tennants in Manchester.[6]

How much it actually cost Young for the oil concession is not certain. We know that he paid J. Oakes and Company £150 in cash on 16 May, 1850,[7] but whether this was a final or an instalment payment it is impossible to say. Young's first customers paid their accounts in July, 1849. There

1. E.M. Bailey, The dawn of Petroleum Refining, in Institute of Petroleum Review, 1948, pp. 357-360.
2. Young and Others v. Fernie and Others, In Chancery, 29 February 1864, Statement by Young's counsel, 1st Day, p.2.
3. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 85, Evidence of James Young.
4. Pocket Diary of James Young, 1847-1849. No exact date was given by Young.
5. Meldrum's Yorkshire address is given in Young's Pocket Diary.
6. Ibid., 22 September 1848: Young records a payment of £5 to Meldrum "on act of the Petroleum works." c.f. also Binney and Company v. The Clydesdale Chemical Company, 1860, p. 87, Evidence of James Young.
7. Cashbook of James Young's Mineral Oil Works, "Alfreton 1849", last page. This cashbook (10 folios only) retained by Miss Thom, was kept by Young.

were only three of them - all cotton spinning firms primarily interested in lubricants.[1] Gradually, other customers and agents took up Young's products and the area of marketing extended further afield. But still most of the customers were from the Manchester area, where Young himself was able to contact them. As Playfair had forecast, the gas companies became interested, and in September, 1849, the New Glasgow Gas Company of Bridgeton bought Young's mineral oil to enrich the illuminating power of its gas.[2]

From March 1850 to January, 1851, the sole buyer was J. Hurst of Manchester, an agent for lubricating and lamp oil.[3] On 3 September, 1850, Young formalised Hurst's position and agreed to his becoming sole agent. Hurst, in return, was to guarantee all accounts, take charge of delivery to customers and collect all debts. For this service Hurst took 10% on all transactions provided that payment was made to Young within a month of delivery to Hurst.[4] On the following day Young received "Bill from Hurst for £455: 17: 0."[5] There were certain advantages in this arrangement with Hurst, which clearly in Young's mind outweighted any disadvantages. No longer need he assess the credit-worthiness of his customers; this was Hurst's responsibility. No longer need he wait for his money:

1. Ibid., fo. 1.
2. Ibid., fo. 3.
3. Ibid., fo. 7-9.
4. Notebook of James Young, 1850, 3 September 1850
5. Ibid., 4 September 1850.

"... for instance on 1st Sept draw for the oil invoice in August ..."[1] No longer need he deliberately court custom, although he retained the right to approach customers directly. Hurst had as much to gain as Young from the expansion of trade and, in fact, advertised Young's mineral oil.

Operations at Riddings were directed mainly to producing

> "... a thick oil for lubricating and a thin oil for lighting - for burning in a lamp ..."[2]

from what Young considered "... a common house-coal ..."[3] At the beginning Young believed that the market for lubricating oils was the best outlet for his products,[4] but he also made and sold lamp oil. Naphtha, he sold for gas-making and as a solvent to rubber manufacturers. Paraffin wax was not produced "... in quantities to sell ..."[5]; the process of separation was not economic at that stage of production and, therefore, Young generally sold the lubricating oil without extracting the wax from it. Thus, the candle market was not yet open to him. Playfair had thought of producing oils for varnish and paint manufacturers;[6] since Young doubted the feasibility of this,[7] nothing came of it. However, Young and Meldrum

1. Ibid.
2. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 85, Evidence of James Young.
3. Ibid., p. 94, Evidence of James Young.
4. Ibid., p. 103, Cross-examination of James Young.
5. Ibid., p. 105.
6. M.S. Letter, Lyon Playfair to James Young, 19 December 1847
7. Fernie and Others v. Young and Others, House of Lords, pp. 240 sq. Cross-examination of James Young.

TABLE 5

THE RIDDINGS VENTURE : FINANCE

Time	Day to Day Expenditure	Receipts	Balance
Year 1	£245. 8. 11.	£125. 14. -.	- £119. 14. 11.
Year 2	£236. 18. 1.	£516. 18. 10.	+ £280. -. 9.
17 Sept. - 30 Nov. 50	£130. 13. 6.	£844. 9. 4.	+ £713. 15. 10.
TOTAL	£613. -. 6.	£1,487. 2. 2.	+ £874. 1. 8.

Source:

Cash Book of James Young's Mineral Oil Works "Alfreton 1849"

"... searched for many things ...;[1] they were anxious to discover as many uses for this crude petroleum as possible.

The relation of operating costs to turnover can be deduced from the accompanying table.[2] Young, undoubtedly, had other expenses not shown by his cashbook: for instance he paid Tennants £60 for chemicals used in the purifying process in August, 1850;[3] his travelling expenses and those of Meldrum must have been considerable. Young's assessment of the scale of operations was quite definite: "... the whole affair was too small ..."[4]

> "... It just about paid for itself it paid nothing for my labour. It paid its expenses but I had no profit upon it. If it had been a larger quantity it would have been profitable ..."[5]

In fact, the rate of profit on operating costs - disregarding capital repayment to Oakes - was certainly exciting enough to stimulate Young's desire to establish a large-scale enterprise elsewhere. Of course, a large plant instead of the small Riddings venture would have heavier initial costs and require greater capital reserves against the cost of plant depreciation, research expenses, raw material stocks and storage space for finished products. On the other hand, a small pilot plant had capital costs that were difficult to recoup over a short period of operations. The larger enterprise would be more likely to provide economies of scale, opportunities for standardized production and a firm profit margin.

1. Ibid., p. 240
2. See Table 5: The Riddings Venture: Finance
3. Notebook, 1850, August.
4. Binney & Company V. The Clydesdale Chemical Company, 1860, p. 103, Cross-examination of James Young.
5. Fernie and Others v. Young and Others, House of Lords, 1864, p. 225, Evidence of James Young.

There were several important obstacles to Young's developing such a firm. His pilot scheme at Riddings was dependent upon an irregular supply of crude petroleum. Playfair, for example, mentions the rate of flow as about 300 gallons on 3 December, 1847,[1] and as an average of 150 gallons per day over the month before 19 December, 1847.[2] Over the period December, 1847 to January, 1851 the supply of crude petrolem gradually diminished. Meldrum, who was nearer the scene of operations than Young, later stated that the petroleum spring virtually ceased "... toward the end of 1850 ..."[3] This approximation is backed by the evidence of the cash-book: on 30 November, 1850, the last payment for production costs was made.[4] The supply of oil did not run dry; it ran more slowly - oil was still being collected in Young's tank at this pit after Young's death.[5] But Young had an urgent incentive in 1850 to start operations elsewhere with a form of production over which more definite quantity control was possible.

One indication of Young's capacity as an entrepreneur was his ability to recognise the need for a more scientific approach to production, before there was any apparent danger that the petroleum spring at Riddings was limited in its

1. Wemyss Reid, op. cit., p. 102.
2. M.S. Letter, Lyon Playfair to James Young, 19 December 1847.
3. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 159, Evidence of Edward Meldrum
4. Cashbook of James Young's Mineral Oil Works, "Alfreton 1849", fo. 10.
5. Derbyshire Times, 21 November 1947, Letter from Walter Thompson who worked at Riddings in the 188os.

economic potential. Soon after observing the flow of petroleum from the roof of the coalmine, he began to speculate about its origin. His theory was: "... it might be very probably a product from coal, made by nature...."[1]

> "... I had the idea that the petroleum might be produced by the action of heat on the coal and the vapour going up into the sandstone ... and remaining there condensed ..."[2]

This erroneous idea led Young to attempt the dry distillation of coal.[3] As the fluctuation in supply from the spring became apparent, Young tried more and more types of coal over a period of two years. He began with the coal sent to Tennants' Manchester works for the furnaces.[4] At this stage, Meldrum was in the dark about Young's experimental activities.[5] The varieties of English coal produced variegated experimental results but at last:

> "... out of a cannel that came to be mixed with the soda ash for making the alkali, I got a quantity of a liquid that contained paraffine ..."[6]

Like the first venture in Derbyshire the experiment with cannel coal "... was a lucky hit ..."[7] Thus, Young isolated the generic groups of coal most likely to yield crude paraffin oil in great quantities.

1. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 159, Evidence of Edward Meldrum.
2. Ibid., pp. 85 sq., Evidence of James Young.
3. Ibid., p. 86. Vide also Fernie and Others v. Young and Others, House of Lords, 1864, p. 224.
4. Ibid.
5. Ibid., p. 159. Evidence of Edward Meldrum.
6. Ibid., p. 86. Evidence of James Young.
7. Fernie and Others v. Young and Others, House of Lords, 1864, p. 236. This phrase was used by counsel in cross-examination of James Young.

Quantity control of supply was not the only desideratum to be achieved before Young could undertake large-scale production. It was necessary for Young and Meldrum to develop additional outlets for their products; otherwise they would be at the mercy of a single agent like Hurst. It is true that sale through agencies has the cardinal advantage of not dissipating the capital of the industrial entrepreneur on the distribution of the products to the consumers; yet, it has one outstanding disadvantage, particularly relevant to Young's experience. The expansion of trade through direct contact with the consumer was less possible for Young; Hurst's chief interest was to promote the sale of products, particularly lubricants, which caused his firm the least material inconvenience. Further scientific research was essential. Better lamp oils and suitable lamps for burning them had to be found. Diversification of production had to occur as rapidly as possible if Young's enterprise was not to be limited to the sale of lubricants. A large-scale enterprise could not be built on the sale of one main product, particularly if that sale could be restricted by the trade cycles of the textile industry or by the irregular demands set up by the capital goods industries.

The outstanding obstacle was capital shortage. Young's capital resources had to expand if he was to build a large-scale enterprise. The time-lag between paying the costs of production and making a profit was a particular strain on the

entrepreneur at the outset of a venture. Young had considerable experience of this particular problem; during the Riddings venture he often had to wait three or even six months before he saw any return for his capital outlay.[1] To get capital in from customers he had to offer generous discounts and ultimately come to terms with Hurst. Capital shortage was first and foremost a possible danger to independence.

The weight of economic facts made the expansion of Young's capital resources essential. A bulk supply of suitable cannel coal and other raw materials, a simple practical procedure to offset the possibility of rising production costs, would involve heavy initial expense. It was necessary to protect the whole enterprise by taking out a comprehensive, and yet, carefully delimited, patent in as many countries as possible. The patent process was expensive and yet vital, since competition from gas-lighting, from natural oils, from wood-tars and tars produced from coal and lignite, from lubricants produced from peat and pitch was likely to be savage enough without allowing the freedom of the market to any other entrepreneur prepared to steal or to stumble upon Young's dry distillation process.

1. Cashbook of James Young's Mineral Oil Works, "Alfreton 1849", passim.

3. The Patent and the Specification (1848-1851)

James Young during much of the litigation in which his patent involved him maintained an attitude of comparative simplicity. He made no great pretensions to chemical knowledge, scholarship or insight. But, in fact, he was being deliberately and unduly modest for reasons which later will become clear. Young indeed began very carefully experimenting with coals to produce lamp oils. To test the luminosity of those oils that he did produce he bought a photometer in September, 1848.[1] In December, 1848 he produced a poor lamp oil from peat taken from Down Holland Moss in Lancashire by Young's attorney, E.W. Binney.[2] But before that the patents of Hompesch and Du Buisson began to figure prominently in his memoranda.[3] But by December, 1848, he knew that paraffin could be obtained from coal and his main anxiety was priority: "... is there anyone before us. Doubtfull ..."[4]

There still remains the important question of taking out a patent and drawing up a specification. Young was very slow to announce his discovery or to take out his patent. First, he had to test as many forms of coal as possible; next, he had to be sure of his refining processes; then, he had to

1. Pocket Book, 1847-8, September 1848
2. Ibid., 7 December 1848
3. Ibid., November 1848
4. Ibid., 7 December 1848

co-ordinate a programme of patent research so that his specification should be as fool-proof at law as diligence could make it. These objectives were bound to take time: Young had to read as many authorities as possible, both in English and French; he had to gain access to translations of German works for he knew no German; he had to consult his friends in academic life and in industry; he had to spend many hours investigating existing patents. Most important of all, Young had to conduct these activities and yet maintain secrecy. This explains why he told no one more than he could help - even his future partners, Meldrum and Binney, were very much in the dark until July, 1850.

Other factors also affected the timing of Young's application for a patent for making paraffin. For much of 1849 he was concerned with his stannate of soda process which he had patented at the end of 1848. In addition, he was still employed by Tennants in Manchester, conducting research into textile bleaching agents and dyestuffs.[1]

As the supply of petroleum from the Derbyshire spring became increasingly irregular in 1850, Young concentrated his attention on techniques of destructive distillation. He had already contacted his friend, Hugh Bartholomew, formerly a fellow-student in Anderson's University, about the properties

1. Young's Memorandum Book, 1849-1851 reveals that he was working on stannate of barytes, tungsten ores and their uses as colouring agents and doing many sample tests.

of cannel coal.[1] Bartholomew's experience was valuable to Young for several reasons. He was engineer and manager of the City and Suburban Gas Company in Glasgow from the time of its erection in 1843;[2] the methods of working later adopted by Young's company at Bathgate were modifications of gas-work practice as was the capital equipment. Bartholomew knew a great deal about cannel coals for they had been the prime coals for gas-making in Glasgow, as long as he could remember.[3] Once Bartholomew knew that Young was interested in cannel coals, their friendship was sufficient guarantee that Bartholomew would inform Young of any new varieties that came onto the market. In January, 1850 Bartholomew received a newly mined cannel coal known as Boghead.[4] Messrs. Russel and Son, writers of Falkirk, had just taken a lease of the coal rights at Torbanehill, the property of the Gillespies..[5] This was yet another twist of fortune in Young's favour for Bartholomew sent a barrel of Boghead coal to Young's Mineral Oil Company at the Alfreton Iron Works. There the barrel rested for a few months, although Meldrum wrote to Young to inform him of its arrival.[6]

1. In Chancery, Young and Others v Fernie and Others, 1862, Sixth Day, p. 11. Evidence of Hugh Bartholomew.
2. Court of Session, Binney and Company v. The Clydesdale Chemical Company, 1860, p. 178, Evidence of Hugh Bartholomew
3. Ibid.
4. Report of Trial, Mr. and Mrs. Gillespie of Torbanehill v. Messrs. Russel and Son, Edinburgh 1853, p. 186, Evidence of Hugh Bartholomew.
5. Ibid., p 2. Counsel for Pursuers.
6. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 160, Evidence of Edward Meldrum.

In May 1850 Young began to finalise his researches. Russel's name - and Boghead - occur in his memoranda;[1] he was determined to "... see about schist and petrol patent look at Mansfields patent French patents ..."[2] From that time onwards Young and Meldrum standardized experiments on a number of English and Scottish cannel coals:

> "Pirney shale gave 29 gall 878 spec gr ...
> ... Pirney coal gave 16 galls good oil ...
> ... Capledrae No 3 gave 21 galls when mixed with 40 p.c. gav good results ...
> ... Caple Drae No 2 gave 28 gall ...
> ... samples of coal to be 28 lbs ... "[3]

However, the best coal for Young's purpose was Boghead. Young and Meldrum succeeded in producing "... a considerable quantity of crude paraffine oil ..."[4] on "... the very first trial ..."[5] This success was reported by Meldrum and Young to Edward W. Binney at the British Association meeting held in Edinburgh in July, 1850.[6] An embryonic partnership had become a definite possibility.

Meanwhile the trials with the various coals proceeded despite the success with Boghead. Clearly, Young wanted to know more about the destructive distillation of coal; he never had the intention of using only one variety of cannel

1. Notebook, 1850, May.
2. Ibid.
3. Notebook, 1850, June - August.
4. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 88, Evidence of James Young.
5. Ibid., p. 160, Evidence of Edward Meldrum.
6. Ibid., p. 88, Evidence of James Young.

coal, as some of his rivals later suggested; to formulate a clear-cut patent specification it was necessary to be sure that the process could be applied to several coals. Above all, in order to establish a plant in the area with the greatest economic advantages it was essential that Boghead coal should be proven the best raw material. Curiously enough, it was not until 1851 that Meldrum and Young extensively tried the coal at Riddings: "... try the coal from the deep pit or the pit where the petrol comes from now ... ... try riddings main hard and main soft coal ..."[1] Perhaps, Young hoped to continue in Derbyshire without adding greatly to his capital costs. Riddings was a good centre for supplying lubricants to Lancashire and the West Riding - there were cannel coals easily available in the Wigan area, and in Staffordshire. Meldrum conducted successful experiments with these coals after the discovery of Boghead coal.[2] In August, 1850 Meldrum went to Scotland to pick up as many samples of Scottish cannel coals as he could obtain. All of them produced mineral oil which Meldrum then refined to check against Derbyshire natural petroleum. Boghead still remained the best coal but little superior to some of the Fife coals.[3]

1. Notebook, 1851, no definite date.
2. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 160, Evidence of Edward Meldrum
3. Ibid., p. 161, Evidence of Edward Meldrum

Scottish Cannels and Mineral Oil (1850)
(based on Meldrum's experiments)

Coal	Gallons of Crude Oil per ton	Gallons of Refined Oil from Gallons of Crude
Boghead	85	45
Brown Methel	78	40
Capeldrae 1	69	20
Capeldrae 2	53	28

The point at which Young's process for producing mineral oil differed from all earlier patented processes was the fixing of the temperature for distillation. By the time of the successful experiment on Boghead Young was fairly certain about the best temperature to be employed but had not constructed a general theory based on his experiments. But it was not until 6th September that Young began the main work of drawing up his patent specification. First of all he concentrated upon the literature of petroleum and paraffin. He wrote to Dr. Wilson in Edinburgh "... about Reichenbach's papers on Tar."[2] He read Hatchet's observations on bituminous substances and the pioneer work of Gregory and Christison on Rangoon petroleum in the excellent library of the Manchester Literary and Philosophical Society.[3] He noted an article, seven

1. Ibid., p.87, Evidence of James Young.
2. Notebook, 1850, September.
3. Ibid.

years back, in the Chemical Gazette by Du Buisson, describing [1]

"... a method of lighting with coal oil and schist oil..."

He went through the more learned journals:

> "New Edinburgh Philosophical Journal for 1831 vol. 11 contains a paper by Reichenbach on Eupion see it in the Library of the Phil and Lit of Manchester ..." [2]

He read the most outstanding recent book on chemical technology - and for one purpose only - and then was led on to other references:

> "... In Knap there is a list of patents connected with gas and oil (look over them) ..." [3]
>
> "... In the gas works at Totenham according to Knap the retorts are charged with 260 lbs which may be raised to 300 and this is worked off in $4\frac{1}{2}$ hours ..." [4]

But, of course, Young had Bartholomew's gas-works experience to rely upon.

> "... Knap at page 170 vol 1 gives the screw to Heginbotham. Look for such a patent ...
> ... Knap at page 164 says Henry found that below a cherry red heat nothing but Hydrogen atmospheric air and some tar passed off with hardly any illuminating gas ... look to Henrys original papers the (sic) should be in the Manchester Memoirs. Look in Henry's Book ...
> ... page 180 Knap mentions the making of gas for illumination from the bituminous slate marl of Autun ..." [5]

This review was essential to the production of a good patent specification. From the first Young knew that his task would not be easy. The main difficulty was to avoid any kind of confusion with the patents taken out by Du Buisson and Selligue:

1. Ibid. Vide also Chemical Gazette, 1 August 1843.
2. Notebook, 1850, September
3. Laboratory Notebook, 1850, 10 September 1850
4. Ibid.
5. Ibid.

"The difficulty appears to me to steer clear of the schist patents. Paraphine as far as I can see yet was never procured from coles but it seems to have been procured from schist and this might be used against us ..." [1]

"... Du Buisson in his patent dated 23 June, 1845 mentions an apparatus patented by Mollerat sealed May 2 1837 he does not say that it is applied to bituminous matters but it would be well to see the specif ... Petroleum from coal might do as main point ..." [2]

Prior publication was also Young's dread:

"... The original paper of Laurents must be consulted soon as possible as it seems of much importance indeed it seems to anticipate our discovery of the production of paraffin from coal and drives us from the pos[n]. of taking that as our main point. I do not (sic) any other point that can be taken to distinguish between us and the schist patents. see if there is no schist or other bituminous patent anterior to Hompeschs ..." [3]

At this stage Young was even thinking of taking out a patent for improvements in gas-making and "... working the process so as to produce at the same time this valuable product ..." [4]

To specify coal shale as the basic material for distillation was, in Young's view, too limiting: "Coal shal comes so near coal that the difference is too narrow a base to stand on ..." [5] It would not be satisfactory to claim a lubricating oil as the main product because of the difficulty in drawing fine distinctions between Young's oil and other oils made from coal or shale. [6] Meldrum suggested that the patent

1. Ibid.
2. Ibid., 12 September 1850
3. Ibid. (A. Laurent's paper on Bituminous Schists and on Paraffin appeared in Annales de Chimie et de Physique, vol. 54, 1833, p. 392.)
4. Ibid.
5. Ibid., 13 September 1850
6 Ibid.

should rest upon a new name for the product, but Young was of the opinion that "... a new name would not avail us much without describing a new property as it can only be the properties of the substance that are usefull not the name..."[1]

On 11 September, 1850, Young created a general chemical law relating to destructive distillation techniques:

> "... The opinion grows stronger with me that olefiant gas and paraffin are from the same source so that a coal that gives olefiant at one temp will give paraffin at another lower temp ... try if olefiant gas can be produced from paraffin by heat ..." [2]

Meldrum did the necessary experiments and proved Young's hypothesis. Young was prepared to rest his patent on this distinction in composition.[3]

Meanwhile Edward Binney had been patiently working his way through related patents in London. Young met him on 16 September after his return to Manchester. He found Binney downcast:

> "... he is not so confident of making a good specif. now as he was before he went to London from what he has seen he seems to think the matter is in a different state from what he thought before ..." [4]

Young himself did not share Binney's cold feet; he was only afraid that Laurent had anticipated his discovery. He was soon relieved. The following day he read Laurent's paper and found that the source of his reference,

> "... Thomson misquotes him he does not produce paraffin from coal shale, but from <u>bituminous schist</u>, this leaves the matter as it was ..." [5]

1. Ibid., 14 September 1850
2. Ibid., 11 September 1850
3. Ibid., 14 September 1850
4. Ibid., 16 September 1850
5. Ibid., 17 September 1850

Thus, Young was prepared to proceed: "... we have still the point an oil from coal containing paraffin ..."[1]

On 18 September, 1850 Young consulted with Binney; they agreed that Young should take out his patent. The same day Young sent Binney's cheque for £130 to his patent agents, J.C. Robertson and Company of Fleet Street and instructed them to proceed..[2] Robertson and Company acknowledged receipt of their fee two days later and informed Young that an Irish patent would take about two months to seal, although little opposition was expected.[3] Meanwhile Young continued his patent research, examining the specifications of Dundonald, Lord Cochrane and Bethell.[4] He was pleased when he found that Cochrane in his patent of 1818 claimed the use of acids and alkalis in purifying tar oils and of hot water and steam for deodorizing oils:

> "... this I think would serve us if atacked for boiling our oil with water to deodorize it ..."[5]

He also took comfort in the thought that if Laurent's paper on oil shales had been translated into English "... it must upset all the schist patents as far as the processes are concerned ..."[6] He meant to look through the learned journals. On this note he completed an eventful fortnight in which the lines of his main patent were drawn.

1. Ibid.
2. Ibid., 18 September 1850
3. Ibid., 20 September 1850
4. Ibid., 18-19 September 1850
5. Ibid.
6. Ibid., 20 September 1850

There was nothing slip-shod about Young's own preparations for taking out a patent. J.C. Robertson and Company formally applied on his behalf, and a grant was made to Young of Patent No. 13,292 on 17 October, 1850, for "Treating Bituminous Coals to Obtain Paraffine and Oil containing Paraffine therefrom."[1] Young's specification was not enrolled in Chancery until 17th April, 1851, Young appearing personally on 16th April to acknowledge it.[2] The six months time-lag was all that was permissable within the patent law. Why was Young so slow to complete the patent formalities? It seems most likely that he was using the time to make his specification fool-proof. By January, 1851, he was becoming increasingly confident as more coals were tried and the process was found successful.[3] Early in February he received reports from four eminent analytical chemists and consultants that "... substances sent are realy Paraffin ..."[4] But he continued to read French works on bituminous materials and got Binney to approach Joule to clear up a point raised by Regnault about the presence of paraffin in coal-tar.[5] Time was also spent in chosing a site for a works. Binney, Young and Meldrum went to Scotland on several occasions between 7 November, 1850 and 14 April, 1851;[6]

1. The Thom Collection includes Young's Official copy of Patent No. 13,292, 17 October 1850
2. Patent No. 13, 292, Specification dated 17 April 1851
3. Laboratory Notebook, 1850-51, 8 January 1851
4. Ibid., 5-6 February 1851
5. Ibid., 13 February 1851
6. Young lists his expenses for these expeditions in his Pocket Book, 1850-51, and in his Laboratory Notebook, 1850-51.

the site was chosen and the works being built before the end of 1850. Perhaps, Young did not intend to have his specification enrolled until a trial running of the plant had occurred.

Young's patent specification was certainly worth the work which his partners-to-be and he put into it; indeed, in many respects it was a master-piece of patent lore, a classic instrument for preserving Young's material interests. The process it described was simple enough. Cannel coals, parrot coals or coals, which existing companies distilled at high temperatures to produce gas, were according to Young's specification :

> "... to be broken into small pieces of about the size of a hen's egg or less ...",

placed in a common gas retort and distilled at a low red heat. The crude oil would pass off as a vapour into a pipe encased in a refrigerator kept at about 55°F by a constant flow of cold water. In the refrigerated pipe the oil vapour would condense as a "crude" and be led off in liquid form into a tank. "This oil will sometimes upon cooling to a temperature of about 40° Fahrenheit deposit paraffine ..." To purify the crude oil Young reheated it to 150°F and then distilled it for a second time. 10% sulphuric acid was added and the mixture allowed to settle for 12 hours when the refined oil would be on the surface of the mixture. This refined oil would be treated with 4% caustic soda which would neutralize any sulphuric acid still remaining in the refined oil. Further refining then occurred to separate "... a fluid more volatile

than paraffin ..." Young also described a pressing process by which paraffin wax could be separated from the oil.[1]

The specification made no claims as to the apparatus nor was it simply a claim to a scientific method. It described carefully a general category of raw materials suitable for production without being precise about Boghead or Fife coals; it analysed the methods and techniques necessary to produce paraffin oils, paraffin wax and a volatile fluid; it stated the commercial purposes to which they could be put without being too optimistic about the market. It was specific about the claim to make commercial quantities of paraffin oil, but most of the products were not claimed as Young's invention. The whole specification was a glorious mixture of careful detail and wide generalisation - it provided no carte blanche for others to seize upon and yet at law its generalisations were likely to be no disadvantage since nothing was claimed for them. Young freely admitted that other arrangements could get the same results - and said so in his specification - but Young's methods were the best. He also specified that his raw material was coal and not shale - and as the future was to show the raw material with the greatest profit potential was found at Boghead and described as a cannel coal. Which ever way the would-be infringer turned, Young's specification

1. Patent No. 13,292, 17 October 1850

prevented passage to lawful manufacture. Not that Young's problems ended with the enrolling of his specification; they were just beginning. The age of oil had its own particular problems for entrepreneurs. Young, Binney and Meldrum were to encounter many difficulties - but as yet they were members of an embryonic, not a legal, partnership.

THE EARLY YEARS OF THE SCOTTISH OIL INDUSTRY

(1850-1864)

"The consumption of oil in Lancashire and Yorkshire is enormous, and although many substitutes have, from time to time, been introduced for economic objects, nothing as yet has supplanted its use. A man who has an extensive oil business with cotton spinners and manufacturers may be regarded as one who is in a fair way to realise a huge fortune, if he has not already done so."

H.S.G. Autobiography of a Manchester Cotton Manufacturer, (H.S. Gibbs), London, 1887. p. 143.

1. The Partnership

The personal psychology of industrialists is occasionally the best guide to the likely success of a new business for it is the personalities directing and controlling business operations who influence most directly the rate of growth. Personality is, therefore, an index to potentiality. The partnership between James Young, Edward Meldrum and Edward William Binney, which became a legal fact as a result of an indenture signed on 22 October, 1851,[1] was no exception to this rule. It was a historic partnership because it marked the real beginning of a new science-based industry in Scotland. But, of course, it had its antecedents: these three men had all been associated with the Riddings pilot scheme from 1848 onwards. Young had sponsored this small venture; Meldrum had

1. Binney & Co. v. The Clydesdale Chemical Company, 1860, p. 174, Evidence of Edward Meldrum.

managed it; Binney had acted as Young's attorney when James Oakes had agreed to lease the petroleum spring.[1] The 1851 agreement,

> "... to enter into partnership for the purpose of manufacturing oils, naphthas, manures and other products under the said patent ..."

was a logical consequence of their earlier association and tangential intimacy. The merits of one partner complemented the talents of the other two. A combination in which strong wills predominated, there was rarely a clash. This was just as well, since they were often faced with business opponents prepared to exploit any likely personal antipathy or incompatibility.

Young's ability was, admittedly, more than could be expected of an exceedingly versatile chemical engineer. Forty years old in 1851, he was at the peak of his powers, a man full of vitality, ambitious and ruthless, rapidly maturing after a late entry into industrial management As a result of his experience with Muspratt and Tennants which made him subject to a relatively low basic salary with, however, high rewards for practical ingenuity and managerial efficiency, he was stimulated to investigate and to invent. Earlier, he had gained a sound theoretical and practical training with Thomas Graham. He had the necessary academic training and scientific

1. Young and Others v. Fernie and Others, Chancery, First day, 29 February 1864, p. 2.

intellect to rationalise questions of plant design and lay-out, to solve decisively problems impeding production and to recognise the value of scientific research to sound industrial development. Wide manufacturing and marketing experience gained in the service of progressive companies enabled Young to establish and maintain helpful contacts in the worlds of business and science. Above all, Young combined a sense of legalistic caution with a broad conceptual vision. He could inhibit grandiloquence, over-reaching ambition or brash stupidity; he could astutely defend his view of the interests of the partnership.

Edward William Binney,[1] (1812-1881), had probably the most powerful character of the three partners. Born at Morton, Nottinghamshire, in 1812, he was apprenticed to a solicitor in Chesterfield, not far from Alfreton where later the Riddings venture began. Despite losing both parents during his training he managed to complete his articles in London and settled in Manchester in 1836. There he made a steady - and, occasionally, spectacular - income from land conveyancing and coal cases.

Because coal-owners became his chief clients, he decided to learn more about the geology of the coal measures and in the process became part of the brilliant amateur scientific circle in Manchester so praised by Lyon Playfair.[2] As a result

1. This account of E.W. Binney is based upon R. Angus Smith, A Centenary of Science in Manchester, London 1883, pp. 447-464.
2. "... there was an active band of young workers in research. Joule was, even then, foremost among these, and the names of Binney, Williamson, Schunk, Angus Smith, Young and others, show that the spirit of scientific inquiry was active." Wemyss Reid, (ed.,) Memoirs and Correspondence of Lyon Playfair, pp. 73-74.

of his energy and intellectual capacities Binney soon became an authority on the fossil botany of the coal measures, and his work in this field secured his fellowship of the Geological Society of London.[1] Over forty-two years Binney produced 134 learned papers on geology - one of his earliest was a joint effort with John Hawkshead Talbot on the petroleum found in Down Holland Moss near Ormskirk.[2] Even though Binney never wrote on the other sciences he had wide scientific interests and a remarkable knowledge of the details of production in the chemical industry. This wide knowledge of science made him the confidant of many eminent scientists, notably Joule, and led him to accupy all the executive offices of the Manchester Literary and Philosophical Society. Admitted to membership on 25 January, 1842, he was in turn Secretary, Vice-President for fifteen sessions and President for eight, symbolically dying in office.[3] Binney in the 1850s was influential in making the Manchester Literary and Philosophical Society into a body with extensive European contacts.[4] He was also a Fellow of the Royal Society and an Honorary Fellow of the Edinburgh Geological Society.

1. H.B. Woodward, The history of the Geological Society of London, London 1908, pp. 166-167.
2. R. Angus Smith, op. cit., p. 454
3. Complete list of the Members and Officers of the Manchester Literary and Philosophical Society, 1781-1896, Manchester 1896, passim.
4. R. Angus Smith, op. cit., p. 287.

Apart from his scientific reputation, Binney had other assets in his personal characteristics. He was strong-willed, diligent, self-made, tenacious as well as legalistic, an admirer as well as an exponent of self-help. Binney's personal qualities presented common ground with Young's, as, indeed, did his experience. Both were of an age; both were contemporaries in the Manchester Literary and Philosophical Society; both were interested in the broad issues of science; both were radicals, liberal activists, men of action. In addition, Binney had outstanding personal regard for scientifically-inclined self-made men rather than trained, ivory-towered intellectuals. For instance, in 1848 he was instrumental in securing a government pension of £50 for William Spurgeon, an early pioneer of electricity.[1] Binney believed that the inventor deserved his reward - and so did Young.

Hand-in-hand with Binney's interests went his investments. He was providing Young with short-term loans;[2] these were the capital reserves with which the business of Bathgate was started. He not only possesed some capital - he was the link to more. This was why Young did not need to take up Mr. Clow's offer of capital "for a consideration"[3], and why Bathgate was never in danger of becoming a subsidiary to Tennants of St. Rollox.

1. R. Angus Smith, op. cit., p. 267
2. Thom Collection: Laboratory Notebook, 1850-51, 18 September 1850. C.f. Pocket Book, 1850-51, 11 October 1850, where Young used his railway shares as security for the advance of £320. 10. -.
3. Thom Collection: Pocket Book, 1851-52, 19 July 1851, "... Clow offered to find cash for a consideration ..."

A legal partnership with Binney was thenatural corollary of this financial nexus. At the 1850 meeting of the British Association in Edinburgh Young first approached Binney for his capital.[1] By September Binney was committed,[2] although it was not until twelve months later that the indenture of partnership was drawn up. It seems likely that Binney was first approached for a direct loan of £3,000 but by October,[3] 1851 had become indispensible to the partnership's credit-worthiness. Binney's acumen, his knowledge of coal-measures, his interest in geology and his willingness to risk his capital were all points of direct contact with Young. He had useful friends: one of them, Dr. John Leigh, a lodger in Binney's house at Chatham Hill, was consultant to Manchester Gas-Works and he brought Boghead coal to Young's notice without knowing of Bartholomew's earlier approach.[4]

Unfortunately, Binney has not received real credit for his contribution to Young's success.[5] Angus Smith was anxious to suppress the rumour that Binney had been the geological genius behind Young's invention. He, therefore, tended to play down Binney's undoubted abilities as a geologist. Not that Binney's geological knowledge or reputation was directly

1. Binney & Co., v. The Clydesdale Chemical Company, 1860, p. 88, Evidence of James Young.
2. Laboratory Notebook of James Young, September 1850
3. Young mentions £3,000 as the sum borrowed in a costing break-down of intended production in 1850
4. Fernie and Others v. Young and Others, House of Lords, 1864, p. 627, Evidence of John Leigh.
5. R. Angus Smith, op. cit., pp. 447-464.

useful to Young at this stage. It was not. But Binney's readiness to invest his money in Young's brains and Meldrum's application can only be explained in terms of the community of interests which existed between them. Binney was clearly impressed by Young and Meldrum; events and profit margins were to prove his investment decision wise. But in the autumn of 1850 he clearly had doubts about the legal validity of Young's specification,[1] and yet he went ahead. He could not have known what prosperity the future held in store; in 1850/1851 he was taking a risk based not merely upon entrepreneurial assiduity but also upon a common, sympathetic, social milieu.[2]

Others have imagined that Binney was merely a sleeping partner. This is to believe that residence or presence in Scotland is the only criterion of direct participation and to misunderstand Binney's vocational ability. He was an expert country attorney with a swollen practice in Manchester and district, which often took him far afield but especially to London. He was an active partner: first and foremost, the legal watch-dog, the expert on patent law, the ever-vigilant, subtle underminer of those who attempted to infringe Young's patent. Generally, the news of an infringement comes

1. Thom Collection: Laboratory Notebook, 1850-51, 16 September 1850
2. E.M. Bailey, The Young Memorial Lecture, 1948, passim; R.J. Conacher, "Dr. James Young - a brief biography" in Oil Shale and Cannel Coal, (Institute of Petroleum), London 1938, p. 4; D. Murray, Paraffin Young : the world's first regular oil man, London 1959, pp. 22 sq.

to the other partners from him; generally he remains in the background, dominating legal strategy, exploiting the weaknesses of their opponents, shrewdly calculating the odds and lessening them. He was the master of coal leases and responsible for the negotiations with Russel and Son, the lessees of the Boghead cannel coal. This could be done by post and by the occasional fleeting trip to Scotland. Above all, Binney provided the partnership with its link with industrial Lancashire and the West Riding; he was close at hand to the most important wholesale agency for Young's oil, J. Hurst and Company of Manchester.

Between James Young and Edward Meldrum there was less division of labour, more direct personal contact and more opportunity for arguments over minor details of production. Much less is known of Meldrum than of the other two partners; he seems to have made less firm impressions on contemporaries than either Binney or Young. It seems that Edward Meldrum became known to Young during Young's last months at Muspratt's works,[1] and while Young was with Tennants, Clow and Company, Meldrum and he corresponded on chemical subjects.[2] Meanwhile, Meldrum gained valuable industrial experience, particularly

1. Thom Collection: Pocket Book, 1843-1844, "Tell Meldrum about advertisement in Mercury".
2. The stannate of soda patent and the preparation of oxalic acid were two subjects in this correspondence. Thom Collection: Edward Meldrum to James Young, 15 October 1847.

in tar distilling.[1] Young was so impressed with Meldrum's ability as an experimentalist that it is not surprising that he wanted Meldrum as his works manager at Riddings.

Meldrum's virtues were essentially those of a practical man, prepared to accept the main lines of thought of other more original and dogmatic men. He was particularly impressed by Young's inventive capacity and originality and never thought of trying to steal Young's thunder. If anything, Meldrum was too self-effacing and modest; his characteristic of giving credit to others was probably matched by lack of confidence in himself. His approach to production was essentially empirical: he was not afraid of novelty but was not capable of initiating vital changes in production. He left that to Young and seemed to regard it as Young's business alone. He was an ideal plant manager, and this Young was not. Meldrum was more calm, more placid that Young, not so vitriolic, more likely to come to terms with the day-to-day management of a new industrial organisation likely to have many nerve-wracking teething problems. He was careful, conscientious and patient. Although he clearly knew the industrial processes very well, his later descriptions lacked the fluency and forcefulness which Binney's possessed. Like Young, he was a man of action rather than a man of conversation. He was likely to be led by Young and Binney rather than to lead them.

1. Binney & Co., v. The Clydesdale Chemical Company, 1860, p. 163, Evidence of Edward Meldrum.

This partnership, therefore, consisted of three hard-working, conscientious individuals, each with his own contribution to make. Young gained the capital assets and legal experience of Binney; he was freed of the trivia of works management by Meldrum. Meldrum gained a new status: he, like Young, moved from the ranks of industrial management to business ownership. Binney shared the financial benefits of Young's inventiveness and Meldrum's industry. But in this partnership there was more than material convenience for the three partners. It was a triumph of human and business organisation. Meldrum, Binney and Young formed three companies - E.W. Binney and Company, E. Meldrum and Company and James Young and Company. The first two were to operate from Bathgate, and the last from Manchester. In fact, for much of this period, they were generally known as E. Meldrum and Company.

1. Fernie & Others v. Young and Others, Lords, 1864, p. 270, Evidence of James Young; c.f. also The Scotsman, 8 February 1869.

2. The Initial Plant and the Initial Products

In the partnership, the locus operandi was the subject of much discussion and argument. Young, Meldrum and Binney visited Fife as well as inspecting the county of Linlithgow.[1] The price of Boghead coal in 1850 - with the prospect of delivery charges at the rate of 1d. per ton - was the main economic argument in favour of the Bathgate area, for the Brown Methil coal of Fife was almost as good for the purposes of the partnership but slightly more expensive.[2] Instead of acquiring a site on the banks of the Forth to command the coalfields of Fife and Linlithgowshire, they, therefore, settled on Bathgate,[3] having already made a firm contract for the supply of a large quantity of Boghead cannel coal with Russels, the only company working that particular coal in 1850.[4] The site was small - about three acres - but with room for expansion in an area not too far distant from lucrative shale-beds, later to be the material foundation of the industry. Their decision was also fortunate for the supply of Brown Methil turned out to be irregular, difficult to work, and expensive to screen from the other coals in the Methil seam.

1. Binney and Co. v. The Clydesdale Chemical Company, 1860, pp. 161-162, Evidence of Edward Meldrum.
2. Ibid., p. 101, Evidence of James Young
3. In his Pocket Book, 1851, Young lists one significant past expense: "... spent £10 when layout of works and land purchase was done at Bathgate ..."
4. Fernie and Others v. Young and Others, House of Lords, 1864, p. 229, Evidence of James Young.

During the winter months of 1850-51 the firm of John Scott of Inverkeithing built the first mineral oil plant in Scotland to Young's specifications.[1] On 8 January, 1851, Young recorded, no doubt with some sense of satisfaction: "... a great deal of work has been done the works are nearly ready ..."[2] Shortly afterwards, and certainly by 24 February, 1851, this plant began production.[3] Later, Young recalled that "... we commenced making paraffine oil in the beginning of 1851 ..."[4]

But there was no public furore in Scotland. This new industry began in a shroud of secrecy. Even Lyon Playfair was not informed until the last minute.[5] Elaborate precautions were taken to prevent any leakage of information. These really began when Young did not enrol his specification until the end of the statutory six months in April, 1851. Nor in it did he mention that his prime raw material was to be Bog-head cannel coal.[6] This omission may well have been the first stage in forestalling patent infringements and in delaying the inevitable patent litigation. There were other inhibitions, physical, technical and legal. A high wall was built around the site to keep out intruders; two heavy wooden gates which

1. Ibid., p. 356, Evidence of William Walls, Scott's foreman
2. Journal and Laboratory Notebook, 1850-1851, 8 January, 1851.
3. Pocket Book, 1851, 24 February
4. Fernie and Others v. Young and Others, House of Lords, 1864, p. 235, Evidence of James Young.
5. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 109, Evidence of Lyon Playfair
6. British Patent, No. 1392, 17 October, 1850; Specification enrolled 16 April 1851.

provided the only entrances to the works were constantly guarded; the workmen, to prevent industrial espionage, were employed under bond of secrecy. To further improve security Young concealed his trade secrets beneath a layer of misleading names which he applied to the various products: crude oil was called Black Liquor; crude oil after the first distillation, Green Liquor; lubricating oils after the extraction of paraffin wax, and before the acid and soda treatment, Blue Oil; refined lubricating oil ready for sale was called Finished Liquor. These names gave no exact indication to strangers as to the stage in refining to which the products belonged, but as time went on they became technical terms and survived as long as the industry itself.[1] A house was built at the works for Meldrum, the works manager, so that he could live on the job and supervise security personally. There was also an office and a laboratory. Generally, windows were few and high above the ground - those in the boardroom were over 8 feet from the floor - no ordinary mortals were to spy on conferences from outside.[2]

This security was effective in the Falkirk area, but it stimulated, just as it frustrated, local interest in the works. A local correspondent reported eighteen months after the plant opened:

1. I.I. Redwood, Mineral Oils and their By-Products, London 1897, pp. 6-7
2. H.M.S.O., The Oil Shales of the Lothians, (Geological Survey, 3rd Edition, 1927) p. 242.

> "These works have lately been erected at Boghead, near Bathgate. They belong to Messrs. J. Young & Co. of Manchester; but being conducted strictly as a "secret work", little is known in the district regarding the articles produced at them, and less of the means by which they are produced. Indeed, all that is known on the subject is, that in them there is used large quantities of the Boghead cannel coal, from which it is understood that oil and various other valuable substances are, by some chemical process, extracted ..." [1]

The physical appearance of the first Bathgate coal oil plant is something of a mystery, since there is no extant plan before 1868. However, from Young's and Meldrum's later statements and some contemporary evidence it is possible to build up a reasonable picture. Young estimated a weekly production which could be obtained from the through-put of six benches of retorts or about thirty retorts in all.[2] These alone would cost, according to the advice given to Young,[3] £60 per bench or a total of £360 for retorts. Young's plant design was dominated by at least one large chimney to which the brick fire kilns were connected by flues - fire-bricks at 7/6d per hundred[4] must have produced great additional capital costs. Above the three brick fire kilns rested the bench of five retorts laid out horizontally, three below and two above.[5] These horizontal retorts, normally sold to gasworks, were made

1. The Falkirk Herald, 9 September 1852
2. Notebook of James Young, 1851
3. Notebook of James Young, 1850. At this stage Young was thinking of four benches of retorts
4. Ibid.
5. Fernie and Others v. Young and Others, House of Lords, 1864, p. 464, Evidence of Dr. Thomas Anderson.

of cast-iron, usually seven and a half to nine or ten feet long and fourteen inches high. This section of the plant would have been subject to heavy depreciation charges for the unprotected cast-iron would oxidate in the heat. To prevent this it was decided "... to brick that portion of the retort where the flame was most violent to prevent the iron being burnt away ..."[1] for "... it is more economical to brick them in ..."[2] Even then, the horizontal gas-retort presented many technical problems to which there was no final solution.

Piles of Boghead cannel coal would be heaped near at hand to a coal-breaking machine which was steam-driven. The breaking of the coals into small pieces before charging the retorts was an important part of Young's process for a more uniform distribution of heat was thereby induced; this reduced fuel costs, accelerated destructive distillation and, ultimately, inventory turnover. Near the brick fire kilns would be the ordinary coal bunkers. One man would refuel the the brick fire kilns and charge the five retorts in one bench.[3] Each retort would normally hold up to 2 cwts. of coal and at the gas-works it was normal to pack in as much coal as possible for this made the coke compact and cheaper to produce. However, Young's process was more effective if the charge was much less than this maximum - some chemical consultants considered 100 lbs. to 1 cwt. the optimum charge![4] This, Young

1. Fernie and Others v. Young and Others, House of Lords, 1864, p. 333, Evidence of Edward Meldrum.
2. Ibid., p. 319, Evidence of Edward Meldrum.
3. Ibid., p. 1038, Evidence of Thomas Nesham Kirkham, gas engineer.
4. Ibid., p. 385, Evidence of Dr. William Odling, F.R.S. c.f. also Evidence of James Young, Ibid., p. 228.

learned from his own experience for Hugh Bartholomew, his adviser on such matters[1], had only gas-works experience to rely on, and there the emphasis was on the economic production of coke.

Retort techniques were mechanised as much as possible, at first. The charge had to be pushed along the retort gradually towards the source of heat. This was done by a steam-driven poker device, rather like Hompesch's screw, which Young had first seen in use before 1840 at Truman's Brewery in London[2]. This screw presented another technical problem for it did not reach the level of expected performance and within a year had to be scrapped[3]. The most important part of the process was the gradual arrival at the correct temperature - of about 800°F - for destructive distillation. Too sharp or too great an increase in temperature adversely affected the distillate and could make it useless. The greater the heat used to accelerate the distillation process, the greater the specific gravity of the oil; this was bound to affect the standard of the product for the best lubricants have low specific gravities. If the heat used was excessively great, a maximum quantity of permanent gas would be produced and a minimum of oil vapour; this oil vapour would condense as a crude "naphthaline", popularly known as 'the gas-maker's pest'[4],

1. Notebook of James Young, 1850, 6 September. "Enquire of Bartholomew all about charges of retorts".
2. Laboratory Notebook and Journal, 1850, 12 September 1850, "I saw the screw used in Truman's the Brewers when I went to London with Graham"
3. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 170, Evidence of Edward Meldrum.
4. Fernie and Others v. Young and Others, Lords, 1864, p. 790, Evidence of Dr. Henry Minchin Noad.

highly volatile and with no commercial value. Care in reaching and maintaining the right temperature was, therefore, vital to life and profit. Capital investment in a modern plant, no matter how farsighted, could not eliminate the opportunity for human error and negligence. The process was really at the mercy of the labour force checked only by the level of managerial supervision.

Assuming that this part of the process was correctly executed, the crude oil was given off as a vapour, which passed from the retort through four "worms", - iron pipes about four inches in diameter, encased in a refrigerator, into a condensing tank 18 feet long, 3 feet wide and 3 feet deep.[1] The refrigerator was full of water which had to be kept at about $55^{o}F$ so that the paraffin would not crystallise and block the "worms". This was also a vital safeguard since blocked "worms" could cause an explosion with consequent danger of fire and wholesale damage to the plant. After the oil vapour passed from the retort the door was opened and the exhausted charge withdrawn, after the ash had been raked out. This took the form of a black, porous, poor quality coke about half the volume of the original charge.[2] At first, its uses were limited. Gradually, instead of being sold merely for lime-burning, brick-making, and baking - or used in small quantities at the plant in the

1. Notebook of James Young, 1850
2. Fernie and Others v. Young and Others, Lords, 1864, p. 228, Evidence of James Young; and The Daily Review, 13 March 1866

brick fire kilns - its uses were extended to welding iron, malting and grain drying, and brass smelting. After Thomas Graham became Master of the Mint in 1855, Young's coke was used to smelt the brass coinage during Graham's reform of the coinage.[1] There was also the waste ash from the Boghead cannel coal which Meldrum, misguidedly, perseveringly, but unsuccessfully, tried to sell as manure:

> "...I have got the farmers round the chemical works to try it over and over again, but they don't think very much of it ..." [2]

The farmers were wise, since the ash from Boghead coal had no value as a fertiliser. Possibly, Meldrum and Young believed that the slight amounts of carbon and nitrogen it contained would be useful. But, despite the tradition of Dundonald and the application of chemicals to agriculture in the 1790s, both farmers and chemical manufacturers were relying on empiricism rather than an adequate chemical theory - this was even the case in the 1860s when sulphate of ammonia for the first time became a significant product of the Scottish oil-shale industry.

The process from coal to oil-condensation took from five to six hours[3] and could not be much reduced as long as the original horizontal retorts were used. The crude paraffin oil, a black viscous liquid, was never sold except in very small

1. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 181, Evidence of Hugh Bartholomew, and The Daily Review, 13 March 1866.
2. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 177, Evidence of Edward Meldrum
3. Fernie and Others v. Young and Others, House of Lords, 1864, p. 230, Evidence of James Young.

quantities "for smearing sheep".[1] It was run from the condenser into large malleable iron stills containing several hundred gallons. In these it was refined using sulphuric acid and caustic soda. Under this treatment the oil became greenish in colour and was transferred to other stills where it was further refined to obtain the purer, very profitable oils.[2] The lightest fraction, naphtha, generally colourless but with a brownish tendency, was often sold in large quantities in the early days of the partnership as a solvent to India-rubber manufacturers and as a substitute for turpentine in the manufacture of paints and varnishes; it was also used in textile mills as a "slubber" substance for removing oil stains and impregnations. Indeed, it could be used for cleaning many widely differing materials.[3] It was a substance quite distinct from "benzole naphtha" - or petrol - with which it was profitably confused at the time: "... We gave it a wrong name to begin with but we stick to that name ..."[4]

However, the "naphtha" was generally left in the next light fraction which was Young's "paraffine burning oil",[5] another misnomer since it contained very little paraffin wax, which would have clogged the wick and impeded burning. The heavier fractions, containing most of the paraffin wax, were

1. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 90 and p. 102, Evidence of James Young
2. Ibid., p. 91, Evidence of James Young
3. Ibid., p. 107, Evidence of James Young, and c.f. The Daily Review, 13 March 1866
4. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 174, Evidence of Edward Meldrum
5. Ibid., p. 108, Evidence of James Young

sold as paraffin lubricating oil, the staple product of the partnership throughout its early years. Very little paraffin wax was separated at first, although Young certainly knew of its presence and possible separate uses. He mistakenly assumed that it provided the basis for the high quality of his lubricants.[1] By 1860, however, Edward Meldrum was able, succinctly, to state:

> "... The products from the distillation of crude paraffine oil are a colourless naphtha, different from benzole naphtha, paraffine burning oil, paraffine lubricating oil and paraffine ..."[2]

These products had to be stored and tanks for this purpose, and storage space for purifying agents and for other natural oils, had to be provided at the plant. There was need for at least one steam engine and, of course, much expensive equipment, in addition, had to be kept free from the hazards of the Scottish climate. There must have been much ancillary civil engineering - for water supply, for example - and this must have raised the cost of the plant. Young's early estimates[3], excluding raw materials and the financing of the pipe-line of production and marketing, varied between £500 and £800, but the later operating costs of the plant included a figure for the repayment of interest on a loan of £3,000.[4] This was probably a more realistic figure and explains the laments of the partnership about inadequate credit facilities in Scotland.[5]

1. Ibid., p. 103, Evidence of James Young
2. Ibid., p. 164, Evidence of Edward Meldrum
3. Notebook of James Young, 1850
4. Notebook of James Young, 1851
5. Fernie and Others v. Young and Others, House of Lords, 1864, p. 264, Evidence of James Young.

TABLE 6

APPROXIMATE PRODUCTION OF COAL OIL, AND, THEREFORE, CONSUMPTION OF BOGHEAD CANNEL COAL (1851-1864)

	Consumption of Boghead	Total Equivalent Production of Coal Oil
1851-1856	10,000 tons	1 million gallons
1856-1861	40,000 tons	4 million gallons
1861-1864	35,000 tons	$3\frac{1}{2}$ million gallons

3. Industrial and Commercial Organization

a. Raw Materials and Costing

Effective demand for Young's lubricating oil, the main product, did not, at first, exceed the capacity of the Bathgate plant. Young intended the plant to produce 900 gallons per week which would be mixed with an additional 600 gallons of natural oils.[1] Total annual production of coal-oil was, therefore, to be between 45,000 and 50,000 gallons. This rate of production would require 22½ tons of Boghead cannel coal per week or over 1,000 tons per annum.[2] In fact, in the second week of July, 1851, 30 tons were distilled,[3] but this seems to have been exceptional for only a few hundred tons were used in the first year.[4]

The supply of Boghead cannel coal to the Bathgate plant was the key factor in production since it was used "almost exclusively" between 1851 and 1864.[5] Over these years less than 400 tons of other types of cannel coal had been consumed,[6] although many different experiments had been conducted without affecting production. It is, however, difficult to assess exact consumption of this basic raw material - and, therefore, production. The Boghead cannel coal had been first worked

1. Notebook, 1851
2. Ibid.
3. Ibid., 6-13 July 1851
4. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 100, crossexamination of James Young.
5. Fernie and Others v. Young and Others, 1864, p. 263, Evidence of James Young.
6. Ibid., p. 264, Evidence of James Young

commercially by Russel and Son of Falkirk on the Torbanehill estate of Mr. and Mrs. Gillespie from the end of 1849;[1] the area was a mining speculator's paradise rich in ironstone, fire-clay, steam-coal as well as Boghead cannel coal.[2] According to Russels' sales-clerk, Robert Marshall, the first general sales of Boghead cannel coal occurred in January 1850 - but only in small quantities.[3] The contract with Young and his associates was their first important contract, and a missive of agreement was signed in October, 1850, before Young and his assodiates became legal partners and just before Young took out his patent.[4]

This ground-floor advantage - a contract for 10,000 tons at the pithead price of 13/6d per ton - was not exactly exhilarating at first:

> "... We were going on with fear and trembling and I think there was a break in the contract I think it was 5000 tons certain with the option on our part to take as much more at a given price it was understood that we paid a little more money to get this option ..."[5]

But even Robert Marshall could not give precise details about actual deliveries. His recollection in 1864 was that this first contract had lasted mœ than five years, but there had been several contracts for large quantities since it ex-

1. Mr. and Mrs. Gillespie v. Messrs. Russel and Son, Court of Session, Edinburgh 1853, p. 2. Counsel for Pursuers
2. Fernie and Others v. Young and Others, 1864, p. 709, Evidence of Dugald Campbell
3. Ibid., pp. 295 sq., Evidence of Robert Marshall
4. Binney and Company v. The Clydesdale Chemical Company, p. 187, Evidence of Robert Marshall
5. Fernie and Others v. Young and Others, p. 264, Evidence of James Young

TABLE 7

OUTPUT OF MIXED OIL	(mainly for lubrication) (3 coal oil : 2 natural oil)
1851-1856	$1\frac{2}{3}$ million gallons
1851-1852	c. 50,000 gallons
1852-1854	c. 620,000 gallons
1854-1855	400,000 gallons
1855-1856	c. 480,000 gallons

pired.[1] There seems to have been sharp fluctuations in the demand curve of the Bathgate plant in its early years, an indication, perhaps, of early technical and development problems and, certainly also, of the need for an energetic sales programme. Young's own impressions of 1851 and of the first year's operations with Boghead cannel coal were similar to Marshall's:

"... we began with a very few hundreds ..."[2]

By 1854 Young was talking of a maximum output-rate of 400,000 gallons of crude oil, per year, the equivalent of roughly 5,000 tons of Boghead cannel coal.[3] But fluctuations in production were still great. From 1854 to 1860 production rose to over one million gallons a year, now mostly refined lamp oil;[4] yet in 1858 sales slumped, and there was deliberate underproduction. Nevertheless, it was a year of extensive capital re-equipment and heavy maintenance costs, especially for the replacement of retorts; also, it was a year of large-scale experimental extraction and purification of paraffin wax.[5] Young and his associates took the opportunity given by their saturation of the market to modernise their capital equipment - and this was bound to restrict output without any

1. Ibid., p. 304, Evidence of Robert Marshall
2. Binney and Company v. The Clydesdale Chemical Company, p. 100, Evidence of James Young
3. Young and Others v. White and Others, Queen's Bench, 1854, p. 11, Evidence of James Young
4. Binney and Company v. The Clydesdale Chemical Company, p. 100 and p. 103, Evidence of James Young
5. Notebook and Business Journal, 1856-1861, Sept. - Dec., 1858

TABLE 8

OUTPUT OF PURE COAL OIL (mainly for Lamp-oil)
1856-64

1855-1856	c.	320,000 gallons
1859-1860		1,000,000 gallons
1862-1863		2,000,000 gallons
1863-1864	c.	1,200,000 gallons

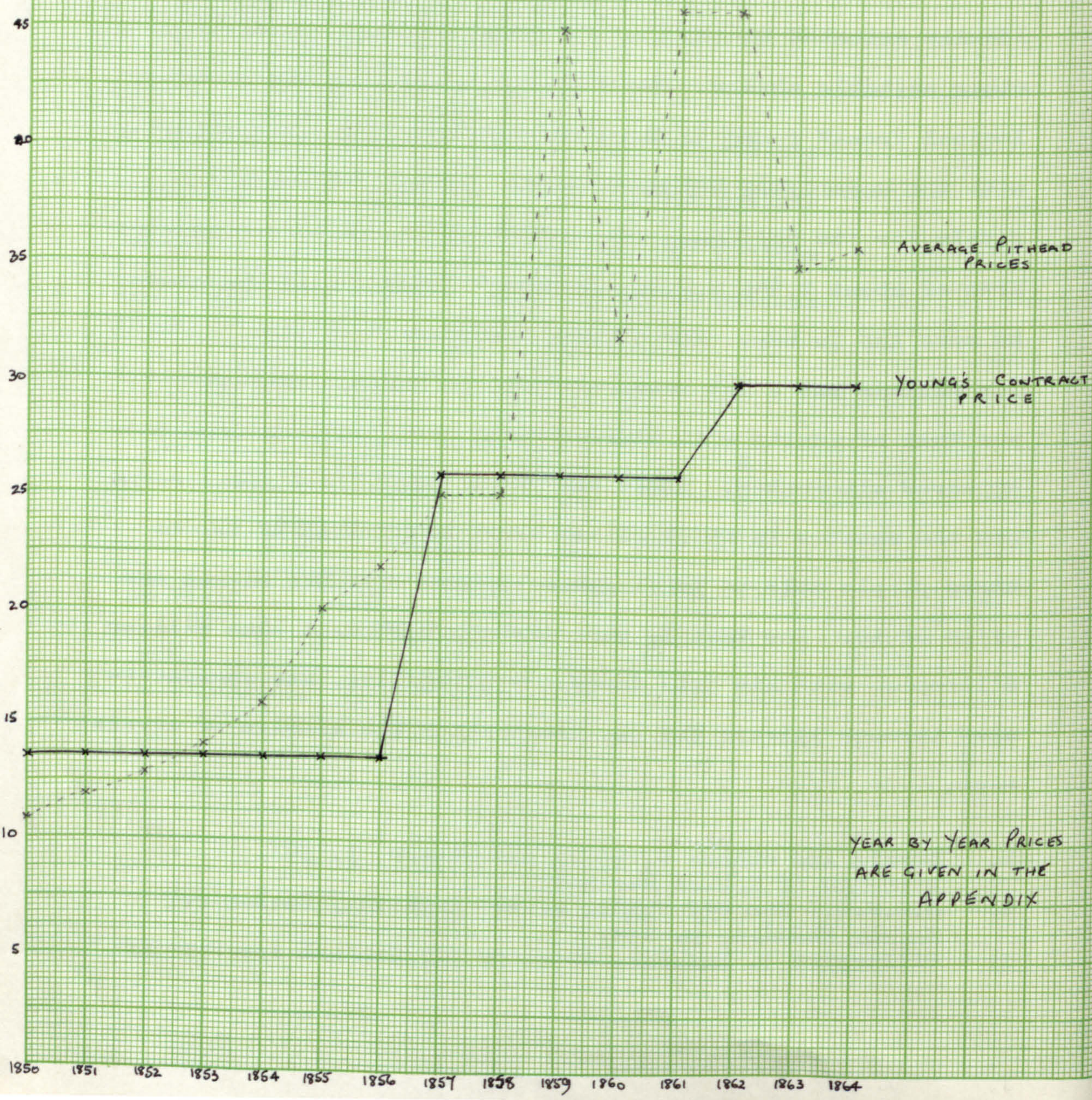
rundown on the skilled labour force. Between 1860 and 1864, when Young's patent expired, production steadied at about 1,200,000 gallons of finished oils, although in 1862 there was a peak when production must have reached about two million gallons.[1]

Such an increase in production was likely to be matched by an increase in raw material prices. The Bathgate plant was ideally situated to exploit the local Boghead cannel - but not other suitable shales. And Boghead cannel coal was a "geological freak" found in the coal measures near their junction with the underlying Millstone grit. It was not in great supply for its incidence was confined to a relatively small area of about 2,500 acres. It became increasingly expensive to mine and to buy. Its average thickness was an 11" seam; its maximum was a 28" seam. Like other cannel coal seams it was full of faults - it thinned frequently and sometimes disappeared altogether.[2] There was great competition for leases, and the estates in which it was found were owned by two or three people able to exert great control over the mining and price of it. The Russels were a shade fortunate that William Gillespie, with his avid taste for litigation, was incapacitated through illness for two years after the missive of agreement.[3]

1. Fernie and Others v. Young and Others, p. 305, Evidence of Robert Marshall
2. H.M.S.O., The Oil-Shales of the Lothians, Geological Survey Memoirs, p. 244.
3. Gillespies v. Russels, 1853, p. 4., Counsel for Pursuers

TABLE 9

BOGHEAD COAL PRICES (SHILLINGS) 1850 - 1864



In these circumstances it is not surprising that the price of Boghead cannel coal rose rapidly in the free market. Young and his associates in 1851 were paying 13/6d per ton with a 1d delivery charge for the two miles to the Bathgate works.[1] This price was 20% higher than the prevailing pit-head price, but land-sale prices in the Glasgow area and sea-sale prices at Leith averaged 15/- per ton.[2] From the beginning Young and his partners gained greatly from their advantageous competitive position: they paid the lowest possible transport costs on their most bulky raw materials which were never entirely offset by higher charges on their finished products. In addition, they gained greatly by bulk-buying in a rising market. By 1853 the average pit-head price was that paid as the land-sale price by Young and his partners;[3] and between 1853 and 1856 the bulk of the initial contract was supplied at a much lower price than the prevailing pithead prices. On 17 March, 1855, Young recorded that coal-prices were very high; his friend, Hugh Bartholomew, was refusing to buy for two months;[4] "... they must go down ..."; Young was trying to take precautions against the end of his first contract with Russels: "... Monkland Iron and Steel Coy offers coals at 25/- at the Broomielaw the charges are 4/8½ per rail cartage 1/6 ..."[5] But this price , because of the high transport costs,

1. Fernie and Others v. Young and Others, p. 264, Evidence of James Young; c.f. Binney and Company v. The Clydesdale Chemical Company, p. 187, Evidence of Robert Marshall.
2. Fernie and Others v. Young and Others, p. 229, Evidence of James Young
3. See Table No.9. Boghead Coal Prices.
4. Pocket Book, 1855, 17 March
5. Ibid.

was not competitive with the pithead price of Boghead which stood at £1 per ton.[1]

The other partners, and particularly Edward Binney, were also agitated about the problem of supply of raw materials. In 1856, when the contract ran out, there was difficulty about getting further supplies of Boghead at prices that Young and his partners considered reasonable.[2] Russel was standing firm to get the highest possible price, and Gillespie was holding tight to his mineral reserves. Binney and Meldrum, having unsuccessfully urged Young to join them, took a lease of a Methil mine.[3] In April and May Young himself was looking for suitable coals at Paisley and at Capeldrae in Fife;[4] he was "much troubled .."[5] Purchases were made of Methil coal, just enough to bring Russel back to his senses,[6] and a new contract for bulk-purchase at 26/- per ton was made.[7]

The sharpest increases in the price of Boghead cannel coal then occurred. This was only partly due to demand from other firms operating under licence from Young. It was largely caused by the competition between gas companies, since Boghead was not only the best oil-making coal but also the most prolific gas-producing coal in Britain. In addition, several of

1. See Table No. 9.
2. Binney and Company v. The Clydesdale Chemical Company, p. 101, Evidence of James Young
3. Ibid., p. 170 and p. 173, Evidence of Edward Meldrum
4. Notebook and Business Journal, 1856-1861, April-May, 1856
5. Ibid., 6 May, 1856
6. M.S. "Cannel Coal used at Bathgate Chemical Works to make Paraffine Oil" (2 fo.) This lists 2 purchases of 24 tons per month in April and May 1856. The price was 14/- per ton
7. Binney and Company v. The Clydesdale Chemical Company, p. 101, Cross-examination of James Young; c.f. also Fernie and Others v. Young and Others, p. 305, Evidence of Robert Marshall

the gas companies were diversifying without incurring further capital costs: they were manufacturing naphtha for general sale and lubricating oils and paraffin wax for their own use.[1] Indeed, until 1857, the main sale by Russels was not to oil-works at all but to gas companies.[2] There also developed an extensive but ephemeral export trade: Young, in 1858 recorded that he:

> "... called on Young the shippers saw the partner not Young he said 42/6 might be given for coal in Glasgow the carriage he said from Bathgate was 4/3 ..." [3]

The principal overseas demand was from the American coal-oil industry, and, in consequence, the price of Boghead rose in 1859 to over 40/- per ton and on occasion reached 45/-.[4] Young

> "... on the way from Edinburgh to Glasgow came as far as Falkirk with Russel he told me he was selling at 42/6 at Boness or as good as 40/- at Bathgate ..." [5]

This period of famine prices ended suddenly. First, suitable coals such as Breckenridge cannel coals were discovered in the United States, and, secondly, the American natural petroleum wellssoon began to demolish the competitive power of their native coal-oil industry.[6] Nonetheless, the prevailing market

1. This is well borne out by the issues of the Journal of Gas Lighting during the Torbanehill Coal Case 1853/1854 and the case in Queen's Bench between Young and Others and White and Others, 1854, c.f. also Pocket Book, 1857, 2 August.
2. Fernie and Others v. Young and Others, p. 303, Evidence of Robert Marshall
3. Notebook and Business Journal, 1856-1861, 11 February 1858
4. Fernie and Others v. Young and Others, p. 306, Evidence of Robert Marshall
5. Notebook and Business Journal, 1856-1861, 17 February 1859
6. T. Antisell, The Manufacture of Photogenic or Hydrocarbon Oils, New York 1860, p. 133

price of Boghead in 1862 varied between 40/- and 46/- per ton,[1] but this was a year of peak demand, and there was little coal available for day-to-day sale since contracts had to be met first.[2] In 1863 the price fluctuated around 35/- and in 1864 it was 36/-.[3]

Already, by 1860, Young and his partners were well established as Russels' best customers. The highest price they paid for Boghead was 30/- per ton in 1864;[4] their general price was usually 5/- to 6/- below the average pit-head price for a particular year. We can be exact when we say that the cost of the prime raw material increased in price from 13/6 to 30/- or about 225% over the period 1851 to 1864. In the free market the pithead price varied, over the same period, from 11/- to 46/- and back to 36/-.

During the same period the cost of kiln coal, or basic fuel, doubled.[5]

PRICE OF KILN-COAL (1851-1864)

YEAR	Price per ton
1850/1851	3/- - 4/-
1863/1864	7/- - 8/-

1. See Table No. 9
2. Fernie and Others v. Young and Others, 1864, p. 284. Evidence of David Landale, Mining Engineer to Russels' Trustees
3. See Table No. 9
4. Fernie and Others v. Young and Others, 1864, p. 265, Evidence of James Young
5. Ibid., p. 306, Evidence of Robert Marshall; c.f. also Notebook 1851

This was caused partly by increased labour and capital costs but more particularly by the increased demand in the Scottish Lowland region, the result of the expansion of coal-consuming industries in the market for similar types of steam-coal: the railway companies, the gasworks, the steelworks, the chemical and heavy engineering industries. However, fortunately for Young and his partners, this increase in fuel costs did not directly produce an equivalent increase in costs per unit of production. New retorts, the result of concentrated research and development, tended to reduce heat-loss and to eliminate fuel wastage, thereby cutting production costs. Improved refining methods assisted in a continuous process of increasing productivity by 50% using the same quantities of the basic raw materials.[1]

A further favourable factor was the fall in the cost of purifying agents, particularly of sulphuric acid. The local supply of this basic refining agent was always excellent for large-scale plants existed at Prestonpans, Burntisland, and the Tennants' works at St. Rollox, Dalmuir and Carnoustie.[2]

In Scotland, the production of sulphuric acid rose 250% between 1851 and 1864,[3] and methods of production were so improved that, although the price fell from £7 per ton to £5. 10/-, the profit-margin was actually widening.[4]

1. Vide infra, pp. 130 sq. and pp. 136 sq.
2. L.F. Haber, The Chemical Industry in the Nineteenth century, Oxford 1959, p. 16
3. Ibid., p. 103.
4. Notebook, 1851; also L.F. Haber, op. cit., p. 103.

TABLE 10

ESTIMATING PRODUCTION COSTS 1851

	Estimate (1) for 900 gallons		Estimate (2) for 1200 gallons
Boghead coal	15. 13. 9		20. -. -.
Purifying agents	15. 10. -.		9. 10. -.
Fuel costs	3. -. -.		7. -. -.
Wages & Salaries	9. -. -.		20. -. -.
Casks	4. -. -.	"wear	
Rent & Interest charge	4. 3. -.	and	12. -. -.
Transport costs to Glasgow	2. -. -.	Tare"	
TOTAL	£ 53. 6. 9.		£ 68. 10. -.

PRICE OF SULPHURIC ACID (1851-1864)

YEAR	Price per ton
1850/1851	£7
1863/1864	£5. 10. -.

By 1864 Young had been instrumental in designing a new sulphuric acid plant at Bathgate, indicating a well-defined urge to vertical integration which did not pass unnoticed.[1]

Costing such a process as Young's is never easy because of the existence of so many variables. For instance, although the price for Boghead cannel coal is certainly known, Young and his associates did not make long-term contracts for kiln-coal but bought at the prevailing market price. Nor was the price of casks so important to them that Young made allowances for this item on every occasion. However, one of Young's greatest attributes was his interest in costing. In 1851 he made at least two attempts to cost the process, and these have great value for our purpose. On the first occasion he was estimating costs for the production of 900 gallons of coal-oil, the quantity which he expected to be the average weekly output; on the second occasion he costed, in less detail, an actual week's production in July, 1851.[2]

1. The Daily Review, 13 March 1866
2. Notebook 1851

Costs per unit of production, according to Young's first estimate, would be 1s:2.455d per gallon; according to the second estimate, they would be 1s:1.7d per gallon. Thus, both attempts at costing the process reached remarkably similar results. However, the differences between the two groups of figures require some explanation. The sharpest difference was in labour costs; this was a result of technical difficulties at the plant which were solved by increasing the labour force. Thus, the second figure showing labour costs as 29.2% of total costs was probably more accurate than the first figure of 17% - but Young, at the time of his first estimate could not have foreseen that. If Young, at first, under-estimated labour costs he also over-estimated the cost of purifying agents. Here, the second estimate showing this cost as 14% of total costs, as against 30% in the first estimate, seems more reliable. The difference in fuel costs has already been explained. Young, in his first estimate, costed for kiln coal at 3/- per ton; in July, 1851 he paid 3/6d per ton.[1] Other interested parties were trying to guess Young's costs. Samuel Clift, writing to his business associate, Jesse Fisher, in May 1851 thought that Young's costs per unit of production came to about 2/- per gallon.[2] Even with this inflated figure the profit margin was remarkably wide.[3]

1. Ibid.
2. Samuel Clift to Jesse Fisher, 22 May, 1851, given in Fernie and Others v. Young and Others, 1864, Respondents' Appendix, pp. 43 sq.
3. Ibid.

No equally good figures can be given for later periods of production. But certain points can be made. Costs certainly rose but so did prpductivity. By 1864 twice as much saleable oil - without considering minor by-products - was being produced from 1 ton of Boghead cannel coal as in 1851 but the contract price of this raw material had increased by 122%. Any reasonably proficient plant manager in 1864 could obtain 80 gallons of burning oil worth £10 wholesale and 20 lbs of paraffin wax worth £1 from 1 ton of Boghead[1], the cost of which to Young was 30/-. In unit terms Boghead coal costs for 1 gallon of saleable oil were 4.2d in 1851 and 4.5d in 1864, an increase of roughly 7%. Kiln coal prices rose in this period by 100% but the fuel costs per gallon of saleable oil rose from 1.4d per gallon in 1851 to 1.5d per gallon in 1864, again by about 7%. The fall in the price of purifying agents by 21% could not entirely compensate for these increases for other costs in production and distribution had certainly risen: the cost of research, development and capital re-equipment, the cost of labour and of transport.

The decisive factor was, however, the margin of profit on the whole operation. This raises the great questions of commercial organisation and patent viability. Elasticity of demand, first for mixed lubricating oils, then for lamp oils,

1. Fernie and Others v. Young and Others, 1864, p. 806, Evidence of Benjamin Horatio Paul.

COST OF MIXED LUBRICATING OILS PER GALLON IN 1851-1856

TABLE 11

"COAL AND LARD OIL"

Coal Oil 3 gallons @ 1/3d	6.	9d.
Lard Oil 2 gallons @ 3/3d	6.	6d.
Cost of 5 gallons of mixed oil	13.	3d.
Cost of 1 gallon of mixed oil	2.	7.8d.

TABLE 12

"COAL AND OLIVE OIL"

Coal Oil 3 gallons @ 1/3d	6.	9d.
Olive Oil 2 gallons @ 4/-	8.	-d.
Cost of 5 gallons of mixed oil	14.	9d.
Cost of 1 gallon of mixed oil	2.	11.4d.

TABLE 13

"COAL AND SEAL OIL"

Coal Oil 3 gallons @ 1/3d	6.	9d.
Seal Oil 2 gallons @ 2/7d	5.	2d.
Cost of 5 gallons of mixed oil	11.	11d.
Cost of 1 gallon of mixed oil	2.	4.6d.

Source;

Notebook 1851, Fernie and Others v. Young and Others, 1864. Respondents' Appendix, pp. 43 sq.

paraffin wax, and volatile fractions sold as solvents, was one vital factor. The other was the capæcity of Young and his associates to maintain Young's patent rights, and their monopoly position of imperfect competition. For, in 1851, with a retail selling price of 5/- per gallon for mixed lubricating oils, Young and his associates had costs varying from 2/4.6d to 2/11.4d per gallon. This difference between cost and retail selling price was the greatest incentive for others to try to enter the industry.

b. Industrial Production and the Challenge of Technical Change

The threat of a rapid rise in raw material costs was bound to provoke a series of complex entrepreneurial responses among the partners; indeed, it was fundamental to understanding the later history of the partnership. For it provided the greatest possible incentive to vertical integration and to the development of new techniques of production. Both these courses necessitated considerable capital reinvestment and the deployment of a section of profits for this purpose. Everywhere enterprising manufacturers were well aware of the labour-saving nature of capital, and, therefore, of the need to plough back profits. But partners faced with the sudden responsibility of urgent investment in future raw materials and expensive research programmes were not generally so easily convinced as individual owners - and even if they were persuaded of the necessity, the variegated question of the allocation of priorities in making investment decisions still remained to be solved. Binney, Meldrum and Young had many differences

of opinion about this question, particularly after the partnership had reached the end of their first contract for Boghead cannel coal. From that time onwards their differences grew.

In the early days of the partnership, it was apparent that James Young's aggressive attitude towards technical innovation was due to his recognition that the application of science to production would enhance the productivity of labour; and indeed he combined a fanatical materialist belief in the power of applied science as a factor in profit-making with a dedicated intellectual's assiduous approach to the concept of academic research which remained with him all his life. But it was not the immediate external stimulus of raw material price inflation nor was it doctrinnaire entrepreneurial ideology which led Young and his partners to encourage and to finance extensive research. Rather was it the direct, piece-meal pressure from abundant technical and sales problems immanent in the development of a new industry and new products.

Young was singularly fortunate that his patent[1] was no obstacle to changes in capital equipment, since it made no claims upon the design of the apparatus or upon the layout of the plant. In fact, there was considerable change within a very short time, especially in the design of retorts. From the beginning of operations the horizontal gas retort proved to be far from suitable for oil distillation. First, there

1. British Patent No. 13,292, 17 October 1850. Specification enrolled 18 April 1851.

was no possibility of continuous production, since the fires had to be placed all round the bench of five retorts and the "low red-heat" temperature gradually reached. This arrangement lengthened the process and made it less economic, because much heat was lost and time wasted when the exhausted charge was withdrawn and the new charge inserted. Continuous charging was impossible.[1] This draw-back did not exist for gas manufacturers since coke, the exhausted charge, provided them with much of their profit. Even more disadvantageous was the fact that most workmen, even the highly skilled, found it difficult to gauge the gradation of temperatures for there was no exact method of measuring temperatures beyond 600°F - the pyrometer normally used for this purpose in gas-works was notoriously inaccurate.[2] In consequence, the quality and quantity of the oil products occasionally suffered particularly from the too rapid application of heat.[3] Production was far too much at the mercy of the good intentions and skill of the labour force.[4] A final weakness of the horizontal retort remains to be discussed. Even if the labour force was punctilious in the performance of its duty, the design of the retort

1. Fernie and Others v. Young and Others, 1864, p. 330, Evidence of Edward Meldrum
2. Binney and Company v. The Clydesdale Chemical Company, 1860, pp. 166 sq., Evidence of Edward Meldrum; Meldrum used a crude time-check system for estimating temperatures over 600°F.
3. Fernie and Others v. Young and Others, 1864, p. 230
4. A note on labour comditions, about which I was able to discover very little good primary evidence, is given on pp. 351-360

ensured that oil-vapour, produced in the course of the distillation process, tended all too frequently to condense within the neck of the retort. Thus, valuable products were lost - and productivity lowered - since this oil ran back into the retort and was further decomposed into volatile gases and liquids.[1]

All these weaknesses of the horizontal retort, which was designed specifically for gas production and not for oil distillation, could be avoided. The vertical retort, ten or more feet high, cased in brick to about five feet, "... one half larger in capacity at the bottom ..."[2] than the horizontal retort was first introduced at Bathgate in 1852. The design was not entirely new, for Lowe and Kirkham had patented an "upright retort" in 1839;[3] but Young greatly modified their concepts and the purpose of operations. John Gibson, who worked at Bathgate for eight or nine months in 1852, recollected the first trials in that year; when he returned to Bathgate in 1855 to work for eleven months, there were only three benches of horitzontal retorts remaining; all the others were vertical.[4] By 1860 there were none left.[5]

1. Ibid., p. 405, Evidence of Professor Thomas Anderson
2. Small Notebook, 1859-62, December 1859; c.f. also Young and Others v. Fernie and Others, Chancery 1862, "Proof of Mr. James Young"
3. British Patent No. 8298, 4 December 1839
4. Fernie and Others v. Young and Others, 1864, p. 1226, Evidence of John Gibson
5. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 170, Evidence of Edward Meldrum.

The advantages of the vertical retort were many. Arranged in benches of four, they could each take a charge of up to 5 cwt. instead of 1 cwt. Fuel costs were cut for continuous distillation was possible, and no time was wasted in allowing retorts to cool. The cannel coals, broken to suitable sizes, were loaded into a hopper standing on top of the retort, and they started from cold descending gradually through the retort towards the source of heat "... as slow as it can possibly be done ..."[1] Thus, working temperatures could be better controlled - there was no sudden alteration of temperature which occurred very often in the horizontal retort. Even better control of temperatures was made possible, when Young, in 1853, decided to install the retorts in what amounted to a brick oven, leaving an air passage between the furnace and the retort. Inventory turnover was likely to be quicker and productivity per man-hour much greater, since the time taken by the vertical retort process was half that taken by the horizontal retort process.[2] In addition, greater freedom from human error existed under the new process, since sight-holes could be placed in the top half of the retort, and it was even possible to regulate the size of coal dropped into the hopper by placing a suitable grid over it. Labour and fuel costs were cut; greater quality control of the product was achieved; greater capital redeployment was made possible,

1. Ibid., p. 169, Evidence of Edward Meldrum
2. Fernie and Others v. Young and Others, 1864, p. 228 and p. 231, Evidence of James Young

since there were savings on fixed assets. The vertical retort process was also space-saving, for as Edward Meldrum stated:

> "... we found it would require a little farm to have contained all our retorts because they occupied so much space ..." [1]

And, of course, the problem of space became more and more urgent as the demand for their oils grew.

If Meldrum recognised the problems, there can be no doubt that it was James Young's province to solve them: "... the idea occurred to Mr. Young to put the retort into a chamber and we did so ..." [2] The quality of the oil so improved and the handling of the raw material was made so much easier by the use of this vertical retort that according to James Taylor, one of Young's first employees, Young was beside himself with joy. He came to the works one morning, about a fortnight after the new retorts became operational and after testing the crude oil, suddenly rushed over tbe Meldrum nearly knocking him over in his enthusiasm. Vigorously shaking his partner's hand Young exclaimed: "Meldrum! I congratulate you, for our fortunes are made." [3]

Thus, technical difficulties provoked by the horizontal retort became the milieu for the evolution for yet another of Young's inventions with a much wider application in the gas industry than in the oil industry; indeed this patent was registered as "Improvement in Gas-making". [4] Instead of

1. Ibid., p. 329, Evidence of Edward Meldrum
2. Ibid
3. I.I. Redwood, op. cit., p.5
4. British Patent No. 326, 10 February 1852

Hompesch's steam-operated screw, Young devised a "stirrer" with radial spikes so that when it was turned manually by means of a pulley wheel, the materials in the retort were prevented from clogging and exposed more regularly to the action of the heat.[1] This allowed a more even distribution of heat and improved the quantity and quality of the oil and of the coke.

Experiments with retorts remained a standard part of research at Bathgate, even though the new vertical retort system was far more effective than the old method. Since Boghead coal tended to swell and coagulate when heated, difficulties arose in manipulating the raw material through these vertical cylindrical retorts. The "stirrer" was not foolproof, and often men were employed to push the spent coal downwards with iron bars. To overcome this problem Young had some tapered cylindrical retorts erected, with the larger end at the bottom;[2] in these the "stirrer" was more effective. Young tried new materials: in August 1855 he tried a new fire-clay retort instead of the normal brick-encased cast-iron one, but the experiment was a failure, since from the first the retort "... seemed to be cracked" and then it exploded dangerously and was "rendered hopeless..."[3] In October, 1856 Young tried to distill Boghead coal in a glass retort to see if he

1. Ibid. C.f. also Binney and Company v. The Clydesdale Chemical Company, 1860, pp. 169-170, Evidence of Edward Meldrum; and also Fernie and Others v. Young and Others, 1864, p. 329, Evidence of Edward Meldrum: "We took the screw and bungled over it a long while until we took to the other apparatus ..."
2. I.I. Redwood, op. cit., pp. 58-59
3. Pocket Book, 1855, 10-11 August 1855

could increase output, but again, this experiment had no positive results.[1] Nonetheless, this experimental work revealed a complex entrepreneurial response to a technical challenge; it was lengthy, tedious and dangerous. But it promised valuable returns as well as acting as a valuable stimulus in the absence of legal competition. It was a revelation of personal character, an indicator towards business success; Young's entry in his Journal for 23 August, 1858, is typical of many:

> "... went to Bathgate by 6.20 a.m. train from Buchanan St started kiln waited till Retorts had got through about 2 tons 15 cwts of coal got 250 galls black liquor. This gave about the same quantity of oil as the upright retorts ..." [2]

The sharpest reaction on research of the increase of Boghead coal prices was in the field of coal and shale distillation. This also involved local geological surveys - and had wider implications for the study of geology in Scotland - and speculation in mineral rights and land values. For one obvious way of relieving the dependence of the partnership on Russels' control of raw material supplies was to experiment with the distillation of other materials: with coals and shales. These alternative raw materials had first to be found and then assessed, before they could become the object of speculation.[3] Young and his son, James, did much of this spade-work. They were aided by Young's contacts especially among consulting

1. Business Journal and Laboratory Notebook, 1856-1861, 14 October 1856
2. Ibid., 23 August 1858
3. James Young, junior, (1838-1885), began work at Bathgate on 14 September 1852 and from the first concentrated on research and learning plant management. (Pocket Book, 1852, 24 September 1852)

mineralogists and mining engineers; their efforts were occasionally disguised or augmented by the employment of agents such as James Napier, an electro-chemist, Alexander Bryson, an Edinburgh watch-maker, David Landale, a mining engineer with many years experience in Scottish coal measures and Thomas Rowatt, Young's manager in Edinburgh. Binney and Meldrum also played their part, although, as we shall see, Young often viewed their efforts with more suspicion than approbation.

The problem of alternative raw material supplies became more immediate in December, 1852 when it became clear that William Gillespie of Torbanehill, the most important but not the only owner of Boghead coal, intended to sue the Russels for mining it. Young knew of the impending lawsuit for late in December, 1852 he was examined by Russels' counsel[1] and "swore affidavitt"[2] on 22 April, 1853; however, he was not called to give evidence in this celebrated trial, and, therefore, we can only suspect his vested interest. Before this, Meldrum had expressed an interest in Methil coal, and both Young and he spent some time in Fife, "looking at coal."[3] Young was also thinking of concentrating production in Glasgow and in the summer of 1853 was examining the Lanarkshire coals, particularly those from the district of Lesmahagow.[4]

1. Pocket Book, 1852, 29 December 1852
2. Pocket Book, 1853, 22 April 1853
3. Pocket Book, 1852, 15 November 1852
4. Pocket Book, 1853, July passim

The period 1855-1856 was full of anxiety for the partnership, since the first contract with the Russels was almost finished, and the prospects of hard bargaining were certain and daunting. By that time the research staff at Bathgate was growing and becoming more specialised. One of this group, John Murray, was almost exclusively concerned with coal distillation, apart from the considerable work done by James Young, junior,[1] and by Young himself. In April, 1856 Binney brought coal samples from a pit in the Methil district of Fife,[2] which, later, Meldrum and he leased, in the abortive hope that Young might agree to their building a new works in Fife.[3] Young spent much of his time prospecting, analysing and distilling. He analysed these samples from Methil;[4] he distilled coals from Capledrae, although in that coalfield there was "not much doing"[5] when he visited it; he went to see a new pit at Castlehead, Paisley, where he noticed a shale "which occurs above a coarse coal."[6] But the best results he obtained were from twelve pieces of Bathvale cannel which, when distilled, produced the equivalent of 98 gallons to the ton.[7]

1. Pocket Book, 1855, 17-21 May, 1855 passim; vide also Business Journal and Laboratory Notebook, 1856-1861, passim; also Laboratory Notebook, 1857-1862, which was almost certainly written up by John Murray, although Young made a number of entries.
2. Notebook, 1856, 16 April 1856
3. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 173, Evidence of Edward Meldrum
4. Business Journal and Laboratory Notebook, 1856-1861, 16 April 1856
5. Ibid., 6-7 May 1856
6. Ibid., 25 April 1856
7. Ibid.

Even after the signing of a second contract with Russels, and despite coal contracts placed elsewhere, this prospecting and analytical research went on apace. There were many isolated experiments with shale-distillation from 1854 onwards, although the most extensive were not undertaken until 1863 when William McIvor, another of Young's research staff produced the first thorough chemical analysis of the oil-shales of the Lothians under Young's direction.[1]

Young was ever on the alert for a good opportunity to speculate in mineral rights and land, but there must have been many moments when he felt abysmal failure:

> "Looked at a bed of shale about 6 feet thick in a quary at the Botanic Garden end of the Byres Road it is common shale wont burn disintegrates in the air when pounded looks like road dust has not a brown streak but a dull streak like road mad. did not distill it as it is hopeless..." [2]

Shales elsewhere appear to have presented greater opportunities for optimism for on 13 January, 1857 Young was thoughtfully musing on labour costs in shale-mining and wondering whether mechanisation was possible:

> "... could not machinery such as steam excavator be got to work coal shale where it is 12 or 14 feet thick it is soft that the tools would stand this should be thought of ..." [3]

But Young's patent was for the distillation of coal; he had a vested interest in preventing his process being applied to shale. This is why he did not begin distilling shales commercially until his patent expired.

1. Laboratory Notebook of William McIvor, 1863-1865, passim
2. Business Journal and Laboratory Notebook, 1856-61, 16 October 1856
3. Ibid., 13 January 1857

All the partners were anxious to extend their raw material supply, although Meldrum and Binney were not so affected by Young's desire "to keep shale quiet". Having already taken a lease of a colliery in Methil, Meldrum and Binney also applied privately to William Gillespie on 2 July, 1856 in the hope of securing a lease of Boghead cannel coal. This greatly alarmed Young, who discovered their negotiations and naturally suspected his partners of double-dealing with the enemy. Yet he was not above making private bargains himself.[1] On 5 February, 1857 Young went to Edinburgh to see Gillespie, but without results.[2] On 7 February, 1857 he noticed an advertisement in the North British Adertiser for a lease of the minerals in West Calder properties.[3] Through his agent, Thomas Rowatt, Young took up this option and also purchased Limefield.[4] In the spring of 1859, after some haggling over the price, the same agent completed Young's purchase of over 280 acres at Addiewell.[5] But these purchases were not for the partnership; they were for Young alone. They were in areas more favourably situated for the exploitation of oil-shales than Bathgate; they represent an individual's investment decisions in the face of a shortage of raw materials not the decisions of a partnership. They represented the seeds of dissolution.

1. In his small Pocket Book, 1857, Young enters his knowledge of Meldrum and Binney's activities
2. Pocket Journal, 1857, 5 February 1857
3. Ibid., 7 February 1857
4. Ibid., 24-30 January 1857, and Notebook, 1853-1857, 27 January, 1857
5. MS. Copy of Letter, John Graham to George Brownlee, 5 February 1859; Letter, George Brownlee to Thomas Rowatt, 17 March 1859; MS. Copy of Letter, Thomas Nicolson to Andrew Howden, 2 May 1859. These letters give the main details relating to the purchase of the very valuable Addiewell estate.

Research in refining techniques was a constant preoccupation of the partnership. Meldrum and Young were both anxious to make better and safer lamp oils. They were singularly fortunate that Boghead cannel coal, unlike most other good gas coals, did not produce great quantities of ammonia and sulphur compounds when being distilled.[1] This made their task much easier - would-be refiners in Lancashire and Shropshire were having great difficulties, simply because the cannel coals they commonly distilled, notably Wigan cannel, yielded a heavier oil than Boghead coal, an impure oil difficult to refine.[2] There was also some mystery about the correct methods of refining coal oils before Young's patent. In the winter of 1849-50 Samuel Keir, an American producer of "carbon-oil" sent a representative to England to find out the English method of refining coal-oil, but his agent returned empty-handed.[3] By April, 1851 Young had found that it was best to heat the refining stills to not more than 150°F to get the best results.[4] Washing the refined oil in sulphuric acid at a proportion of 10% was very severe treatment which Young advocated in 1851 but had modified by 1859. Even after the last refining operations it seems likely that the lightest fraction of the refined oil may still have contained too much dissolved paraffin wax to make a good illuminating oil for cheap lamps, although more expensive lamps could burn it without any problems.

1. Fernie and Others v. Young and Others, 1864, p. 980, Evidence of Dr. Alfred Swaine Taylor
2. Ibid., p. 842, Evidence of Benjamin Horatio Paul
3. P.H. Giddens, The Birth of the Oil Industry, New York 1938, p. 24.
4. British Patent No. 13,292, 17 October 1850.

Young concentrated upon improving the burning proficiency of this light oil and in the process he succeeded in purifying this burning oil. Success was by no means immediate or certain, since Young had not yet discovered that he had to exclude as much paraffin wax as possible from this light oil. He tried mixing 10% rosin oil with one of his experimental oils in January, 1852: "... tried in lamp did not burn well flame reduced ..." In fact, the unmixed light fractions of this oil burned well in the Argand lamp but not so effectively in Holliday's lamp.[1] Gradually, he produced better and safer lamp oils with which he conducted some rather daring experiments: "... Found the Burning Oil did not kindle at a temp. of 130° with blazing match ..."[2] By November, 1852 the cheapest lamps burned the light oil well.[3] Nonetheless, for several years, Young found it generally easier to sell oils for burning which had been mixed with natural oils,[4] not because he had not cracked the light fraction but because the cheapest lamp available was still not cheap enough to achieve massive sales. Finding a cheaper lamp was, therefore, an important technical problem.

1. Pocket Book, 1851-1852, January 1852
2. Pocket Book, 1852, 14 July 1852
3. Ibid., 15 November 1852
4. For instance, Young records on 15 May 1855 that "all the oil that has gone out this week up to tonight has been made up with Olive instead of Rape ..." (Pocket Book, 1855, 15 May 1855).

Elsewhere, technical progress was held up by the cut-throat competition which existed between producers and refiners, for it should be remembered that, generally, these were separate business enterprises with conflicting commercial motives. The greatest producer of the relevant crude liquid products, the gas industry, with its quantities of tars and oils, wanted to sell these valuable by-products at the highest price possible. The oil and tar distillers wanted to buy them at as low a price as possible. Thus, there was every commercial incentive for the distillers and refiners to concentrate on the established lucrative markets for their products: the naval dockyards, the railways, and the chemical industry.

However, in the United States, Luther Atwood produced a refined lubricant from coal-tar in 1853 which he called "coup-oil" in honour of Napoleon III;[1] both Atwood and his patent passed into the employ of Samuel Downer of Boston, an early entrepreneur in the American coal-oil industry. Downer, in 1855, was asked by George Miller and Company, a Glasgow firm of general chemical manufacturers with more economic ambitions than capital, to allow them to operate the coup-oil process on license. Downer agreed and sent William and Luther Atwood and Joshua Merrill to superintend the erection of the necessary plant. George Miller and Company had diversified considerably already; they were supplying solvents to several makers of

1. "Process of preparing Paranaphthaline Oil from the distillate of Coal Tar; collecting the products at certain fixed temperatures; calls the products 'coup-oil'. U.S. Patent No. 9,630, 29 March 1853

waterproof clothing dealing in army contracts during the Crimean War; they had connections with paint manufacturers; they were oil merchants with a booming trade in burning oil, exporting extensively to Germany and Holland. One of the main suppliers of burning oil and naphtha was John Young, who acted as an agent for his brother James Young.

A garbled version of the facts, intended originally for American and British court consumption, has gained great circulation in most of the existing works on the oil industry. The fable goes that Luther Atwood was the first to crack the crude brown Bathgate naphtha and thereby produced a colourless, illuminating oil from it which he burned in a lamp of a type common on the continent and also by 1855 in the United States but not so common in Britain outside industrial establishments, notably iron foundries. James Young visited the offices of George Miller and Company and noticed his refined Bathgate naphtha burning in Beal's lamp.[1]

What was the truth? First, James Young and his associates certainly sold great quantities of naphtha and burning oil between 1853 and May 1856 to George Miller and Company.[2] These were secondary products to their main business of selling lubricants. But "naphtha", itself, was a generic term covering

1. J.D. Henry, History and Romance of the Petroleum Industry, London, 1914, i., pp. 82 sq.; P.H. Giddens, op. cit., p. 21; K. Beaton, "Dr. Gesner's Kerosene: The Start of American Oil Refining" in Business History Review, xxix, 1955, p. 48; H.F. Williamson and A.R. Daum, The American Petroleum Industry, 1859-1899, Evanston, 1959, pp. 50-51.
2. Fernie and Others v. Young and Others, 1864, pp. 1340-1341, Evidence of John Poynter.

a multitude of volatile oils. Young's firm sold crude and refined naphtha and burning oil which often contained refined naphtha. Thus, Young must have known that his naphtha would burn in lamps but he knew from his experiments that it was not as safe as his refined burning oil.[1] He also knew how to purify the crude naphtha as is clear from his specification in which he mentioned a fluid more volatile than his lubricating oil: "... this fluid will be clear and transparent ..." and "... may be burnt for the purpose of illumination or applied to any other useful purpose to which it may be applicable ..."[2] This made a claim to a colourless burning oil identical with that later discovered by Atwood. How, then, could Atwood be its inventor? Why did John Poynter, a partner in Miller's enterprise, not make this claim for Atwood?[3] He had the opportunity and he had the motive for Young had broken his firm; he was certainly a hostile witness in Young's marathon case with E.W. Fernie.[4] Why did Atwood not take out a patent for this "new illuminant"? He took out nine others for related processes in the period 1853-1860.[5] The truth was that in 1855 Atwood was trying to break Young's patent by applying in Scotland the processes patented by Abraham Gesner in the[6]

1. Ibid., p. 280, Evidence of James Young
2. British Patent, No. 13,292, 17 October 1850
3. Fernie and Others v. Young and Others, 1864, pp. 1339-1343, Evidence of John Poynter.
4. Ibid.
5. Thomas Antisell, The Manufacture of Photogenic or Hydro-Carbon Oils from coal ..., New York 1860, lists these nine.
6. American Patents No. 11,203 - 11, 205, June 1854

United States in 1854. It is surely significant that Gesner, despite his antipathy to Young, never claimed this important achievement for Atwood but reserved it for himself.[1] The connection between Gesner and Atwood was Samuel Downer; later, he employed both of them.[2] Gesner's 1854 patents were intended to bypass Young's earlier patent of 1852; this attempt was a failure, and Downer took a licence from Young.[3] The written origin of the fable was Joshua Merrill and it was reproduced in 1898 long after the other active participants were dead.[4] The fable was part of a cold war extending across the Atlantic, a minatory gesture by American illegal producers of Young's products.

What was new to Young was not 'kerocene', kerosene or paraffin but the type of lamp. Beal's lamp had a flat wick with an adjustable glass dome. The same characteristics were to be found in the "Vienna lamp", as it was known to Americans after its introduction to the United States in the 1850s. In Britain the same lamp was called the "German lamp". Its history and development are obscure, so many claimed to be its originator. In the form in which it influenced Young's life its inventor was Neuberger in 1854.[5] John Young, James Young's agent, imported and sold great numbers of this very cheap lamp

1. A. Gesner, Coal, Petroleum and Other Distilled Oils, New York 1861, passim
2. K. Beaton, op. cit., p. 47 and p. 59
3. Vide infra pp. 230sq.H.F. Williamson and A.R. Daum, op. cit., p. 54.
4. Merrill's "Reminiscences" in The Derrick's Handbook of Petroleum, Oil City 1898, pp. 881 sqq.
5. R.J. Forbes, More Studies in Early Petroleum History, Leiden 1960, p. 112.

from 1856 onwards.[1] For James Young its widespread dissemination was a stroke of great good fortune: "... There is an excellent German lamp as it is called very well suited for burning these oils ..."[2] Young's references to the events of 1855 are quite precise; on 1 May, 1855 he records: "... Meldrum in told him about our oil burning in Beals lamp ..."[3] Notice that Young calls the illuminant 'oil' not "naphtha". It was the same oil that had been supplied along with crude naphtha to G. Miller and Company. The German market, with little concern for safety, took refined burning oil and crude naphtha in great quantities from G. Miller and Company. In Britain:

> "... the light naphtha was and is but little used for illuminating it is used instead of oil for turpentine and for dissolving Indian rubber ..." [4]

What was new to Young was the lamp and the market for the oil. He found both at the same time to the economic loss of G. Miller and Company.

Research into refining techniques and into the design of suitable capital equipment went on continuously. In the autumn of 1852 Young was conducting experiments to find out whether large stills ought to be replaced by smaller vessels which took less time to work off; he found that paraffin had been lost and that the oil deteriorated in the larger stills.[5] His out-

1. Fernie and Others v. Young and Others, 1864, p. 269, Evidence of James Young
2. Ibid., p. 268, Evidence of James Young
3. Pocket Book, 1855, 1 May 1855
4. Letter Copybook, 1860-1863, Young to A.W. Hofmann, 16 August 1862
5. Pocket Book, 1852, 13 September-2 October, 1852. C.f. also I.I. Redwood, op. cit., pp. 110-111

standing business achievement was the application of steam-power to the refining process in 1859. On 3 January, 1859 he made a remarkably successful experiment:

> "... to distill oil in the ordinary still with steam blowing in through the liquor the steam pipe came from the engine boiler and passed through a gas retort then into No. 1 still ..." [1]

By 20 May, 1859 this technique was a normal part of a continuous mass production process: "... One of the large boilers with the steam blowing into it was running 2 galls a minute very clear ..." [2] The successful application of steam to the refining process greatly increased productivity since first, it cut the time required for the process, secondly, it reduced the number of workers required for this process, and thirdly, it drove off the volatile naphtha and increased the yield of burning oil. Steam-power was later applied to clear the retorts of volatile products and thus, increased inventory turnover.[3] One of the secrets of Young's success was his willingness to learn from established industries. His shale or coal-breakers were modelled on machines used in the gas-works; Young and Meldrum took any opportunity to see these techniques.[4] His first attempts in 1854 at extracting paraffin wax in large quantities were based on methods used to separate spermaceti from whale oil.[5] In September, 1862 he was pointing out to Meldrum:

1. Business Journal and Laboratory Notebook, 1856-1861, 3 January 1859
2. Ibid., 20 May 1859
3. Fernie and Others v. Young and Others, 1864, p. 328, Evidence of Edward Meldrum
4. For instance "took Meldrum to Gasworks to see how they break coals" (Pocket Book, 1855, 3 September 1855)
5. I.I. Redwood, op. cit., pp. 146 sqq.

> "... There was a hint in Frankland's article for Johnsons' book we must not lose sight of that is to heat the steam we blow through the paraffin to drive off the naphtha ..." [1]

Apart from their own scientific staff, Young and his partners were always anxious to engage "prestige" advice from the best consultants. He writes to Edward Frankland:

> "... When you come back to London we would be glad if you would make some experiments for us <u>in the way of business</u> ..." [2]

His letters to Hugh Bartholomew mixed friendship satisfactorily with business: "... We want your opinion about a gas holder at the works ..." [3] This was necessary to store incondensable gas given off during the destructive distillation process, previously wasted but now to be stored to light the works, saving burning oil for sale.

An interesting entrepreneurial response is to be found in Young's dealings with W. Siemens in 1862. This episode shows the empiric nature of Young's dallyings with monopoly; that he realised, despite his extreme Liberal views, that monopolistic control of useful capital equipment could be obtained by other methods than by discovery, inventions and patent rights. In June 1862 Young made up his mind to buy the exclusive use of Siemen's regenerator for oil distilling and refining in Scotland. Siemens "asks £900 for the sole

1. Letter Copybook, 1860-1863, Young to Meldrum, 2 September 1862
2. Ibid., Young to Frankland, 13 August 1862
3. Ibid., Young to Bartholomew, 15 September 1862

use of the patent as applied to Bituminous Substances in Scotland ..."[1] A formal draft agreement was drawn up by J.H. Johnson, the partnership's London solicitor, in co-operation with Siemen's agents - but, characteristically, Young wanted to see the draft before it was finally settled.[2] By 4 August, 1862 Young had read the draft of the licence granted by Siemens; he wanted it to be made more specific about the materials to which it was to apply: "... I understand it means all bituminous substances or products ..."[3] By September 20th the deal was done, and Young sent Siemen's licence fee of £900 to Johnson for him to transmit.[4] For that £900 Young was left to exploit for his own purposes the latest method of heating retorts by gas having eliminated legally at source the possibility that Scottish competitors would use it.

Despite the fact that paraffin wax was not generally sold for profit until after 1854, Young's earliest industrial research, apart from the distillation of coal and the refining of mineral oil, was concerned with the separation of paraffin wax from oil. While still engaged at Riddings, on a cold spring morning in 1848 he had approached Lyon Playfair - who was living at Barnes - about the cloudiness of the oil which he had refined.[5] Playfair told Young that the oil was cloudy

1. Ibid., Young to Siemens, 18 June 1862 and Young to Johnson, 18 June 1862
2. Ibid., Young to Johnson, 31 July 1862
3. Ibid., Young to Johnson, 4 August 1862
4. Ibid., Young to Johnson, 20 September 1862
5. Fernie and Others v. Young and Others, 1864, p. 237 and p. 240; Cross-examination of James Young; vide also Ibid., p. 202, Evidence of Lyon Playfair

because it contained paraffin and suggested that Young should extract enough to make candles. Young made two candles with which Playfair lighted his desk at the Royal Institution during a lecture on petroleum and its products:

> "... These two candles, which when cost about twenty shillings each, are the fathers of the great paraffin industry, and of the cheap candles now found in every house, just as the small spring of naphtha in Derbyshire became the parent of the gigantic petroleum industry all over the world ..." [1]

There were a number of small sales for candle manufacture in the early years of the partnership,[2] but after it became clear to Young that the best burning and lubricating oils should have paraffin wax removed from them, methods of separation became gradually more scientific. Stocks of crude paraffin wax meanwhile were allowed to accumulate at the Bathgate works.[3] Young's chief laboratory assistant, John Galletly, eventually devised new refining processes for paraffin wax at the end of the 1850s, and, in consequence, the partnership no longer needed to rely upon the established market with candle manufacturers.[4] However, by 1858, extraction was becoming a large-scale enterprise requiring new capital equipment: "... proposed Hydra-extractor and agreed to see after one ..."[5] Hydraulic pressing

1. Wemyss Reid (ed.)., Memoirs and Correspondence of Lyon Playfair, London 1899, pp. 102-103; also Fernie and Others v. Young and Others, 1864, p. 186, Evidence of Lyon Playfair
2. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 102, Evidence of James Young
3. Ibid., pp. 102-103, Evidence of James Young
4. I.I. Redwood, op. cit., p. 6.
5. Business Journal and Laboratory Notebook, 1856-1861, 27 December 1858

was the normal method but this was expensive on labour. Young and his works engineer, Alexander C. Kirk, conducted considerable research into refrigeration techniques, since the solidification of the residual oil was the easiest and cheapest possible method of separating the paraffin wax. This work led to a patent[1] in 1864 for a new industrial refrigerator, using atmospheric air not ether; this refrigerator was fully described by Kirk who gave a lecture on the subject to the Chemical Association of the British Association at Bath:

> "... Such a machine was in use for fully a year, at the works of Messrs. Young and Co., Bathgate for cooling the paraffin oil ... in order to extract the solid paraffin it contains, a substance of great value in itself and whose presence is otherwise undesirable ..." [2]

From 1858 onwards Young and his partners often thought of diversifying further and becoming candle-makers, but they decided to sell the wax wholesale to the large firms already operating in this industry. As curiosities and for research purposes their scientists occasionally made candles and paraffin wax coloured shapes; these were generally impressive to all those who saw or used them:

> "... I was at Bathgate with my clerk McPhail and got from Mr. Meldrum a beautiful Paraffin Candle which has served well for three nights in the absence of gas. It is beautiful and affords a fine light. I also got a "shape" of paraffin, it is most beautiful ..." [3]

1. British Patent, No. 327, 27 January 1864
2. Journal of Society of Arts, 7 October 1864, pp. 733 sqq.
3. Letter, Thomas Nicolson to Young, 2 April 1860

This developing interest in the production of paraffin wax for the market was one more good reason why the original plant at Bathgate did not remain in its pristine state, for there was need for paraffin sheds and at least one refrigeration room. Yet another was the pressure of demand for the original plant had not sufficient space to house expanding fixed assets and widening capital equipment. Additional space was also a pre-requisite of Young's attempts to rationalise production. Naturally, an enterprise at the beginning of its career concentrated on those piecemeal changes necessary to the maintenance and improvement of production; these changes eventually lost the original simplicity of the first plant design in complications. By 1858 all three partners had become convinced that fundamental reconstruction of the plant was necessary. After a series of discussions at the end of that year[1] several decisions were taken. There were to be new condensers, the same as the condensers used in the gas industry, "... as the one we have tried does well"; there were to be new "cisterns" to hold the burning oil, specially insulated against the danger of fire. A rough sketch of such a cistern 7 feet by 4 feet by $3\frac{1}{2}$ feet deep was drawn by Young in a small notebook.[2] In 1859-60 the capacity of the plant was greatly enlarged by replacing the remaining horizontal by upright retorts and also by adding several new sets of retorts. By November, 1859 the

1. Business Journal and Laboratory Notebook, 1856-1861, 27-29 December 1858
2. Small Notebook, 1859-1862

Bathgate plant was consuming 280 tons of Boghead coal[1] per week; this represented a 40% increase on the previous winter.[2] New stills were also being built[3] - but not as fast as Young would have liked. The decision to build 6 more sets of retorts "inside the old where the Lab. and old gateway now are ..." further increased capacity.[4] This work was all done by John Scott and Company of Inverkeithing.[5]

Early in 1860 Young left Scotland for the United States. Whilst he was away, Meldrum and Binney became convinced that greater expansion was both desirable and possible. Meldrum broached the subject to Young, and much correspondence on this subject went both ways across the Atlantic. Young agreed with Meldrum that further extensions were desirable; Binney at first effusively concurred:

> "... I was very glad to find that you recommend an extension of the works so as to attempt to do something to meet the demand for our oil. In doing this not a moment should be lost ..."

Binney had been in Scotland staying with Meldrum for two days; there he had seen the exchange of letters between Young and Meldrum. Both Meldrum and Binney were convinced that new land would have to be bought:

1. Ibid., 16 November 1859
2. Business Journal and Laboratory Notebook, 1856-1861, 27 December 1858
3. Pocket Book, 1858-1859, 19 November 1859
4. Business Journal and Laboratory Notebook, 1856-1861, 6 December 1859
5, Fernie and Others v. Young and Others, 1864, p. 357, Cross-examination of William Walls.

> "... We both came to the conclusion that after the new Retorts have been built on the site of the old laboratory all extension there is ended ..."

An Adjacent site of a further six acres, belonging to Durham Weir, a local ironmaster and coal owner, was, in Binney's opinion, the best place for building a new works in Bathgate. But Binney was not convinced that Bathgate was the best place: he was afraid that cannel coal reserves in the area were inadequate to justify such a capital outlay. Local rumour had it that another five or six years would see the end of Boghead cannel coal; this would have to be checked scientifically. A suitable source of raw materials had to be found "... for if Russel can squeeze us in price you know he will do it ..."[1] Meldrum's answer to this problem was to offer a partnership to Russel;[2] Binney's alternative was to move lock, stock and barrel from Bathgate to Fife where he still retained a lease on a Methil colliery.[3]

The deed of partnership was co-terminous with Young's original patent; this was due to expire in October, 1864. Binney was clearly doubtful whether the partnership would survive:

> "... It is late enough now to be ready for the sale ... In the existing new works we must consider for how short a time they will be wanted and when the coal is done they are worthless ..."

1. Letter, E.W. Binney to Young, 6 March 1860
2. Letter, E. Meldrum to Young, 10 December 1859
3. Letter, E.W. Binney to Young, 6 March 1860

Yet, he was convinced that any rebuilding had to be done as quickly as possible, but Young's influence - and absence - was decisive:

> "... Whatever you determine to do as to extensions should be ordered immediately or it will be too late for this year ..." [1]

But rapid change did not occur. Young and his partners were deeply involved in patent litigation in Britain and the United States; Meldrum was under considerable pressure, and his was likely to be the supervisory responsibility; Young did not want to move to Fife - he was already thinking of Addiewell; Binney was equally obdurate in his belief that Bathgate was an unsuitable site for expansion. Stalemate resulted. Capital re-equipment proceeded slowly on the original site but the project for major extensions lagged. Eventually, Binney became convinced that it was better to await Young's return from the United States, because he did "not feel warranted in acting without your consent and concurrence ..." [2] [3]

Meldrum was less involved in the principles but more closely concerned with his immediate responsibilities. He was plainly overworked throughout 1859 and 1860. Testily, in April, 1860, he wrote to Young:

1. Ibid.
2. Letter, E.W. Binney to Young, 21 March 1860
3. Letter, E.W. Binney to Young, 24 March 1860

> "... It is all very well for you and Binney to keep singing, build, build, extend, spend money but to go as far as I should like in coal contracts taking a Feu & getting on with another work I must have assistance from you both. I am doing what I can in extending the present work & I shall get on with it as fast as I can ..." [1]

Nonetheless, a new works was built at Bathgate, which by December, 1862 was producing twice as much oil as the old works.[2] Total acreage by October, 1864, when the partnership was dissolved, was in the region of 25 acres.[3] By that time all the partners were ready to go their separate ways - but on Young's terms!

1. Letter, E. Meldrum to Young, 2 April 1860
2. M.S. Memorandum "Week ending Sat. 6 Dec. 1862", gives output in both plants.
3. The Scotsman, 15 May 1883

4. Commercial Organisation and the Challenge of Sales Promotion (1851-1864)

James Young and his partners could reasonably feel satisfied with the technical efficiency of their plant, when, by 1864, one ton of Boghead coal, costing them 30/-, produced eighty gallons of burning oil worth £10, 20 lbs of paraffin wax worth £1 and ten gallons of lubricating oil worth 50/-. Labour costs per ton were estimated at 1/6d; depreciation charges and capital reserve cost about 4d per ton.[1] There was a remarkably wide margin of profit at the plant; but, of course, these products had to be marketed. Young's technical success at Bathgate Chemical works was, in fact, a reflection of the profit opportunities within the market. To exploit this success an effective commercial organisation had to be built and a satisfactory sales image of quality products had to be created; changes in demand had to be anticipated to ensure marketing efficiency.

Until 1855-1856 the commercial organisation was relatively simple. There were two main agencies through which Young's oils were sold. James Young's brother, John, took premises in Gallowgate,[2] Glasgow, probably assisted with capital supplied by his brother, and acted as sole agent in Scotland. Young, himself, also took offices in Glasgow and was responsible for

1. Fernie and Others v. Young and Others, House of Lords, 1864, p. 988, Evidence of Dr. Alfred Swaine Taylor.
2. The exact address was 222 Gallowgate according to an invoice of 15 June 1852. John Young was described as sole agent.

shipping oils from the Broomielaw to Liverpool, Manchester and Belfast, where the other agency, that of James Hurst and Company of Manchester[1] was operating. Deliveries were made to Glasgow from Bathgate at first by horse and cart, then by rail. Since Young acted as the firm's sales representative, he often arranged direct delivery to customers from Bathgate, if this was possible. Similarly, when Hurst obtained orders in Belfast, delivery was direct from Glasgow and not via the English agency. If crude oil was sold - and this was rare - it was generally sold at 4d per gallon to local farmers directly from Bathgate.[2]

The division of management was both simple and flexible. Meldrum was placed firmly at Bathgate while Young had a roving commission with sales as his main charge. This suited Young's temperament admirably and made best use of his profit-earning potential, for he would have been wasted if his sole task had been plant maintenance and improvement. In the early years of the partnership, particularly in 1851 and 1852, Young could not devote all his energies to sales promotion. Apart from the technical changes which he inspired at Bathgate, he was employed by Tennants in the capacity of consultant; for instance, he superintended the winding up of operations at their Rouen plant.[3] His patents were still being worked by Tennants until 1861[4] and producing sufficient income for him

1. Hurst and Compahy of 14 High Street, Manchester is described as "Sole Agent for the United Kingdom" in sales literature, but this probably referred to their position outside Scotland
2. Fernie and Others v. Young and Others, House of Lords, 1864, p. 934, Evidence of George Parry
3. Pocket Book, 1851, passim
4. Letter Copybook of James Young, 1860-1863, Young to Messrs. Tennants & Co., 5 March 1861

to be financially independent of the Bathgate operations. Gradually, however, in 1852 he spent more and more of his time promoting the sales of his oils. This arrangement of executive functions between Meldrum and Young had much to commend it. Young possessed considerable energy and a flair for marketing; in Lancashire textile circles his name was well-known and highly thought of; his Riddings pilot scheme had created his connection with James Hurst and Company, and this could be readily adapted to the marketing of a more abundant supply of oils. From Glasgow his brother could supply industrial Scotland; from the port of Glasgow he could supply the textile areas of Lancashire, the West Riding and Ulster.

One immediate problem was financing this sales structure as well as the Bathgate works. Fortunately, Hurst and Company provided their own storage space for oils and were responsible for their own capital assets. But the time between the production of oils and payment for them was bound to be considerable. Accounts from suppliers had to be met often before receipts were to hand. Credit facilities for new firms operating in Scotland appear to have been woefully inadequate. Having used most of their available capital in building the works and organising storage in, and delivery to, Glasgow, Young and his partners found the Scottish banks remarkably uncco-operative, almost hostile. Customers and also Hurst and Company generally settled their accounts with Young by bills of exchange; the banks refused, at first, to discount these. Scottish suppliers of capital equipment were equally remiss;

the idea of giving credit to this new firm was abhorrent to them. Young pithily described their situation:

> "... We were poor and scarce of money so much that after we had built the works and sold the stuff the bank would not discount the bills we got for it and our neighbours yonder would not give us time to pay for a retort so that we had great difficulties to meet ..." 1

Excuses for both banks and suppliers can be made. Young and his partners lacked both reserves and a credit-worthy reputation; they were more highly prized in Lancashire than in Scotland. The banks were, perhaps, rendered firmer in their determination not to discount these bills, because the Bathgate works was not providing a standardised product in an existing line of business; there was a great element of risk in any infant industry - and in this one there was no established demand. This prejudice might have been an insuperable obstacle to business growth, had not the margin of profit been so wide that reserves could quickly be accumulated to enable costs to be settled even though the partnership was not being paid in ready cash. In addition, the Scottish agency of John Young provided a safety valve for financial pressure, since some of his accounts were settled in cash at time of sale, and all within two months. Young quickly realised the importance of encouraging rapid settlement of customers' accounts. One common and obvious solution was to make cash terms much more

1. Fernie and Others v. Young and Others, Lords, 1864, p. 264, Evidence of James Young

attractive than credit; a generous discount of 5% on the retail price was allowed for settlements made within fourteen days of receipt of the invoice. Irish customers were, however, generally given two months credit at nett cash terms.[1] In turn, once capital reserves came into existence, the partnership ceased to forfeit the discounts available upon suppliers' accounts - this explains Young's habit of paying cash for cannel coal at each month end.[2]

Sales promotion was largely determined by the state of the market. The partnership was fortunate to be operating in a rising market. Industrial developments, in particular railway expansion, growth in the cotton industry and the development of steam navigation, assisted the growth of demand for the staple products of the Bathgate works: heavy oils and greases. The growth of the rubber and paint industries provided a market for light fractions which could be used as solvents. The growing demand for burning oil widened the market - and not merely for domestic consumption. The railway signalling systems depended upon the economic use of oils - paraffin burning oil was ideal for this purpose. Young won a contract from the Edinburgh and Glasgow Railway Company in February, 1858,[3] and many others followed. Later, he sold special light oils both at home and abroad for use in light-

1. Evidence of this generous discount policy: Pocket Books 1850-1853 passim; sales literature released by James Hurst and Company in 1854
2. Fernie and Others v. Young and Others, Lord, 1864, p. 305, Evidence of Robert Marshall
3. Binney and Co. v. The Clydesdale Chemical Company, 1860, p. 205, Evidence of James Boyd Thomson

houses. The basis of this success was activity, for Young did not long remain office-bound. He toured mills, factories and foundries in many different parts of the United Kingdom, pursuing a most vigorous, personal, sales campaign. In 1853 he secured orders by personal visits to Kilmarnock, the Border textile towns, Belfast and Dublin.[1] John Young also seems to have been very energetic in his local Glasgow area. His first two months in business were occasions for James' elation:

"... John accounts for Feb and March £485 60 of which is for naptha[2]..."

Marketing enterprise certainly stimulated demand. But the market could not be dominated without massive effort and great changes in sales structure. For existing natural oils - sperm oil, seal oil, lard oil, rapeseed oil, olive oil, rosin oil and local variants such as Welsh tarry greases - had to be supplanted. Prejudices against coal-oils certainly existed, and where they did not exist, they were unscrupulously created:

> "... some Sperm oil dealers have gone about among their friends and customers, depreciating the character of "YOUNG'S PATENT MINERAL OIL", and stating that it is dangerous in use; that many have made trial of it, but that almost all who have done so, have discontinued its use; with a variety of other statements equally opposed to the truth ..."[3]

1. Pocket Book, 1853, passim
2. Pocket Book, 1851, 1 April 1851
3. Testimonials, Medical, Chemical and Mechanical of the Properties of Young's Patent Mineral Oil, 1854, p. 4.

The existing trade in oils was bound to oppose the introduction of cheaper products until its profit potential and turnover was damaged. But the divisions within the trade prevented any chance of boycott, for the existing trade was highly individualistic with many wholesalers and vast numbers of retailers, each wholesale house making its own price-list.[1] This degree of internal competition within the trade made it inevitable that Young's oils should be favourably placed to pluck the market from natural oils.

This process was gradual. Richard Wilson, the head of the firm of Wilson, Rose, Graham and Company, the largest oil-brokers in London, noticed that coal oils began from nowhere and gradually but savagely undercut the existing trade.[2] From 1854 Young and his partners had an agency and warehouse in Bucklersbury, London, and wholesalers, instead of being sought after, began to seek connections with it. As Samuel Ward, an oil merchant of Thames Street, found to his cost, the trade in natural oils began to diminish remarkably in the mid 50s.[3] The agency system was so readily controlled that Young and his partners could quickly manipulate the supply curve according to their assessment of the market. This was a great stabilising factor in the wholesale price structure. No matter what arrangement existed among other firms, as sole suppliers

1. Fernie and Others v. Young and Others, Lords, 1864, p. 367, Evidence of Samuel Ward.
2. Ibid., p. 361, Evidence of Richard Wilson
3. Ibid., p. 367, Evidence of Samuel Ward

Young and his partners were in an extremely strong commercial position. The more time passed, the stronger they became. Direct sale to the general public was an additional source of profit. After 1855-1856 the penetration of the London market became sharper; the elasticity of demand for burning oil was such that, in an area of concentrated population, a fall in price brought in many more consumers.

But even before the great expansion of the market for burning oil, Young's fortune was secure. He had been highly satisfied when recording in July, 1851 that: "... Hurst has had sent to him from Glasgow 2600 galls and about 1000 is ordered ..."[1] By March, 1855 a weekly total of 8,000 gallons was merely the result of competence.[2] The staple product, lubricating oil, was being sold retail at half the price of sperm oil: in 1851 its price was 5/- to 5/6d per gallon; for part of 1853 it reached 7/- per gallon; by 1864 it was selling for 3/- to 3/6d.[3] Young and his partners made no attempt to extract the maximum return: their aim was to seize the market gently not to bludgeon it into resistance. Their pricing policy was aimed to effect this. Sperm oil was a quality competitor not a price competitor, but once the prejudice against organic lubricants disappeared, the fact that sperm oil never cost

1. Pocket Book, 1851, 14 July 1851
2. Pocket Book, 1855, February - March passim
3. Fernie and Others v. Young and Others, Lords, 1864, p. 267, Evidence of James Young; Hurst's sales literature in 1854 gave 5/6 per gallon as the price; Invoice dated 15 June 1852 gave 5/- per gallon

less than 9/- and more often no more than 10/- per gallon explained the gradual predominance achieved by Young's Patent Mineral Oil. Young's reaction to this situation was openly complacent: "... Sperm oil has no chance with us. We are so far below sperm oil in price ..."[1] Nonetheless, the price of natural oils was a limitation upon the development of a pure monopoly position.

Sales policy had to be linked to the technical realities of production. It was impossible to produce lubricating oil without producing lighter fractions. At first these products, naphtha and burning oil, contributed slightly to the profit margin. However, once it became technically possible to diversify production to suit demand, wider profit margins became likely. Greater quantities of burning oil could be produced for a greater market; less proportion - but similar quantities - of lubricating oil would then be available; paraffin wax could be extracted and sold separately. As technical efficiency advanced so the opportunities for market manipulation were increasing. Young also recognised the economic significance of diversification - he had no wish to be dependent on one product. Asked what product provided the greatest part of their profit, he evaded the question to the point of untruthfulness when he said that:

> "... They so rank together that one without the other would not be a profit so that I cannot say because if we charged a high profit on one we should have less profit on the other ..." [2]

1. Fernie and Others v. Young and Others, Lords, 1864, p. 235, Evidence of James Young
2. Ibid., p. 234, Evidence of James Young

But he revealed his view that diversification was a desider-atum.

The greatest change in sales policy occurred in 1855 when Young discovered how to reach the greater market for lamp oil. Despite high pressure salesmanship the burning oil, at first, did not sell well: "... We had great difficulty in getting the public to buy it ..." This was Meldrum's simple honest view.[1] Consumer resistance was largely caused by the noisome smell of coal-oils - this precluded the use of burning oils made from coal at the high tables of the fashionable.[2] Early attempts to deodorise this light oil were only partially successful; a great deal was done with greater success after 1857.[3] It is important to realise that this oil and other light fractions were regarded as nuisances at the refinery; they had either to be sold or disposed of as effluents. The position fortunately led Young and his partners to adopt cut-price policies, especially for burning oil and unrefined naphtha. These pricing policies stimulated demand. The burning oil was sold in a refined state but if customers were not available it was mixed with other more volatile fractions and sold as naphtha. Some firms who bought it found that it did not dry well when used as a solvent, and, therefore, the

1. Ibid., p. 235, Evidence of Edward Meldrum
2. Ibid., p. 364, Evidence of Samuel Ward;
   c.f. also Ibid., p. 268, Evidence of James Young
3. Business Journal and Laboratory Notebook, 1856-1861, passim; Laboratory Notebook 1857-1862, probably John Murray's book; Laboratory Notebook 1863-1865, probably W. Mc.Ivor's book

market price fell.[1] Burning oil was sold at 6d per gallon while refined naphtha, a good solvent, was being sold at 2/6d. These pricing policies only make sense if we remember that lubricating oil was the main product and the light oils accummulated inevitably in the productive process. The partnership was most anxious to dispose of these light oils at almost any price:

> "... we had a large stock at the time and we could not get rid of it. It was running out of the casks and we were glad to get rid of it ..." [2]

In addition, the lighter fractions were difficult to transport, especially in the unrefined state. Young, therefore, tended to safeguard his own reputation - and that of the partnership - by calling all his impure volatile oils "naphtha" because of the danger that explosive vapours would be emitted in transit: "... When naphtha is sent by rail or ships they take certain precautions and that is the reason we called it naphtha ..."[3]

The prime obstacle to selling burning oil was the lack of a suitable lamp. No efficient, inexpensive lamp was on general sale to the public, although there were many cheap naphtha lamps commonly used in iron foundries, coal mines and other industrial establishments. James Young stumbled casually upon the solution to this technical and commercial problem. His version of the introduction of this burning oil was euphemistic:

1. Fernie and Others v. Young and Others, Lords, 1864, pp. 265-266, Evidence of James Young
2. Ibid., p. 266, Evidence of James Young
3. Ibid., p. 267, Evidence of James Young

TABLE 14

STATEMENT OF NAPHTHA AND BURNING OIL bought of Messrs. E. Meldrum and Company., by George Miller and Company, at the following dates.

Date	Naphtha gallons	Burning Oil gallons	Total Quantities of Naphtha for the Year	Total Quantities of Burning Oil for the Year
1853 Sept.	488	101		
1853 Oct.	-	1695		
1853 Nov.	261	1981		
1853 Dec.	1430	909	2179	4686
1854 Feb.	-	652		
1854 March	-	409		
1854 July	-	461		
1854 Aug.	493¾			
1854 Sept.	215			
1854 Oct.	704			
1854 Nov.	2321¼	212		
1854 Dec.	3260	617	7494	2351
1855 Jan.	2478	421		
1855 Feb.	2483	340		
1855 Aug.	1209			
1855 Sept.	416			
1855 Oct.	6611	580		
1855 Nov.	6771	1619		
1855 Dec.	3499	999	23467	3959
1856 Jan.	4709	604		
1856 Feb.	2100	612		
1856 March	2325	399		
1856 April	2825	281		
1856 May	169	-	12128	1896
TOTAL	45268		12892	

Source:

Fernie and Others v. Young and Others, Lords, 1864, p. 1341, Evidence of John Poynter

> "... At the beginning of our works we had great difficulty in getting people to use this oil. It cost us a great deal of trouble and pushing and driving to get people to use it. It came in by degrees and now it is a large trade. They did not like the smell ..." [1]

It has been suggested that this burning oil was not sold before 1856. This is mistaken. It was sold often in large quantities at prices varying from 1/3d to 1/6d per gallon in Scotland and 2/- per gallon in Ireland.[2] When Young, himself, was asked if his light burning oil had been sold as early as 1856, he replied firmly: "... No doubt of it. Long before that.[3] I could shew it from the book ..." Young had tried to interest customers by giving away samples in Glasgow, and in 1853 he reached an extensive market as a result of this initiative. George Miller and Company of Glasgow contracted for supplies of impure naphtha and light burning oil.[4] The burning oil was the refined article; the impure naphtha contained as much of all the light fractions as could possibly be included. George Miller and Company treated this impure naphtha in two ways; part they refined and sold as a solvent to India-rubber manufacturers and paint firms; part they refined and mixed with the burning oil, exporting this product to Germany as "photogen". This trade in photogen became more and more the

1. Ibid., p. 268, Evidence of James Young
2. Pocket Books 1851-1856 passim; c.f. also Fernie and Others v. Young and Others, Lords, 1864, pp. 1341 sq., Evidence of John Poynter
3. Fernie and Others v. Young and Others, Lords, 1864, p. 274, Evidence of James Young
4. Ibid., pp. 1341 sqq. Evidence of John Poynter. See also Table No. 14; Sales by E. Meldrum and Company to G. Miller and Company, 1853-1856

escape-route for the light fractions, which Young and his partners still did not consider to be their main products. Millers' demand for the impure naphtha increased so greatly that they were prepared to pay 1/7d to 1/8d per gallon for it while in the meantime the market price of refined burning oil dropped to 6d.[1] In 1855 Young discovered what was happening. The impure naphtha was providing the main ingredient of the burning oil; the continental photogen trade was not so particular about safety factors in these light fractions as the British market. Photogen was being burned in Beal's lamp, a common naphtha lamp, on 1 May, 1855 when Young visited the office of George Miller and Company.[2] The type of lamp suitable for burning his refined lamp oil came to Young so gratuitously. All that was necessary was to multiply its presence on the British market - or imitate its main characteristics in a new lamp. In the meantime Young settled for finding the market which Miller and Company had developed. Scrupulously, he fulfilled the terms of their contract, but when it ended in May 1856, it was not renewed. George Miller and Company did not give in without a struggle. Much correspondence passed between them and E. Meldrum and Company - but to no avail. Eventually, John Young admitted that: "... they had found a better market for the oil in Germany in short that they had found our market ..."[3] This was the crie de coeur of

1. Ibid., p. 1342, Evidence of John Poynter
2. Pocket Book, 1855, 1 May 1855
3. Fernie and Others v. Young and Others, Lords, 1864, p. 1342, Evidence of John Poynter

John Edgar Poynter, an interested partner and one of the shadowier figures of the early Scottish shale oil industry.

There were other signs that Young and his partners were making large sales directly to the continental photogen trade. Meldrum and Young[1] sought customers in France. By 1856 the first complaints from continental customers about the quality of burning oil were being tested by Young at Bathgate and found wanting.[2] At the end of February, 1857 John and James Young visited Holland and Germany.[3] Their main object was to meet C.H. Stohwasser, the largest oil-broker in Berlin, whose firm had an extensive photogen trade in Central, Northern and Eastern Europe.

This visit had one other important effect. The Young brothers had their first encounter with German photogen lamps, and it was from Germany that the "paraffin lamp" was introduced into Britain.[4] Young and his partners, despite their knowledge of Beal's lamp found it difficult to find suppliers of a modified household version: "... We had great difficulty in getting lamps. The lamps we had provided were made by ourselves ..."[5] Recognising that the sale of paraffin burning oil was conditional upon the accessibility of a cheap lamp, Young and his partners regarded it as part of their service

1. Pocket Book, 1855, passim
2. Notebook, 1856, passim
3. Small Pocket Book, 1857, 25 February 1857 et seq.
4. Business Journal and Laboratory Notebook, 1856-1861, Jan, 1857 - June, 1857, passim. Lamps sent and brought back from Berlin were used in Young's experiments to produce better refined paraffin oils.
5. Fernie and Others v. Young and Others, Lords, 1864, p. 320, Evidence of Edward Meldrum

to customers to supply the lamp as well as the oil. The lamp trade began piecemeal and was at first purely secondary:

> "... although we were not traders in lamps we were doing all we could to induce people to use our oil and it was not an uncommon thing for us to give them a lamp ..." [1]

John Young took up the lamp trade in 1857 and introduced the German lamp into Scotland, probably using James' capital.[2] By 1859 James Young was directing this lamp trade as a major commercial venture throughout the United Kingdom. David Laidlaw, gas engineer, brass and iron-founder, lamp-maker, of Edinburgh and Glasgow provided most of the manufacturing capacity for lamp production. In 1859 alone, Laidlaw supplied 247,431 lamps to Young's Paraffin Light Company and in 1860 was supplying an average of 1,200 lamps per day.[3]

A revolution in the market for oils had occurred. Elasticity of demand for burning oils was such that no single firm could supply the total demand which by 1864 was running at about 250,000 gallons per week in Britain alone.[4] For where gas was not used for light it was normal to find paraffin burning oil, since it was so much cheaper than other oils: in 1860 1d worth of paraffin oil provided the candle-power equivalent of 1s $4\frac{1}{2}$d worth of sperm candles.[5]

1. Ibid., p. 274, Evidence of James Young
2. Ibid. James Young denied supplying capital of John Young for this purpose, but in the Business Journal (1856-1861) there is much evidence of Young's direct intervention im John Young's lamp trade business and of his own ventures.
3. Binney and Company v. The Clydesdale Chemical Company, 1960, p. 206, Evidence of David Laidlaw
4. Fernie and Others v. Young and Others, Lords, 1864, Joint Appendix, Answer of E.W. Fernie, para. 96 given in Chancery, 29 January 1863
5. Ibid., p. 308, Evidence of Hugh Bartholomew.

Because of this great and sudden increase in demand for burning oil dating from 1856, it has been suggested that "paraffine burning oil" was a new product then. This was not the case as Poynter's evidence shows. Although he was by no means friendly towards Young - and appeared as a hostile witness in 1864 - he admitted freely that he had sold Young's light oil for burning from 1853 onwards: "... It burns we sold it as burning oil ..."[1] After 1856 this burning oil was refined better than it had been before - it was figuring larger in Young's commercial success - but it was still almost identical with the burning oil sold to George Miller and Company three years earlier. When asked what similarity there was, if any, between the burning oil for which he paid 6d per gallon and the burning oil sold by Young's Paraffin Light Companies in 1864 for 2/3d per gallon, Poynter could not go beyond: "... It is a little better rectified it is a little better burning oil ..."[2] Certainly, it was not a new discovery in 1854-1856 by Luther Atwood, Abraham Gesner or anyone else!

This revolution in the market smashed the old commercial organisation of selling through two main agencies. A number of Paraffin Light Companies, in Young's name, were established throughout the United Kingdom - and thus, Young took a manufacturer's and a wholesaler's profit. A start was made in

1. Ibid., p. 1342, Evidence of John Poynter
2. Ibid.

Edinburgh in 1858, and by 1864 there were ten such companies or "stations", showing a total profit of £12,000.[1] This new sales structure had many problems, mainly stemming from Young's failure to pick efficient managers. The Edinburgh "station" was managed by Thomas Rowatt from 26 January, 1858[2] who, despite his technical knowledge and capacity for land negotiation, lacked administrative method and ability. Fortunately, at first, Young was often in Edinburgh and was able to take an active interest in this business and took many executive and managerial decisions on the production and assembly of lamps and on general stores policy.[3] Young hoped that Rowatt would be able to take complete managerial control, but this proved to be unjustified. Young's criticisms of Rowatt gradually increased in their intensity and in the privacy of his journal he becomes almost angry:

> "Rowatt still without goods ... I see I must attend to this business as nothing seems to teach Rowatt he argues as if it was not his business to attend to matters ..." [4]
>
> "... Rowatt could say nothing but that he could not attend to everything ..." [5]
>
> "... Rowatt has got into the same mess he was in last year he either does not give his attention to the business or he is unfit ..." [6]

Nonetheless, Young seems to have attempted to be fair to Rowatt and in this process he finally became recriminative.

1. M.S. Account and Valuation Book, 1865-1867. A minute of agreement (1865) in this book gives this figure.
2. Business Journal and Laboratory Notebook, 1856-1861, 26 January 1858
3. Ibid., 13 April 1858 - 15 December 1858
4. Ibid., 21 November 1859
5. Ibid., 29 November 1859
6. Ibid., 30 November 1859

By 1 December, 1859 it was clear to Young that "Rowatt must be looked after more closely". He knew he must:

> "... attend to Light Coy or it will be ruined. Rowatt seems to take no thought about the matter meir hap hassard hury bury no order or system indeed he knows little about it cannot give an answer to vital question. This is a very serious matter I expected he would take the burden of this matter off me but I now find he does not attend or does not give his thoughts to the business ..." [1]

Thus, Young finally was compelled to resume direct control of the Edinburgh concern. He still hoped for reform in Rowatt; after chastening errant suppliers, he tried to infuse some method into the administration. With Rowatt in charge this was a hopeless task: "... Asked Rowatt about a Stockbook he had no stock book and said to keep a stockbook was impossible ..." [2] Rowatt evidently preferred to rely upon the memories of his store men. Young would have none of this. A stock book was essential to good business, the only efficient method of maintaining a steady flow of goods into and out of store. Business efficiency and Thomas Rowatt were incompatible; Young, eventually replaced him with Peter Shaw, a man of much better business capacity.

Similar managerial inefficiency occurred at the Manchester "station". Just as Edinburgh became the key "station" in Scotland, because of its local links with lamp making and glass manufacture, so Manchester, by virtue of its ready access

1. Ibid., 1 December 1859
2. Ibid., 5 December 1859

to a concentrated market and to the glass industry of St. Helens, was the entre-pôt "station" in England from which lamps were supplied to all other branches. Rae, the manager of the Manchester "station", was inventive and technically able, but inefficient. Young was beginning to realise this by the end of 1860, when his London manager, Brown, complained about inadequate supplies: "... Brown is very short of lamps he says he could do three times the trade if he had the stuff ..."[1] By 1862 Young had devised an accounting system which reduced the necessity for his own intervention. All his Paraffin Light "stations" were audited by Alexander Moore, his Glasgow accountant, twice a year. The relation of profit to turnover became his guide to business efficiency. Although this system of remote control at distance operated effectively, Young also relied upon frequent personal visits and informal reports from his managers. These were only valuable, if the individual managers were both honest and efficient. On the other hand, Moore was outside the system and reported directly to Young. A manager had six months grace at most before the reckoning.

Rae misinformed Young about the state of the Manchester "station". It was not that he was merely untrustworthy; he was capable of self-deception as well. But he could not escape Moore's audit and Young's inevitable wrath:

1. Letter Copybook, 1860-1863, 6 November 1860, Young to Rae

> "... I am vexed to find by Mr Moore's report that the Manchester concern has shown a large amount of loss as you always led me to understand the affair was doing well and I beleived you the matter is the more serious. How do you explain it ..." [1]

Rae temporised, accused Moore of personal spite in not allowing sufficient for stock in hand, blamed bad debts, his own price reductions in lamps and oils, abnormal damage and breakages and sundry local expenses. Young countered Rae's excuses by detailed questioning.[2] To this, Rae could give no satisfactory answers and simply increased Young's exasperation:

> "... if you have not the stuff I cannot see how charging it to this or that account will in any way account for the great loss shewn by the books ..." [3]

It could not explain the £800 owing at stock-taking nor the fact that much of this money had been owing for more than two months. Wherever Rae looked for escape-routes, Young's questions followed, point by unavoidable point. Despite Young's insistence on specific answers to specific questions, Rae tried to hedge - and was only successful at the expense of revealing that he had been completely unable to trace the source of the loss.[4] Young weighed the situation exactly: "... Rae has made a mess and he wants to blame everyone but himself ..."[5] To Rae he was more tactful but just as definite:

1. Ibid., 31 July 1862, Young to Rae
2. Ibid., 7 August 1862, Young to Rae
3. Ibid., 11 August 1862, Young to Rae
4. Ibid., 15 August, 1862, Young to Rae; also 20 August 1862, Young to Rae
5. Ibid., 22 August 1862, Young to Shaw

> "... I have gone over all you say about the explanation of the loss but all you say even taking your own way of it does very little to explain the matter ... of course the concern cannot go on losing such large sums without knowing where it goes ..." 1

Rae was replaced in 1862, but Young was never free from anxiety about his "stations". One important reason for this was the deliberate policy of operating on a tight margin of profit, which in 1864 was still averaging only £1,200 per "station". Young became increasingly interested in maintaining secure outlets for his oils rather than in making a great wholesale profit, the more so as American petroleum began to flood into Europe. The advice that he gave to his manager, Peter Shaw, on 12 December, 1862 best conveys this impression:

> "... you must keep in mind that it is not of so much consequence to me that you make a large profit as that you sell the oil and of course get the cash for it as our stock is large it is of the utmost importance that it should (sic) sold. I get the profit on the oil although you do not make a profit on the sale and as we are now making more than we can sell the thing is to sell although there should be no profit on the sale of it if I get the profit on the making I am well of ..." 2

The average profit at Bathgate in the last four years of the patent (1861-1864) was large enough to justify Young's policy: £57,000 per annum.[3] To that had to be added licence fees in Britain and America; this was an important but diminishing source of income. By 1864 Young and his partners enjoyed a dominant position in the British oil market, but their success was hard-won and emphemeral.

1. Ibid., 27 August 1862, Young to Rae
2. Ibid., 12 December 1862, Young to Shaw
3. Account and Valuation Book, 1865-1867, Minute of Agreement, 1865.

In winning this position Young's advertising policy was an important weapon. At first, the deliberate manufacture of a public image for his firm was primarily defensive in the battle against natural oils. There was no strategic plan to capture the whole market by advertising; it was hoped merely to inform potential customers of the existence and efficiency of coal-oils. Young's patent received favourable notices because of his exhibits in the Great Exhibition of 1851, which took several prizes. Yet the publicity for industrial products during the Great Exhibition was so enormous that mere mention in newspapers and trade journals was insufficient to attract great attention. Young's versatility - he had on display a model apparatus for making stannate of soda, a bottle of mineral oil from Riddings and a sample of paraffin wax produced from Boghead coal - was one obvious cause of favourable comment, especially in the Illustrated London News[1], The Times[2], and The Manchester Guardian[3]. Young deliberately and constantly sought favourable newspaper publicity because he recognised its economic value: he cultivated contacts in the British press and fed them suitable "slips": "... In today's Scotsman there is a puff about us if you could spread it it might do us good ..."[4] But this "puff" was inserted in the Scotsman, the North British Daily Mail[5], and the Liverpool Mercury at Young's own insistence

1. Illustrated London News, 31 May 1851
2. The Times, 6 September 1851
3. The Manchester Guardian, 1 September 1851
4. Letter CopyBook, 1860-1863, 10 December, 1862, Young to McIvor
5. Ibid., 10 December, 1862, Young to Bartholomew.

and was based on a complimentary article which had appeared earlier in the Journal of Gas Lighting[1] because of Young's friendship with the editor.

In the partnership's early years Young's personal energy in the Manchester area produced great interest in his lubricating oil. Would-be competitors were disgruntled, resentful and envious - they were fearful of Young's energy.

> "... I fear some one else will be before us in the market as Young's oil is causing a great stir ..."[2]

> "... Everyday I feel more anxious about the rock oil in consequence of the fuss Mr. Young is making about his great discovery ..."[3]

> "... every time I go amongst my friends in Manchester I hear of Young's oil ..."[4]

Young's activities were supplemented in 1852 and again in 1854 by brochures of testimonials, a form of restrained advertising, issued by James Hurst and Company. A copy of the 1854 brochure has survived.[5] Its first purpose was to deal with the malicious slanders put about by sperm-oil dealers. This was effectively done by Hurst's challenging any one of them to test his oils against Young's, following the routine of standard friction tests; the loser was to pay Manchester Royal Infirmary £100.[6] The testimonials were

1. Journal of Gaslighting, 20 October 1862
2. Fernie and Others v. Young and Others, Lords, 1864, Joint Appendix, Copy Letter, S. Clift to J. Fisher, 22 May 1851
3. Ibid., Copy Letter, S. Clift to J. Fisher, 23 May 1851
4. Ibid., Copy Letter, S. Clift to J. Fisher, 28 May 1851
5. Thom Collection: "Testimonials, Medical, Chemical and Mechanical of the Properties of Young's Patent Mineral Oil," 1854 (12pp).
6. Ibid., p. 4

both general and particular. The judgment of the Chemical Jury at the Great Exhibition was cited as being above vested interest:

> "... This oil is exceedingly well adapted for lubricating machinery; it does not oxidate in air, and is equal to the best Sperm Oil for the purposes stated ..." [1]

Much was made of the safety qualities of Young's oil, that it was "not liable to spontaneous combustion," that fire-risk was much reduced compared with animal and vegetable oils and that this was a point "particularly worthy the attention of INSURANCE COMPANIES ..."[2] The superiority of the product was constantly emphasised: it was less liable to clog than sperm-oil, produced 15% less friction and, therefore, reduced wear on working parts of machinery, and did its job just as well as natural oils at less cost, being a "great saving". The quality of Young's oil was uniform, and this was one paramount advantage over natural oils whose quality tended to fluctuate greatly.[3] Some testimonials, particularly from medical men following ancient traditions, stressed the medicinal properties of Young's oils:

> "... perhaps the most valuable property the "Mineral Oil" possesses, is its being an antiseptic. Its constant use, therefore, in large establishments, where many operatives are working together, is decidedly favourable to their health, as its tendency is to destroy the contagious miasms likely to be generated in such places ..." [4]

1. Ibid., p. 5
2. Ibid., p. 8
3. Ibid., pp. 8-11
4. Ibid., p. 6

This sedate judgment was part of a respectable folk-lore tradition with an abnormal record of longevity. Generally, the geographical distribution of the individuals and firms providing testimonials is clear-cut. Most came from Belfast; the rest came from Manchester and district and also from the West Riding; none came from south of the Mersey-Humber line.

To aid marketing, Young, from the very beginning, adopted brand names. This may well have been a technique that he copied from Tennants in whose service he had already used brand names with success. His lubricant was sold as Young's Patent Mineral Oil; the casks in which his other oils were transported were either marked 'Paraffine burning oil' or "Naphtha".[1] Thus, Young always claimed that he had called his light burning oil "paraffine burning oil"[2] from the beginning, but this name was certainly not commonly used as a brand name until 1855. For the market for burning oil was largely Young's personal creation after 1855; there was much research devoted to deodorising this oil still further to reduce consumer prejudice.[3] But the necessity for a brand name grew as the lamp oil trade became increasingly competitive, and, in addition, there were spurious imitations, dangerous plagiarisms, lacking not only in quality but also in safety. John Poynter

1. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 107, Evidence of James Young
2. Ibid
3. Business Journal and Laboratory Notebook, 1856-1861, passim: c.f. Note 24

recalled his version of the history of this brand name in 1864 when he said that John Young had told him that his brother:

> "... would very likely call it paraffine oil as the lubricating oil was called paraffine and that he would introduce his oil by calling it the same name ..." 1

But, as we have already noticed, Young's lubricant was never called "paraffine" but 'Patent Mineral Oil'. We know that Young had a penchant for brand names even before he entered the oil industry. Poynter's analysis was merely his opinion and not necessarily the truth. Young knew without any prompting that a reputation for quality was the best insurance against competition, and a brand name was the obvious instrument to secure this. Competitors could be restrained from adopting the same name. When, before 1862, so many dangerous burning oils were available to the public without fear of state intervention, a brand name was also a safeguard against disastrous publicity.

All the partners took part in the game of besmirching the reputation of the other burning oils. With the growth of competition from American petroleum after 1860 the safety factor became a fundamental plank in Young's advertising policy. This was helped by the carelessness - and often the wilful negligence - of American refiners who exported many dangerous fractions in their burning oil, causing accidents in different parts of Europe in 1861-1862. This was Young's

1. Fernie and Others v. Young and Others, Lords, 1864, p. 1342, Evidence of John Poynter

opportunity to rally public opinion against these dangerous foreign oils; the British national and provincial press in 1862 contained several articles and many letters against American petroleum which can be traced to Young's agents, partners and retailers.[1] This pressure from the press was influential in securing the Petroleum Act of 1862. Young was also suspicious of the "Cambrian Oil" produced by his great rival E.W. Fernie in 1862; he thought it might well be petroleum crude which was being refined in Britain.[2] A patent battle was imminent. What better than to get the public to prejudice the case in Young's favour. With the expansion of capacity at Bathgate in 1862, Young had more oil for sale than effective demand warranted. The answer was greater advertisment: "... We are still far short of what we would like for sales we think of an extensive system of advertising ..."[3] But public relations had not become so specialised that consultants existed to advise. Young asked his friends and his managers for samples of their advertisements and began a pragmatic study of techniques. Agents and retailers also took a hand,

1. National and provincial newspapers in Britain throughout 1861 and 1862 contain many accounts of accidents with light burning oils. Binney, Meldrum and Young joined in the Correspondence arising from these. C.f. The Scotsman, 2 May 1862 and 26 May 1862; The Lancet, 29 March 1862; The Times, 23 January 1862 et seq.; North British Daily Mail, 5 March 1862; Morning Chronicle, 4 March 1862; Evening Courant, 19 May 1862; Manchester Examiner, 6 May 1862; Birmingham Journal, 2 May 1862; Daily Telegraph, 29 February 1862 et seq.; Mining Journal, 18 January 1862; Bristol Daily Express, 27 January 1862
2. Letter Copybook; 1860-1863, Young to Brown, 20 October 1862
3. Ibid., Young to Brown, 23 October 1862

often displaying greater ingenuity than Young's own firm - doggerel advertising was one such technique.[1]

There were many minor opportunities for marketing by 'prestige-type' devices. Lamps and official notepaper were embossed with Young's trade names.[2] At the end of 1860 Young was trying to get Field's paraffin candles introduced into Buckingham Palace so that sales could be boosted by claiming royal use.[3] The improvement in candle manufacture, a corrollary of the use of paraffin wax, was, however, so striking to most observers that sales were bound to rise:

> "... A modern candle of the better sort is an elegant, portable gas-work, which a lady may handle without soiling her fingers and not the greasy snuffy thing it used to be in former days ..." [4]

Exhibitions and trade fairs were also treated as a means of advertisement, and stands were made as spectacular as possible. At the International Exhibition of 1862:

> "... The Bathgate Paraffin Company show the very largest block of solid paraffin they have ever made. It is about half-a-ton in weight, and is a cube in form of about thirty one inches on the side of the square. The block is surmounted by candles and oils of the same substance and also by specimens of paraffin obtained from some other Scotch and English coals ..." [5]

1. Young's Scrapbook contains one excellent example.
2. For lamp embossing c.f. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 206; Evidence of David Laidlaw; Letter headings on notepaper containing advertisements are very common among Young Papers
3. Letter Copybook, 1860-1863, 6 November 1860, Young to Meldrum.
4. The Scotsman, 17 May 1862
5. The Scotsman, 14 May 1862

The Court of Session in Scotland, the court of Chancery and even the Appeal Court of the House of Lords were used as advertising media by Young and his partners, making advantage from necessity.[1] Patent trials which took six days in 1860 and thirty four days in 1864 were bound to attract public attention and to bring the prestige names of Young's products before the public and the trade. That the claims of Young and his partners were always upheld by the law was certain to provide favourable publicity and to associate their products with their own probity. Young almost enjoyed the reputation of a public servant when he threatened to prosecute those who infringed the trade name of his burning oil:

> "... Mr. Young is only doing his duty to the public as well as to himself in instituting proceedings to check the fraudulent use of his trade name for an oil the safe use of which has been proved ..." [2]

What a fortunate natural identity of interests to the detriment of Young's competitors!

In conclusion, the organisation of production and sales mirrored the need for remote control by an executive committee. For this is what the partnership meant as the business grew. This executive committee was a remarkable combination of personalities, a triumvirate at the head of a complex administration for ever on guard against local mismanagement. When this executive committee disagreed on policy, little was

1. The patent cases with White (1854), with the Clydesdale Chemical Company (1860) and with E.W. Fernie and Others (1862-1864) received great publicity, particularly in the trade journals, but also in the national press
2. The Weekly Dispatch, 2 March 1862

done; when they decided to make changes, especially in capital equipment, events moved with the speed of light. The system was based on personal appraisals and reports between partners; its weaknesswas local human frailty. Young's personal reports to and from managers, his system of auditing, his visits to local "statinns", his constant viligance against procrastination and negligence reflect this problem of general control. So does the insistence on local thoroughness, scrup ulous honesty and pain-staking devotion to duty.

Young, Meldrum and Binney were exponents of a new kind of business economics. They were not any of them typical old-fashioned captains of industry. The traditional view of the captain of industry allows for his creativity and ability to calculate risks but condemns him for his "public-be-damned" attitude. Young and his partners recognised that ultimate success in their business, the survival of their enterprise, depended upon thinking in new terms. All jealously guarded the reputation of the product; all assisted in the general stages of growth; all approached large-scale business in an enlightened pragmatic fashion. They were prepared to use pricing policy to stimulate or to deflate demand; they related ultimate profit not to the unit of production but to inventory turnover; they were content with less of a margin and yet succeeded in making a greater total profit. They believed in research, technical efficiency and advertising. They, as a transitional form of business, were entering the epoch of the large-scale limited liability company when Young's patent came to an end.

INFRINGEMENTS, COMPETITION AND THE LAW

(1851-1864)

"... Young's patent for obtaining crude paraffin oils, does not ... leave a loophole for the patent to be successfully evaded, as it is well known, among practical men, that any heat greater than that which his patent claims will produce only a very small quantity of oil of but little value, and much gas ..."

George Bower, gas manufacturer, 1863.
(Journal of Gas Lighting, 10 February 1863)

Patent litigation is often pedestrian in its scope and devitalising in its effect upon interest. But occasionally, classic actions arise which reveal inter alia the nature of competition in the industry, the view that the inventor holds of his own worth, and the value of specially gifted individuals to a partnership or company.

Before Young's patent was enrolled, as we have seen,[1] at several widely scattered points of Britain - inventors were seeking with varying degrees of success a commercial process for the manufacture of paraffin wax, lubricants and lamp oil. Young and his partners could not be free from competition nor could they escape vituperation, since conscientious and sincere individuals often believed that Young had stolen a crafty

1. Vide infra., pp. 43 sqq.

march upon them. In and around the ironworks of Coalbrookdale experiments were being conducted throughout the 1840s; in South Wales tarry "tram-oil" had been produced from coal for nearly two generations before Young's patent. Samuel Clift, the manager of Bethel's Tar Distillery and Chemical Works of Manchester, the largest tar distillery in Britain in the 1840s, had been corresponding with Jesse Fisher of Ironbridge in Coalbrookdale, and in 1851 they became partners in an ill-fated attempt to exploit the commercial possibilities of Shropshire shales.[1] Alexander Parkes, in the employ of Elkington and Company was conducting a great number of experiments with Staffordshire and Welsh cannel coals from 1843 onwards;[2] in Salford, Samuel Lees was busily engaged on distilling Lancashire cannels.[3] In Ireland and the Hebrides, at the turn of the decade, there were attempts to distil peat to produce paraffin wax and oils;[4] in Flintshire and on the Dorset coast attempts were being made to distil shale.[5]

Abroad the same problem was being assiduously tackled in a number of countries. In France there was the prosperous

1. Fernie and Others v. Young and Others, Lords, 1864, vol. ii., Respondents' Separate Appendix, pp. 40-41, Agreement of Co-partnership between Jesse Fisher and Samuel Clift; Ibid., Answer of E.W. Fernie, pp. 3-4.
2. Fernie and Others v. Young and Others, Lords, 1864, pp. 1325 sq. Evidence of Alexander Parkes
3. Fernie and Others v. Young and Others, Lords, 1864, vol. ii., Answer of E.W. Fernie, pp. 3-4.
4. E.W. Binney and Company v. The Clydesdale Chemical Company, Court of Session, Edinburgh 1860, pp. 308-309; c.f. also British Patent No. 12,346, 25 January 1849, Rees Reece, for making paraffin from peat; and British Patent No. 12,990, 7 March 1850, William Benson Stones for treating peat.
5. Fernie and Others v. Young and Others, Lords, 1864, vol. ii., Appendix for Appellants pp. 100-101.

shale-oil industry of Autun; in the Prussian Rhineland 'paper-coal' and lignite were being distilled; in many different parts of central and eastern Europe oil refining was well established as an industrial technique. In the United States and Canada, Abraham Gesner and Lord Dundonald were interesting themselves in cannel coals, shale and the bitumen of Trinidad. Gesner was to claim for himself the title of the father of the North American oil industry and to perpetuate[1] his fame by inventing the word "Kerosene" or 'Kerocene'. Wherever Young and his partners turned, they were likely to be met with claims of prior usage or publication. That they expected this is almost certain: the care they took to draw up the patent specification omitting shale is one corroborative indication; another is the fact that they decided not to take a French patent, although for other inventions Young sought a Brevet d'Invention.

Quite apart from the deliberate decisions of grand strategy, Young and his partners were singularly fortunate that their basic raw material, Boghead coal or Torbanehill Mineral, was not widely known before 1849-50. There had been extensive sinking, boring and mining in the parish of Bathgate in the late 30s and early 40s.[2] An Edinburgh mining engineer, John

1. Business History Review, Vol. xxix, 1955, pp. 28-53 Kendall Beaton, Dr. Gesner's Kerosene: The Start of American Oil Refining. Thomas Antisell, The Manufacture of Photogenic or Hydro-carbon Oils, New York 1860, p. 16 and pp. 115-116
2. Second Statistical Account of Scotland, vol ii. Linlithgowshire, Edinburgh 1845, pp. 154-155

Williamson, was tenant at Boghead about 1837; he worked the top-coal but could not sell it economically because his costs were so great; he found that seams were so thin and irregular that they were expensive to open, and before the great era of Lowland railways transport costs were oppressive.[1] Thus, the first attempt to exploit Boghead coal was a commercial failure. In 1841 a company bored for ironstone in the same property and were disappointed when they found this cannel coal instead. Andrew Aitken, a Bathgate mason, took two leases of Boghead coal in 1843 but did not work them for lack of capital.[2] George Foster, a local mineral borer, who had been employed by Williamson in 1837-38, later worked for William Dixon, the Glasgow coalmaster, in 1847 when cannel coal seams around Bathgate were being opened. But Dixon was looking for steam coal not gas coal.[3] In 1847-48 William Gillespie had been negotiating with Alexander Buttery, partner in the Monkland Steal and Iron Company, about his minerals, but no agreement was reached.[4] In 1849, James Russel took Boghead coal samples from the first borings to Frederick Penny, Professor of Chemistry in Anderson's University, Glasgow, and sought Penny's professional services in assessing its value. Penny, by accident, dis-

1. E. and W. Gillespie v. Russels, Court of Session, Edinburgh 1853, p. 175, Evidence of John Williamson
2. Ibid., pp. 175 sq., Evidence of Andrew Aitken
3. Ibid., p. 177, Evidence of George Foster
4. Ibid., p. 181, Evidence of Alexander Buttery

tilled some of these samples in experiments at low temperatures and produced oil. Russel was more interested in finding a coal with a ready sale to gas-works, and when Penny assured him that Boghead cannel was the finest gas-coal of his experience, that was all he wanted to know. Penny, therefore, did not bother to analyse the oils that he had produced.[1] All the evidence, therefore, suggests that well before 1850 a tar distiller or a manager of a gas-works or a mining company might have tried to secure oil from this coal - but they did not.

1. E.W. Binney and Company v. The Clydesdale Chemical Company, Court of Session, Edinburgh, 1860, pp. 28-29, and p. 37, Evidence of Frederick Penny.

1. The Early Skirmishes (1853-1855)

The commercial exploitation of Boghead cannel coal began on the estate of Durham Weir in 1849, when the Russels first took a lease. They, then, applied to the Gillespies for the lease of the Torbanehill minerals, well knowing that the seam of this excellent gas-coal discovered on Weir's property - and other valuable minerals - would occur on the Torbanehill estate. By letters dated 20 March and 1 April, 1850 the lease was eventually agreed: Gillespie was to receive £300 per annum rent and lordships of 1/6d per ton for iron ore, 1/- per ton for ironstone, 6d per ton for coal, limestone and fire-clay.[1] The great commercial success of the Boghead cannel rapidly raised its price and when the Russels were known to be marketing this coal at 15/- per ton in Leith and Glasgow, William Gillespie became convinced that he had been the victim of a shabby confidence trick. The lordship was not only inadequate; the Russels had known it to be inadequate and had deliberately concealed the value of the minerals on the Torbanehill estate.[2]

Because of Gillespie's poor health for most of 1850 and 1851, the inevitable clash was delayed. At first he tried to get the Russels to pay a fresh lordship, since, he suggested, Boghead was not a true coal and, therefore, not really covered by the lease of 1850. Because the Russels refused to accept this interpretation, Gillespie proceeded to law. Damages were fixed at £10,000.[3]

1. Gillespies v. Russels, 1853, p. 107, Counsel for Defendants
2. Ibid., pp. 202 sqq. Counsel for Pursuers
3. Ibid., pp. 4 sqq. Counsel for Pursuers

Although on the surface it appeared that Gillespie was acting against the Russels and was concerned only with a coal lease, the Torbanehill Mineral Case was also a direct attack on Young's patent and the partnership. For, if it was found that Boghead cannel was a shale and not a coal, Young's patent would lose its effectiveness, if not its validity. Any one using Boghead coal to make paraffin oils and waxes would be free of Young's patent since his specification could not claim shale but only coal as a raw material - Du Buisson's earlier patent[1] would be the valid shale patent, and since the Wareham Oil Company which controlled his English patent was already bankrupt and about to be dissolved in Chancery in 1854[2], there would be a free-for-all widening of capital. Young's contract for 10,000 tons of Boghead coal would no longer be binding; instead of Russel, Gillespie would control the price of Young's raw material. This would probably mean a great rise in price and therefore costs; indeed, Gillespie would either nominate those who would produce coal-oils or his pricing policy would lead to the inevitable exploitation of oil-shales as they became more economic to use. No matter whom the case directly involved, Young and his partners were potentially the greatest losers.

From 29 July to 4 August, 1853 the battle of learned societies engulfed the Court of Session in Edinburgh[3]: twenty

1. British Patent No. 10,726, 23 June 1845
2. Fernie and Others v. Young and Others, Lords, 1864, pp. 1194, Evidence of George Woolfries
3. Gillespies v. Russel, Court of Session, Edinburgh 1853, passim

eight eminent and learned geologists, mineralogists, chemists, microscopists, civil and mining engineers paraded for the pursuers and forty one for the defendants. Geologists contradicted geologists; chemists quarrelled with the findings of chemists; Fellows of the Royal Societies of London and Edinburgh dogmatically disputed the dicta of other Fellows. The whole trial degenerated into petty intellectual dog-fights between scientists. Yet this galaxy of scientific talent was unable by scientific tests to decide whether the Torbanehill Mineral was shale or coal. The world of science was divided; this was all the Torbanehill Mineral Case proved "... for a stronger body of scientific evidence never was laid before any jury ..."[1] The Lord President charged the Jury, ironically enough, to disregard the scientific evidence as weighty but inconclusive and said that the important point was whether this disputed mineral was let as coal by Gillespie in the lease, and not whether it was really coal or shale:

> "... you are to determine whether it is coal or is not coal ... in the language spoken in the missive ... not ... in the language of geologists ..."[2]

Weight of numbers prevailed. The forty one for the defence, many of them engaged by Binney and Young on Russel's behalf, triumphed. After such a long hearing the Jury retired for ten minutes only,[3] returned, and found for the defendants. So

1. Ibid., p. 232, Counsel for Defenders
2. Ibid., p. 236
3. Ibid., p. 246

ended the first round of a cause célèbre; Young's patent was safe for the time being.

But the fight continued. All that had been decided was that the Boghead cannel was within the terms of Russel's lease. Mineralogists, chemists and mining engineers continued the debate on the nature of this mineral in the columns of the trade journals and the scientific press. But scientific consultancy received a sharp blow from this trial, and academic scientists became a laughing-stock in most trade quarters.[1] Nor was Gillespie content. He carried the case further and did not finally compromise it until 1860. By that time Russel was weary, and Gillespie out to make oil.[2] Gillespie was both irritated and irritating. He refused to advertise his Torbanehill minerals as coal; in "The Theology of Geologists" he even attacked the fundamentalist theology of one of the geologists who appeared for Russel at the trial and he linked this with a "proof" that Torbanehill Mineral was shale not coal.[3] But Russel's commercial acumen and Young's monopoly restricted the sales of Boghead cannel coal and, therefore, reduced the profit potential of Gillespie's reserve minerals. For good economic reasons he remained a litigious menace to Young's patent.

1. C.f. especially, editorial in Journal of Gas-Lighting 10 August, 1854 which attacked the scientific testimony of Professor D.T. Ansted and provoked him to reproach the editor for suggesting venality in Journal of Gas Lighting, 10 September 1854
2. M.S. Letter, Binney to Young, 17 January 1860
3. J. Urquhart, William Honeyman Gillespie, Scottish Metaphysical Theist, Edinburgh 1920, passim, but especially, pp. 431-440

The publicity of the Torbanehill Mineral Case - even before the formal hearing - widened the possible area of infringement. At the trial William McLintock, manufacturer of naphtha, asphalt and artificial manures, with works at Glasgow, Perth and Irvine, told the world that he had distilled the Torbanehill Mineral for its liquid products, according to Young's specification and gave the profit margin of roughly 100% which was open to the skilful but inexperienced.[1]

Mc. Lintock's Costing of Young's proccess per ton ¥

Value of Products	£5. 14. -.
Total Costs of Products	£2. 18. 9.
Profit	£2. 15. 3.
Profit in terms of Costs %	94.04%

¥ Source: Gillespie v. Russel, 1853, p. 90

Nobody could be unaware of the nature of Young's raw material after the Torbanehill Mineral case. Gas companies using Boghead cannel might be encouraged to diversify since no additional capital equipment was necessary. Generally, in Scotland the managers of gas companies in the larger cities and towns - in Glasgow, Edinburgh, Dundee and Aberdeen - were more interested in their established trade in coke than in making paraffin oils.[2] In England not all gas works had this profitable connection with heavy industry; those in the textile areas were often prepared to seek complementary products with a ready local sale.

1. Gillespies v. Russels, 1853, pp. 89 sq.
2. Evidence of Scottish gas managers in the Torbanehill Mineral Case was all to this effect.

One of them, the Hydro-Carbon Gas Company of Manchester and Salford, had special advantages. This company employed Edward Frankland, Professor of Chemistry at Owen's College, as chemical adviser, and he had been one of the provers of Young's patent and knew the specification well.[1] Frankland made a scientific investigation of gas coals and advised the Hydro-Carbon Gas Company to try Boghead Coal knowing its equal possibilities for paraffin and gas production.

Even before the Torbanehill Mineral Case the hydro-carbon method of producing gas was attracting considerable attention from the gas trade.[2] But the company was faced with financial difficulties which it hoped to solve by producing lubricants from Boghead cannel coal as well as gas. Experiments at Salford cost the lives of several of their workmen,[3] but ultimately they produced paraffin lubricating oil. Frankland seems to have connived at this infringement of Young's patent; he assisted in improving refining techniques and later justified his connivance by claiming that he had advised Young in 1850 not to claim paraffin oil as his patent product.[4] From Salford the Lancashire textile market was at hand without

1. Gillespies v. Russels, 1853, pp. 150 sq., Evidence of Edward Frankland; c.f. also Young and Others v. White and Others, Queen's Bench, 1854, Evidence of Edward Frankland, pp. 97-98
2. Journal of Gas Lighting, 1853, passim but especially letter of Samuel Clegg published 10 June, 1853
3. Young and Others v. White and Others, 1854, p. 64 Evidence of William Collier
4. Ibid., p. 98, Evidence of Edward Frankland

heavy transport costs; it was in the process of conversion from natural oils to coal oils. Early in 1853 the Hydro-Carbon Gas Company was selling paraffin lubricating oils in Lancashire.

Fortunately, Young and Meldrum could rely upon the scientific interest and vigilance of Edward Binney. Early in 1852 Binney had visited the Hydro-Carbon gas works at Southport and Rhodes. There he had noticed that instead of using resin the Hydro-Carbon Gas Company was distilling Boghead coal. They then began to advertise lubricating oil in the Lancashire local press, and Binney noticed their advertisment in the Preston Guardian of 1 January, 1853. By 20 January, 1853 Binney was aware of the extent of their competition and early the next month he visited the Salford works and confirmed that they were operating according to Young's patent; on 24 February, 1853 he secured a 10 gallon sample with receipted invoice through one of his agents.[1] Young, Meldrum and other chemists examined this oil and found it almost identical with that sold as Young's Patent Mineral Oil.

In April, 1853 Young filed a Bill in Chancery and succeeded in obtaining an injunction restraining the Hydro-Carbon Gas Company from making this oil. This injunction did not prevent the development of competition from other gas companies which also began to manufacture oils from Boghead cannel coal. Nor would the Hydro-Carbon Gas Company accept the injunction

1. Ibid., p. 46, Evidence of E.W. Binney

as final. But the case did not come to court until 28 and 29 June, 1854, when it was heard in the Queen's Bench before a Special Jury: a test case between the partnership and the gas companies.

Binney organised the defence of Young's patent; Young acted on his advice especially in finding witnesses. Baron von Reichenbach was asked to disclaim the commercial production of paraffin wax, and Binney telegraphed for his statement that he had never produced paraffin oil. Reichenbach generously obliged.[1] One witness presented difficulty: George Miller, chemical manufacturer of Glasgow. Binney thought he would be a good witness for their case, but his desire to see over the Bathgate works excited Meldrum's suspicions which Binney echoed: "... Thank him for his kindness but state that we will not trouble him to go over to Bathgate ..."[2]

The case for White and his partners was based on the standard pleas in patent cases: that Young was not the first inventor of the process; that the process was not new to Britain at the time of the patent; that the specification did not describe the process adequately and that Young's patent had not been infringed by their own process. They did not deny that they were producing paraffin lubricating oil; they simply said that it was up to Young and his partners, as the

1. Journal fur Praktische Chemie, Leipzig, 1854, pp. 63 sq. Reichenbach, "Notiz sur Geschichte des Paraffins".
2. M.S. Letter, Binney to Young, 20 June 1854

plaintiffs, to prove that their method of production was an infringement of Young's patent; in any case they doubted the validity of his patent.[1] This kind of defence was repeated in all the cases in which Young's patent was involved, but the scientific evidence and the assembly of witnesses backing White's case was not so substantial as that later arrayed against Young and his partners.

The battery of scientific witnesses on Young's behalf proved victorious, and Lord Chief Justice Campbell, in his charge to the Jury, helped Young's case considerably by directing them to recognise Young's specification as an adequate description of his process. He left the Jury to decide whether there had been prior publication but cited the evidence of Young's best academic witnesses, Graham, Playfair, Hofmann, Stenhouse and Fyfe, all of whom emphatically gave Young the novelty. He also drew the Jury's attention to the fact that the defendants had begun as gasmakers and now apparently had changed to oil-making and repeated the main charge brought by Young's counsel: "... the defendants, under the pretence of making gas, have been making paraffine ..."[2]

At twenty three minutes past six the Jury retired, returning at two minutes to seven. They found for Young. This verdict did not satisfy the defence who entered a Bill of Exceptions to the direction of the Lord Chief Justice. But

1. This is a brief summary of the case for White and his partners
2. Young and Others v. White and Others, 1854, p. 145, Lord Chief Justice Campbell to the Jury

all the gas companies using Boghead coal stood to lose if the case had gone to judgment. Many of them were preparing to diversify and awaiting the Court's decision before they went ahead. Others, like the Chartered Gas Works, Westminster, were already producing paraffin, paraffin oil and naphtha.[1] The Journal of Gas Lighting, mistakenly assuming that Young's patent also covered the production of paraffin wax from coal tar, treated the Jury's verdict to a short, sharp editorial attack which ended:

> "... it certainly does seem unreasonable that gas companies should be prevented from converting these residuary products into substances well known before Mr. Young took out his patent ..."[2]

The Bill of Exceptions was eventually abandoned by the defendants in favour of securing a rule nisi calling upon Young and his partners to show cause why a new trial should not be held on the grounds that the verdict was against the weight of evidence, and that the Lord Chief Justice, in refusing to admit Du Buisson's shale patent, had improperly rejected evidence which he ought to have received.[3] However, there was no new trial. Both parties agreed to settle out of court, although Young was pressed by Binney and Meldrum into accepting the compromise. The defendants agreed to give up

1. Ibid., pp. 122 sqq., Evidence of F.J. Evans
2. Journal of Gas Lighting, 10 July 1854
3. Fernie and Others v. Young and Others, Lords, 1864, Appellants' Appendix: E.W. Fernie's Answer to Respondents' Bill of Complaint, p. 8; c.f. also Ibid., Appellants' Case in House of Lords, p. 107

their business as oil manufacturers and to grant a licence to Edward W. Binney to use their Hydro-Carbon process, mentioned in their letters patent, for a distance of six miles from St. Pauls. In return, Young and his partners were to pay the defendants £3,000.[1]

Both sides gained from this compromise. White and his partners were heavily committed financially in the South American gas industry at Rio de Janeiro as well as in Britain at Edinburgh, Leith, Southport, Rhodes, Manchester and several other places. They received £3,000 and did not have to meet additional legal costs which a further action in the Court of Chancery would have entailed. But Young and his partners appeared in the short term to have gained most. They had succeeded in holding off the extensive competition likely from the whole gas industry. But the compromise was a source of future embarrassment to the partnership. Since Binney did not operate the Hydro-Carbon Gas process, it was easy to suggest, if not to prove, that White and his partners were being bought off, that there was never any intention of operating White's patents and that the £3,000 licence fee was a bribe to prevent further litigation and possible damage to Young's patent, a settlement of legal costs in favour of White and his partners. Young realised this and opposed the compromise, but Binney had his way, having later to retract.[2]

1. Ibid., Respondents' Bill of Complaint, p. 7 and also E.W. Fernie's Answer ... p. 8
2. M.S. Letter, Binney to Young, 16 July 1859 and M.S. Draft Letter, Young to Binney, 19 July 1859

2. The Clydesdale Chemical Company and Others, 1855-61

Infringements continued to occur; illicit competition multiplied. This was partly the fault of the partners, since they were very slow to grant licences and, therefore, compelled competitors to infringe. It was also a reflection of the acquisitive nature of men who sought to by-pass the legal obstacle of Young's patent.

In 1853 William Brown and Company started to make black oil at Port Dundas[1] using processes patented by Brown and Bellford - Bellford's patent had been bought by Brown.[2] Binney, Meldrum and Young knew of these patents and recognised them as mere repetitions of the principles of Young's earlier patent. At the end of August, 1854 the partners agreed to meet "... to have a talk ... about the Browns ..."[3] After their recent experience in the White case before the Queen's Bench, they decided to avoid the law at this stage for no action was brought; Young and his partners could not afford to waste capital on the law when they needed it for investment and expansion, for technical change and research. Why risk their patent at this stage? Although in 1855 Brown and his partner John Bain extended their operations to Cambuslang, there was room in the market for their lubricants particularly as Young and his partners were finding new markets for lamp oil and paraffin wax.

1. E.W. Binney and Company v. The Clydesdale Chemical Company, Court of Session, Edinburgh 1860, pp. 196-197, Evidence of Donald McDougall
2. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 329, Evidence of Thomas Carlisle, manager of the Clydesdale Chemical Company
3. M.S. Letter, Meldrum to Young, 22 August 1854

The collision between these two companies was further delayed when in 1857-58 the Western Bank ran into difficulties and failed. Brown went bankrupt; Bain and his son continued the Company, alone and at the mercy of their creditors with whom they came to terms, under difficulties of inadequate finance, a labour force reduced compulsorily, and lower capacity. The Clydesdale Chemical Company, as Bain and Company was called, proved exceedingly resilient. The Bains were exceedingly energetic and they sensibly concentrated upon the manufacture of heavy lubricants and railway grease and won many long-term contracts with English railway companies. From this base by the end of 1858 the Clydesdale Chemical Company was beginning to penetrate the Lancashire textile market and at this point, their interests clashed with those of Young, Meldrum and Binney. By November, 1858 a prosecution for patent infringement was very likely. The partnership's attorneys in the United States were told of this, and since they were attempting to force settlements on infringers in North America, they were glad to hear of the partners' firmness in Britain: "... It is important that you show no sign of wavering there ..."[1] But there was to be no hurry to fight the British case; Binney was instructing the partnership's Edinburgh solicitors to delay bringing the case to court as long as possible, "... to throw it over to next November ..."[2]

1. Copy Letter, Benedict and Boardman to Binney, 24 November 1858
2. M.S. Letter, Binney to Meldrum, 11 January 1859

In Lancashire, Young's oldest agent for lubricating oils, James Hurst, began to suffer from the competition and complained to Binney about it. Binney advised him to write to Young and Meldrum at Bathgate:

> "... I told him that it was no use reducing price but it was a question for you and Mr. Meldrum to consider whether or not it was not desirable to give notice to consumers and serve 3 with writs ..."

After the White case Binney was wary of the legal process - and from the beginning he had expressed privately to Young his doubts about whether the patent would withstand considerable pressure at law. He thought issuing a few writs might be sufficient to frighten the consumers "... and it would do harm if they resisted ..."[1]

Hurst took Binney at his word - and more. He wrote to Meldrum and Young, saying that Binney was in favour of sending notice to Bain's customers and of beginning an action for patent infringement against them in England. Young did not object to a war of nerves against Bain's customers but he did not want to hear Binney's opinions second-hand: "... I should like to have your opinion on this direct and not through Hurst ..."[2] Binney soothed Young's ruffled feelings by saying that the decision of when and where to prosecute the Clydesdale Chemical Company would have to be made by Young and Meldrum. Hurst had gone away from his meeting with Binney to some of Bain's customers and cautioned them for conniving at a patent infringement. Swift retaliation followed. The Clydesdale

1. M.S. Letter, Binney to Young, 1 March 1859
2. M.S. Letter, Young to Binney, 26 February 1859

Chemical Company issued a circular in the Manchester district stating that they had been informed that their customers had been annoyed "... with the most groundless threats of prosecution for using the oil which is made at their works ..." They reassured their customers that they guaranteed perfect immunity against any proceedings, since their own process was both different and better than that of Young. The bluff had been called; the principals had to be attacked; the preliminary jousting before the orthodox legal battle was over.

There was some difference between Young and Binney about where to fight the Clydesdale Chemical Company. Binney was convinced that the case ought to be fought in England "... as I despair of the Scotch lawyers ever getting the case well up ..."[1] However, when the partners met in Glasgow in March, 1859, they agreed to bring the case in Scotland. There were two reasons, probably, why Binney did not get his way. First, in the Court of Session it was least likely that the Boghead coal would be adjudged a shale after the Torbanehill Mineral Case decision of 1853; in England the question was still open. Thus the Clydesdale Chemical Company would be prevented from making the best use of the shale patents anterior to Young's. Secondly, the Scottish law, because of its insistence on the use of counsel in patent cases from their inauguration, was likely to take even longer than the English Courts of Equity. Having obtained an interdict against the Clydesdale Chemical

1. M.S. Letter, Binney to Young, 1 March 1859

Company, the partnership lost little by delay and gained much. If the case was delayed or protracted through the English Courts to the House of Lords, even if the partnership finally lost, they gained profit-earning time, since the patent was taking longer to be demolished. Speculative spectators on this legal scene, who hoped that the Clydesdale Chemical Company would be successful, would at least be deterred from entering the industry as long as the case lasted - a rapid widening of capital would thus be avoided. If the partners won, they secured damages just the same. Against the background of seeking control over the American coal-oil industry, the partners' desire to proceed more slowly in Scotland than in the courts of Boston and New York is not merely intelligible; it was brilliant strategy. It was far less likely that an adverse decision in an American court would influence the outcome of the Scottish case than that the Scottish judgment could prejudice the American case. To secure a decision or settlement in America first was an obvious policy.

By 18 March, 1859 the case of E.W. Binney and Company against the Clydesdale Chemical Company had begun.[1] From Manchester, by remote control, Binney began to conduct two cases, one in America, the other in Scotland, and with Young's help he collected learned works and extracts for reference and assembled a brilliant panoply of scientific consultants,

1. M.S. Letter, Nicolson and Steven to Young, 18 March 1859, enclosing Copy Letter, Horne and Rose to Nicolson and Steven, 18 March 1859

even retaining those like Edward Frankland who had previously testified against them in the White case.[1] Potentially hostile witnesses were restrained. Jesse Fisher was subpoened by both parties, but because Binney had secured Fisher's correspondence with Samuel Clift - in which he admitted Young's priority - and threatened to bring an action for perjury, Fisher did not testify. Binney thought that Fisher's evidence might be damaging to the partnership, although he knew it to be false; according to Fisher - and he was not contradicted - Binney "... wished to keep me out of the way ..."[2] Occasionally, Binney was unsuccessful. Plaintively, he informed Young "... Dr. Miller writes me that he has been a long time engaged on behalf of the Clydesdale Chemical Company ..."[3] But the advantage of having such an astute lawyer as Binney within the partnership to consider briefs before they went to counsel meant that the potentialities of damaging cross-examination and the limitations of patent cases were privately recognised.

Not that Binney was naturally litigious; he recognised the possibility that the dissolution of Young's patent would be a defeat for all, since the coal-oil industry would be opened to widened competition. The Clydesdale Chemical Company would lose their shelter behind Young's patent; this was a

1. M.S. Letter, Young to Binney, 23 March 1859; M.S. Letter, Binney to Young, 3 November 1859, enclosing copy letter, Binney to Frankland, 31 October 1859; Frankland to Binney, 2 November 1859; Binney to Frankland, 3 November 1859
2. Fernie and Others v. Young and Others, Lords, 1864, p. 1246 and p. 1294, Evidence of Jesse Fisher; c.f. also Ibid., vol. ii., Appellants' Appendix, p. 106; Copy letter, Binney to Jesse Fisher, 14 October 1860
3. M.S. Letter, Binney to Young, 18 January 1860

bargaining factor which Binney hoped to employ to good effect. He would have preferred to:

> "... come to some arrangement with the Clydesdale Company and others by granting them licenses to work at a royalty and thus stop our law ..." [1]

By September, 1859 as the partners had correctly anticipated, the Clydesdale Chemical Company struck out their plea that the Torbanehill Mineral was shale and, therefore, not covered by Young's patent. There was talk of a compromise settlement but not between the principals.[2] Young was jubilant but even he did not want the case to go beyond Counsels' chambers: he suggested to Binney that the respective solicitors, Rose and Macnaughton, should tentatively fix the basis for mutual discussion.[3] Binney was pessimistic - the principals were so far apart. He asked Rose to find out what terms Macnaughton proposed[4] but, privately, to Young, he confided: "... I have not much faith in his negotiation ..."[5] But diplomacy delayed the day of legal decision.

Binney was right. As Rose admitted when the trial had been ordered: "... unless a negotiation could be opened thro' some mutual and influential friend I do not suppose anything will come of it ..."[6] Binney felt that an agreed course of action was necessary in case the case went much more quickly than his other partners had thought likely: "... We should

1. M.S. Letter, Binney to Young, 26 March 1859
2. Copy Letter, Rose to Binney, 5 September 1859
3. M.S. Letter, Young to Binney, 5 September 1859
4. Copy Letter, Binney to Rose, 13 September 1859
5. M.S. Letter, Binney to Young, 13 September 1859
6. Copy Letter, Rose to Binney, 4 November 1859

meet together and determine what we are to do in this matter soon ..."[1] Meanwhile, he was urging the importance of delay on Rose; he wanted every point fought over:

> "... so that we might gain time, even by going to the House of Lords, so that the American suit might be determined ere we went before a Jury at Edinburgh ..."

Perhaps, the respective solicitors could discuss a compromise for England and thus be time-absorbing, if Rose correctly applied himself.[2]

On 11 January, 1860 the case of E.W. Binney and Company against the Clydesdale Chemical Company was entered in the Roll of the Court of Session. But there was still hope of compromise in the hearts of the respective solicitors. John Bain's agent, Macnaughton, had suggested to Rose for a second time that the case should not go to court. The Clydesdale Chemical Company:

> "... would settle upon the same terms as you had settled White's case ... that is, if they got a sum to indemnify them from the expense of this suit, they would allow an interdict to pass and would pay you, not an illusory, but a substantial sum for an Annual License ..."

John Bain "... had out of the profits of his work, been able to pay off his composition to his creditors ..."; he could afford to pay a royalty. The firms were able to divide the market without much fear of outside competition; they could arrange that no internal competition occurred between their products, since the Clydesdale Chemical Company expressed their clear intention not to make burning oil which they recognised

1. M.S. Letter, Binney to Young, 7 November 1859
2. Copy Letter, Binney to Rose, 7 November 1859

to be the staple product of E.W. Binney and Company. Rose thought this assurance would be kept and he was quick to point out that Young's patent safeguarded the Clydesdale Chemical Company from competition; to destroy the patent would serve no useful purpose except to make trading circumstances less conducive to profit. But if the case was settled on the terms suggested by Macnaughton's clients, then Young and his partners would settle this case only to be faced with other infringers emboldened by the publication of this settlement or by rumours relating to it. Macnaughton tried to allay these fears but without success.[1]

On 13 January, 1860 Young left for America. Meldrum and Binney went to Liverpool to see him off and to have a last minute conference to discuss Rose's information received the same day:

> "... we concluded that we would not give Bain one penny peice. We are glad to hear that he has made some money and we will try to get some of it ..."

Rose was instructed "... to get the cause ready for hearing by next July ..."; it would be easy to get recent evidance of infringements; citing Brown's and Bellford's patents as imitations of Young's would require little thought - in parts they were word-for-word copies.[2]

Progress was slow; Binney acted as Young's informer in his absence and he was constantly irritated by the slackness

1. M.S. Letter, James Rose to Binney, 12 January 1860
2. Copy Letter, Binney to Rose, 16 January 1860

of their Scottish law agents and the snail's pace of the Court of Session.[1] In March the Clydesdale Chemical Company had submitted their printed extracts. Binney was by that time quite optimistic:

> "... On the whole I don't think with the exception of the Shale Patents they are much worse than they were in White's case ..."

Binney, then, instructed Rose to seek a commission to go to Vienna to examine Von Reichenbach, knowing that the Baron would help destroy the validity of the Clydesdale Chemical Company's pleadings relating to prior publication. This was part of the technique of destroying the defendants' nerve: Binney thought that they might at last "... see we are in earnest and come and offer terms ..."[2] Meanwhile, industrial espionage was proceeding at Port Dundas and Cambuslang. Young's Glasgow solicitor, Thomas Nicolson of Nicolson and Steven, secured excellent technical information about methods of production used by the Clydesdale Chemical Company and he was convinced that their relation to Young's patent could readily be shown in court.[3] Robert Angus Smith went to Vienna to get Reichenbach's evidence,[4] but when this was obtained, Binney preferred the earlier statements of his generous article[5] in which he ascribed all credit to Young.

1. M.S. Letters, Binney to Young, 24 February 1860 and 29 February 1860
2. M.S. Letter, Binney to Young, 6 March 1860
3. M.S. Letter, Thomas Nicolson to Young, 2 April 1860
4. M.S. Letters, Binney to Young, 4 April 1860 and 18 April 1860; Copy of Reichenbach's Recognition, 1860
5. Journal fur Praktische Chemie, Leipzig, 1854, pp. 63 sq.

Binney had met Macnaughton in Edinburgh and was again told that "... the matter should be compromised ..." To this proposal, Binney said that he and his partners were prepared to grant the Clydesdale Chemical Company a licence at a moderate sum. Macnaughton was empowered to offer only a nominal royalty of from £50 to £100 per annum; his clients wanted E.W. Binney and Company to contribute £200 to their costs; on no account would they pay a royalty based on production. Binney told Macnaughton "... such a thing was ridiculous ..." His terms were that each party should pay its own costs, and the Clydesdale Chemical Company should then pay a royalty for every gallon of crude oil made. Otherwise, "... we must fight and then if the patent was blown up it would be their loss as well as ours ..." [1] This threat was very real but not absolute, since the Clydesdale Chemical Company was proposing to double productive capacity quickly so that its competitive position on the eve of a general widening of capital would be no worse than that of E.W. Binney and Company.

These attempts to compromise the suit failed. Young and his partners were bolstered in their judgment to go to court by Dr. John Stenhouse's view of the case just before the trial was due:

> "... I think your case improves the more rigidly it is examined and unless something very extra-ordinary occurs I think you will certainly gain the day and I believe your opponents are of a similar opinion ..." [2]

1. M.S. Letter, Binney to Young, 18 April 1860
2. M.S. Letter, Stenhouse to Young, 14 September 1860 enclosing his report on the case

In the first week of November, 1860 the case was tried at Edinburgh in the Court of Session, inevitably with William Gillespie and other interested parties looking on. The issues were three:

(a) Whether the Clydesdale Chemical Company had infringed Young's patent between July, 1855 and March, 1858.

(b) Whether Young invented the process described in his specification.

(c) Whether the process described in Young's specification was known and publicly used in Britain before the date of Young's letters-patent. 1

The pursuers assembled, as a result of Binney's efforts and Young's intimate knowledge of the world of chemical consultancy, a great number of eminent scientists; the defence lacked such men both in quantity and quality. Instead of personalities, they relied upon pleading prior use and publication; instead of scientists they assembled books, extracts from books, and patent specifications to indicate that Young's process had been adequately described well before 1850; instead of using Young's process - or Brown's or Bellford's - they claimed to use Lord Dundonald's which dated from 1781. If their process was an imitation of Young's, his must have been an imitation of Dundonald's. They thought Young's main contribution was to apply Du Buisson's shale process to Boghead coal instead of using bituminous schist, and, as they rightly said, Young could not claim to have invented Boghead coal. 2

1. E.W. Binney and Company v. The Clydesdale Chemical Company, Edinburgh 1860, p. 2., Counsel for Pursuers
2. Ibid., pp. 211-315

The Jury were not convinced by these pleadings and found for Young and his partners on all three issues, but even before they retired, the Counsel for the Clydesdale Chemical Company entered a Bill of Exceptions to the Lord President's charge to the Jury.[1] This was to be argued in January, 1861 but in December, 1860 Young, Meldrum and Binney met to discuss their offer of compromise.[2] The Clydesdale Chemical Company offered to withdraw their Bill of Exceptions, provided they were given a licence immediately. This was agreed. Thus, the suit was finally compromised: the Bill of Exceptions was withdrawn on 22nd January, 1861, and on the following day the verdict for E.W. Binney and Company was put into force. The Clydesdale Chemical Company were ordered to pay £7,500 damages and all legal costs for their infringement in the period before 7 November, 1860; they, then, took a licence at a royalty of 4d per gallon of crude oil made, this account to be settled monthly and assessed by persons appointed by the three partners.[3] In the three and a half years from November, 1860 and June, 1864 the royalties paid under this settlement amounted to more than £8,000[4] for about 500,000 gallons.

Because the defence tried unsuccessfully to show that others before Young had distilled coal for oils, a number of

1. Ibid., pp. 429 sqq.
2. Letter Copy book, 1860-1863, Young to Meldrum, 10 December 1860.
3. Fernie and Others v. Young and Others, Lords, 1864, vol. ii., Respondents' Appendix, Bill of Complaint, p. 8.; c.f. also Ibid., Appellants' Appendix, E.W. Fernie's Reply, p. 10
4. Ibid., Case of Respondents, pp. 9-10

other infringements of Young's patent were brought to light. Young and his partners had thought it wisest to turn a blind eye, until they were forced to prosecute. At Wareham and Weymouth in Dorset the shale oil industry took root before the Bathgate concern was built. John Braithwaite, a London civil engineer, erected the works at Weymouth in which he employed William C. Homersham from Autumn, 1849 to the end of July, 1850. By then, Braithwaite was a bankrupt and had been compelled to assign the works to his creditors;[1] they were not re-opened.

In 1848 a company had been formed to build a shale-oil works on leased land adjacent to the Southampton railway at Wareham. It was intended to work Du Buisson's English patent - and operations were clearly modelled on the flourishing French shale-oil industry - to produce Mineral oil and spirit, varnish, paraffin wax, greases and oil manures. The Board, a chairman and eight directors, issued a prospectus in 1849 asking for a total capital of £25,000 made up of 500 shares at £50 each, the first call to be for £30.[2] By 1853 it was also bankrupt being formally dissolved in Chancery in April, 1854.[3] This in-

1. E.W. Binney and Company v. The Clydesdale Chemical Company, 1860, pp. 188-189, Evidence of Samuel Clift; c.f. also Ibid., pp. 192-196, Evidence of W.C. Homersham; c.f. also Young and Others v. Macrae, Chancery, March 1862, Brief Affidavits: Affidavit of W.C. Homersham
2. Fernie and Others v. Young and Others, Lords, 1864, vol. ii., Appendix for Appellants, pp. 100-101; c.f. also Ibid., pp. 1156-1161, Evidence of William Percival Pickering, a Director of this Company; and Ibid., pp. 1210-1213, Evidence of John Barnett, formerly station-master at Wareham.
3. Binney and Company v. The Clydesdale Chemical Company, 1860, p. 189, Evidence of Samuel Clift; Ibid., p. 233, Counsel for Defendants; Ibid., pp. 318 sqq., Evidence of William Heathfield; c.f. also Fernie and Others v. Young and Others, Lords, 1864, p. 1134, Evidence of Richard Spyer; Ibid., p. 1149, Evidence of William Heathfield

dustry failed because the locale was too distant from textile factories, because the Kimmeridge shale was not so productive of crude oil as the Scottish cannel coals, because, on account of the sulphur in them, the oil products could not be easily refined or deodorised, making sales difficult, and because the tar distillers were already taking the subsidiary markets for varnish and naphtha.

Between 1854 and 1864 there were six further changes of ownership with a kind of interregnum from 1854 to 1857 during which the local squire, Colonel John Mansell, the owner of the Kimmeridge shale pits, prohibited their local exploitation, because he objected to the smell produced by the distillation process.[1] However, there was intermittent working by a French company, La Société Knab, the best customers of which were circus folk who used the crude oil for lighting their caravans and tents. Failing to solve the problem of refining the crude oil for the market, this company began also to use Boghead coal in quantity, but still employed the same capital equipment and methods as had been applied to Kimmeridge shale.

By 1858 Vincent Wanostrocht of Parkstone near Poole was head of the Company of Wanostrocht, Knab and Company and the "South Boghead" mines at Kimmeridge were booming, since new methods of refining shale oil had been discovered.[2] By January, 1859 Binney was afraid that action was necessary:

1. Fernie and Others v. Young and Others, Lords, 1864, p. 1197, Evidence of George Woolfries
2. Journal of Gas Lighting, 29 September 1857; Ibid., 28 September 1858. M.D. Magnier, Nouveau Manuel Complet de la Fabrication et de l'emploi des Huiles Minerales, Paris, 1867, p. 9, gives details of the Knab company in Paris

"... I think it desirable to write Mr. Wannostrocht giving him notice that he was infringing our Patent ..." [1]

Vincent Wanostrocht took the coward's way out; in 1859 his company sold their works to Charles Humfrey and Son. Humfrey and Son began operations on 1 January, 1860 and used principally Boghead coal and Young's process. Confident of success after the verdict in the Clydesdale Chemical Company case, Young and his partners entered a Bill of Complaint in Chancery in February, 1861 and sought an injunction to restrain Humfrey and Son. Before this Bill was argued, Humfrey and Son were faced with a Bill of Foreclosure in Chancery brought by a Mr. Wills or Willes to whom they had mortgaged their stock and plant. Since Humfrey and Son were now bankrupt and out of business, Young and his partners saw no opportunity for securing financial redress and had no further motive for filing their legal action.[2] However, the works continued in existence and from 1862 was managed by E.R. Southby on behalf of the Wareham Oil and Candle Company which was now once more owned by Vincent Wanostrocht. The infringement of Young's patent continued but not so obviously, since Wanostrocht's company often used Kimmeridge and Scottish shales as well as Boghead coal.[3] This technique of evasion was skilfully employed by a number of small firms in the British Isles and also by the large firm set up by E.W. Fernie.

1. M.S. Letter, Binney to Meldrum, 11 January 1859
2. Fernie and Others v. Young and Others, Lords, 1864, vol. ii., Respondents' Appendix; Bill of Complaint, pp. 8-9
3. Ibid., vol. i., pp. 1167-1186, Evidence of Edmund Richard Southby; Ibid., pp. 1191-1205, Evidence of George Woolfries, managing foreman of the Wareham Oil and Candle Company's works.

Elsewhere by 1861 there appeared to be more dangerous infringers than the ephemeral Wareham companies. Offshoots of that progressive Glasgow firm, George Miller and Company, previously attacked by Young's commercial bucanneering, sprang up in Glasgow and Aberdeen; John Miller and Company of Aberdeen and William Miller and Company of Glasgow. Early in 1859 the partners knew of the Aberdeen venture and set their spy to watch it closely: "... It was agreed that Lang should go to Aberdeen and learn what Miller and Poynter were doing ..."[1] In the summer and autumn of 1859 Young and Binney gathered as much information as they could in the hope of securing a royalty from these two companies.[2] There was a truce in 1860 as a result of Young's absence in the United States and the concern of the partners with the Clydesdale Chemical Company case, but early in 1861 they filed separate actions in the Court of Session against John Miller and Company of Aberdeen and William Miller and Company of Glasgow. They were striking at their competitors and using the precedent of the Clydesdale Chemical Company as an anvil. A compromise was reached in each case; the two firms agreed to pay £5,000 damages and all legal costs and were granted a licence at the rate of 3d per gallon. Between 1861 and 1864 they paid a further £2,500 in royalties but from 1862 on-

1. M.S. Business Journal and Laboratory Notebook, 1856-1861, 12 April 1859
2. M.S. Letters, Binney to Young, 23 August 1859; Young to Binney, 24 August 1859; Binney to Young, 7 September 1859

wards they were also refining much American petroleum. The growth of American petroleum exports was one important cause of the compromise, since natural petroleum served the purpose of the Millers very well. It was cheaper and less prejudicial to settle the case out of court, even if these firms believed that Young's patent was invalid.[1]

William Gillespie refought the battle with James Russel and Son over the nature of the Torbanehill Mineral until 1860.[2] There were rumours of an approaching compromise from November, 1859 but arguments over its details took time. Young and Meldrum were careful to avoid direct intervention in this battle, but from time to time Binney met Russel and stoked the fires of contention. For the partners did not want a combination of Gillespie and Russel, until they were prepared to abandon the production of oils from cannel coals. Young realised the importance of securing Gillespie's reserve minerals before the compromise between Russel and Gillespie was concluded. On 1 December, 1859 Gillespie and Young had a long preliminary conversation on this subject which came to nothing;[3] a week later Meldrum and Young visited the new open-cast workings on Gillespie's land near his house at Torbanehill and they saw blocks of Boghead coal 28" thick being brought out. There and then the two partners agreed that Young should

1. Fernie and Others v. Young and Others, Lords, 1864, vol. ii., Respondents' Case, pp. 10-11; Respondents' Appendix: Bill of Complaint, p. 8; c.f. also Ibid., Appellants' Appendix: E.W. Fernie's Reply to Bill of Complaint, p. 11
2. There were several actions in the Court of Session from 1856
3. M.S. Business Journal and Laboratory Notebook, 1856-1861, 25 November 1859; 30 November 1859; 1 December 1859.

see Gillespie and offer a lordship of 10/- per ton for the right to exploit the reserve minerals on the Torbanehill estate. Young saw Gillespie and suggested these terms with a cash advance of £5,000 to seal the bargain. Gillespie was pleased but noncommittal.[1]

His refusal to lease his reserve mineral rights was not ill-considered. Binney judged the matter precisely: "... This looks as if Gillespie is going to try to make oil of his stuff ..."[2] William Gillespie knew of the forthcoming case between E.W. Binney and Company and the Clydesdale Chemical Company and he was hoping and expecting that Young's patent would be dissolved. Young was in some doubt as to what policy Gillespie would adopt:

> "... don't see yet the course Gillespie can take unless he infringes and set up the plea of no coal which I dont much fear in Edinburgh ..."[3]

Young was writing on the eve of victory in the Clydesdale Chemical Company case; on the following day he was even more positive: "... I dont fear Gillespie ..."[4] After his disappointment over the Clydesdale Chemical Company's failure to break Young's patent, Gillespie decided to seek the repeal of Young's Scottish patent. He initiated proceedings in the Court of Session against Young personally and also the Bathgate firm "... for the purpose of having it declared that the

1. Ibid., 7 December 1859
2. M.S. Letter, Binney to Young, 17 January 1860
3. M.S. Letter Copybook, 1860-1863, Young to Meldrum, 6 November 1860
4. Ibid., Young to Meldrum, 7 November 1860

Torbane Mineral is not coal ..." and that, therefore, Young's patent could not be applied to it. Young's reaction was to treat Gillespie in an almost contemptuous fashion: "... I can't see how this is to work ..."[1] However, Gillespie secured the concurrence of the Lord Advocate to his starting proceedings, but then decided to try his luck in England by combining his attack upon Young's patent with that of E.W. Fernie and his partners. By March, 1861 he had applied to the Attorney-General for his fiat so that a writ Scire Facias for the repeal of Young's patent, issued from the Petty Bag office of the Court of Chancery, could be heard in a Court of Equity. The Attorney-General refused his fiat - and repeated his refusal in 1862 when Gillespie made a second attempt. By then Gillespie had begun his action in Scotland in the Court of Session; this was to take him to the House of Lords in 1867 and by then Young's patent had expired and so had Gillespie's chances of making capital from his law cases.[2] He had sympathised with, even if he had not supported financially, all attempts to break Young's patent from White's case onwards; but his opponents were men of intelligence and courage. They were also victorious.

1. Ibid., Young to Meldrum, 8 December 1860
2. Ibid., Young to Meldrum, 5 March 1861; c.f. also M.S. Letter, J.H. Johnson to Young, 11 March, 1862, enclosing Copy of Declarations in support of application for Fiat, The Queen v. Young, 1862; c.f. also Fernie and Others v. Young and Others, Lords, 1864, vol. ii., Appellants' Appendix: E.W. Fernie's reply ... pp. 13-14; Ibid., Respondents' Appendix: Bill of Complaint, pp. 9-10; Ibid., Agreement between Fernie and Carter and William Gillespie, 4 October 1862; c.f. also Pocket Book of James Young, 27 June 1867

3. The Battle with E.W. Fernie and Others, 1861-1866

The greatest case of all, a classic in Victorian patent litigation, was that with E.W. Fernie and his partners, William Carter and Joseph Robinson. Although Fernie had important financial interests in several industries, the connection with his partners was essentially produced by their several interests in the iron and steel industry of Coalbrookdale and Ebbw Vale. By speculation in mineral rights and railways Fernie had made a vast fortune. He virtually controlled the supply of manganese to the British chemical and steel industries; he was associated with the Darbys of Coalbrookdale in the Shropshire and South Wales iron industry.[1] At the height of the coal-oil boom in the United States in 1859-60, he had been over in New York "... winding up two railways ...", and the prospect of making a large fortune in the British coal-oil industry enthralled him.[2]

Fernie's American experiences provided him with two important pieces of information, one fortuitous, the other contrived. First, he was shown pieces of Albert coal and Breckenridge cannel, both excellent oil producers, with which he was later able to compare the Welsh and Scottish cannel coals and shales.[3] Secondly, he had the opportunity to buy

1. Fernie and Others v. Young and Others, Lords, 1864, pp. 1398 sqq., Evidence of E.W. Fernie
2. Ibid., p. 1413, Evidence of E.W. Fernie
3. Fernie and Others v. Young and Others, Lords, 1864, vol. ii., Answer of E.W. Fernie to Bill of Complaint, Chancery, 29 January 1863, pp. 16-17

information about American refining processes[1], which enabled him to enter the shale-oil industry or specialise in refining petroleum as alternatives to relying entirely upon breaking Young's patent.

After his return to Britain the chain of fortuitous circumstances was so strong as to suggest more than mere co-incidence. In November, 1860 because of his father's fatal illness, Fernie went to Scotland at the very time when the case of E.W. Binney and Company against the Clydesdale Chemical Company was being tried and actively discussed. There he met William Charles Hussey Jones of Leeswood, Flintshire[2]; Jones was trying to peddle the Leeswood Green cannel coal, samples of which he showed to Fernie, who noticed its resemblances to the American oil-producing coals. Later, assisted by Jesse Fisher who lived nearby at Ironbridge, Fernie distilled samples at Coalbrookdale. Other samples were sent to London for chemical analysis[3]. The oil-yield of this coal was sufficiantly great that Fernie was encouraged to negotiate with Jones about the establishment of works at Leeswood and Saltney early in February, 1861[4].

The previous month, Fernie had ineffectually sought an interview with Young, ostensibly to seek an understanding to avoid litigation and to make reasonable terms for his entry

1. Fernie and Others v. Young and Others, Lords, 1864, p. 1409, Evidence of E.W. Fernie
2. Fernie and Others v. Young and Others, Lords, 1864, p. 1413, Evidence of E.W. Fernie
3. Fernie and Others v. Young and Others, Lords, 1864, vol. ii., Answer to E.W. Fernie in Chancery, p. 17
4. Ibid.

into the coal-oil industry.[1] In February, 1861 Fernie's solicitors formally wrote to Young's solicitors, telling them that Fernie intended to manufacture coal-oil, that he would prefer to avoid litigation, provided a reasonable arrangement could be reached, but that if there was any attempt to restrain or inhibit his economic activities, he would dispute the validity of Young's patent. Young and his partners refused to budge; they merely offered the usual licence at their normal rate of 4d per gallon.[2] Fernie had no intention of paying such a tax on production, and he sent a Mr. Drennan to call on Young and his partners who delivered a blunter ultimatum making this clear. Drennan told Young and his partners that Fernie intended to enter the oil industry and would not pay a royalty based on production; he knew certain facts about the validity of Young's patent which he would disclose to them at a meeting; then, they might come to terms. Although Meldrum and, particularly, Binney thought that it might be wiser to have such a meeting, Young adamantly refused.[3]

Meanwhile, by a carefully drawn-up indenture, on 23 February, 1861 Young and his partners granted Jones a licence to use their process at Leeswood, charging him 4d per gallon of crude oil produced.[4] This provided Fernie and his partner, William Carter, with a second line of pressure on Young's

1. Ibid., p. 15
2. Ibid.
3. Ibid., pp. 15-16
4. Fernie and Others v. Young and Others, Lords, 1864, vol. ii., Separate Appendix of Respondents, pp. 1-8, Licence 23 February 1861

process. Two days after Jones had obtained his licence he was contracting to supply Leeswood Green cannel to Fernie and Carter. By this agreement Fernie and Carter covenanted to erect 75 retorts of which 35 were to be kept in constant operation.[1] A second agreement, also signed on 25 February, 1861, divided the potential spoils and made the provision that Jones should not aid James Young or his partners in any forth-coming patent action nor be responsible for any expenses incurred in any such action.[2] Similar agreements were signed on 1 July, 1861.[3] All these agreements were unknown to Young and his partners until Binney visited Leeswood at Easter 1862; Fernie's sense of industrial security and secrecy was very pronounced.

But in March, 1861 George Vary went to see Bain's works in Glasgow, posing as the representative of Jones, but once it was clear to the management of the Clydesdale Chemical Company that Vary was acting for a potential competitor, he was refused admittance to the works. Then, Vary went on to Bathgate, where Meldrum, after questioning him closely, gave him every facility to inspect the distillation, but not the refining, processes. Vary was really being instructed by Fernie and, in fact, was paid by him not by Jones. Thus, Fernie gained access to valuable technical knowledge without any

1. Ibid., pp. 9-14, Agreement between Jones and Fernie and Carter, 25 February 1861
2. Ibid., pp. 12-14
3. Ibid., pp. 14-19

realisation by Meldrum, Binney and Young that industrial espionage had occurred. Vary also called upon John Scott and Company of Inverkeithing, the firm that had built the Bathgate works.[1] Scott then supplied stills; retorts were made in England, according to specifications supplied by Vincent Wanostrocht, until 1860 the owner of the Wareham Oil Company. Wanostrocht, previously warned for infringement by Binney, was being employed by Fernie's other partner, Joseph Robinson, making experiments on Welsh shales at the works of the Ebbw Vale Iron Company.[2] To make the technical expertise complete, Scott's workmen, formerly employed at Bathgate, helped build the refinery known as the St. David's Works, Saltney; the crude oil works was built earlier at Leeswood, and both plants were connected by ten miles of branch railway; and at Saltney Fernie employed Charles Humfrey junior, who, before his father's bankruptcy, had gained great practical experience infringing Young's patent at Wareham.[3]

Certainly, Fernie and his partners represented more than a simple competitive threat to Young and his partners; they were a pressure group mobilising the discontent of all the parties restrained or inhibited by Young's patent. They secured the services of the best scientific and practical witnesses available from the gas industry, representatives from the Kimmeridge shale area of Dorset, from the Wareham Oil and

1. Fernie and Others v. Young and Others, Lords, 1864, pp. 340 sqq., Evidence of George Vary
2. Fernie and Others v. Young and Others, Lords, 1864, pp. 1403-1404, Evidence of E.W. Fernie
3. Fernie and Others v. Young and Others, Lords, 1864, vol. ii., Bill of Complaint, p. 13

Candle Company, from the South Wales and Coalbrookdale iron and coal companies who had vested interests in local coals and shales, and representatives from the Scottish cannel coal-oil industry who were paying royalties to Young and his partners. This enormous confederacy was backed by efficient industrial espionage and completed by the ever-litigious William Gillespie in October, 1862.[1] William Charles Hussey Jones was expendable, as every facade sooner or later becomes unnecessary; he was in dire financial straits and gradually, in 1861-62 Fernie and Carter seized financial control of Leeswood Green Colliery by advancing him loans and guaranteeing his debts.[2] This made it easier for Fernie later to deny that he had gained any advantage or knowledge from his connection with Jones, but under cross-examination his evidence was not very convincing.[3]

In the course of 1862 Young and his partners became increasingly aware of the nature of the conspiracy against them and the scale of the infringement. Binney, after his early reconnoitre at Leeswood on Good Friday, 1862, became alarmed and clearly did not want to go to law; this attitude was consistent with his earlier wish to meet Fernie in January, 1861.[4] Without the unity of the partners the case might well be lost. Young provided that unity and press-ganged Binney into line;

1. Fernie and Others v. Young and Others, Lords, 1864, vol. ii., Respondents' Separate Appendix, pp. 30-31, Agreement between Fernie and Carter and William Gillespie, 4 October 1862
2. Ibid., pp. 22-25, Agreement between Jones and Fernie and Carter, 28 March 1862
3. Fernie and Others v. Young and Others, Lords, 1864, pp. 1402-1403, Evidence of E.W. Fernie
4. Fernie and Others v. Young and Others, Lords, 1864, vol. ii., Amended Bill of Complaint (first filed in Chancery, 8 September 1862) pp. 10 -11

Meldrum was willing to follow Young's determined lead. The unravelling of Fernie's intrigues was time-absorbing, but by the middle of August, 1862 a case was on the stocks.[1] Young was urging Meldrum to avoid other legal commitments: "... we must do all we can to steer clear of a law suit ... we have the name of being rich ..."[2] He was finding it difficult to discover who were Fernie's partners, but he hoped Meldrum would discover all he could from Scott of Inverkeithing.[3]

John Rennie, an employee at Bathgate, was sent by Meldrum to Leeswood and Saltney to obtain evidence of infringement; by a mixture of guile on the part of Rennie and a degree of carelessness on the part of Fernie's manager, a sample of the crude oil was obtained in August, 1862.[4] A thirty gallon cask of Fernie's "Cambrian Oil" was obtained by similar cunning, and with it a receipted invoice.[5] This provided, after analysis, all the material evidence of infringement necessary for Young's case. But Young felt it likely that Fernie's refined oil had another alien origin: "... I suspect the most of the oil sold by Fernie is petroleum oil ..."[6] Young was taking other steps to deal with the competition of American petroleum.

1. Letter Copybook, 1860-63, Young to Meldrum, 20 August 1862 and 22 August 1862
2. Ibid., Young to Meldrum, 21 August 1862
3. Ibid., 22 August 1862
4. Fernie and Others v. Young and Others, Lords, 1864, pp. 344-352, Evidence of John Rennie
5. Ibid., pp. 359-360, Evidence of Walter Turner; Letter Copybook, 1860-1863, Young to Meldrum, 2 September 1862
6. Ibid., Young to Brown, 20 October 1862

Young was quite pleased to delay this case as long as his patent lasted; his tactics were not intended to be expeditious. Writing to his solicitor, J.H. Johnson, Young put it precisely: "... I need not tell you as you know well that our game is delay at present ..."[1] The state of the law assisted this strategy. Young, Binney and Meldrum filed their Bill of Complaint in Chancery on 8 September, 1862, but this mentioned only Fernie's name, for Young had been unable to discover the names of Fernie's partners. Fernie filed his answer to this Bill of Complaint on 29 January, 1863 and, at that stage, named his partners as William Carter and Joseph Robinson. On 9 April, 1863 Young and his partners, therefore, filed an amended Bill of Complaint against all the partners in Fernie's company. Carter and Robinson, then, filed their separate answer to this amended Bill of Complaint on 17 June, 1863. The final preliminary was a replication made by Young and his partners on 8 August, 1863.[2]

Although an injunction was obtained by Young and his partners in November, 1862 the Court ordered it to stand over until the case was heard.[3] Meanwhile, Fernie decided to insure against failure by taking part in the limited scramble for shale rights at Broxburn;[4] in the process he helped to

1. Ibid., Young to Johnson, 4 April 1863
2. Fernie and Others v. Young and Others, Lords, 1864, vol. ii., passim
3. Ibid., Appendix to Appellants.
4. See p. 274

show the way round Young's patent. This safeguard was just as well for not only did Fernie lose the case but also Jones' cannel coal seam at Leeswood had failed to reach Fernie's expectations by 1864.[1]

The order for the trial was not made until 21 December, 1863; on 30 December Young and his partners entered details of the infringements upon which they intended to rely. On 15 January, 1864 the order of 21 December, 1863 was varied, with the consent of both parties, so that the trial was to be held in Chancery without a Jury. On 25 January, 1864 Fernie and his partners entered particulars of objections to the validity of Young's patent; on 1 February, 1864 they entered further particulars of objections, especially the list of patent specifications to be used as evidence of prior publication and use. After minor quibbles the first of the thirty-three days of the trial before Vice-Chancellor Stuart began on 29 February, 1864.[2]

There was a massive parade of witnesses and scientific learning. Thirty-one witnesses appeared for the plaintiffs, forty-two for the defendants. Forty-six extracts from works of reference, dating from 1657 to 1850, were cited by Fernie and his partners as part of their attempt to prove that Young's invention was well-known before the date of his patent; six important patent specifications, beginning with Lord Dundonald's in 1781, bolstered this plea. But Vice-Chancellor

1. Young v. Fernie, (Chancery), Brief Affidavit (copy) of E.W. Fernie filed, 22 June 1864
2. Fernie and Others v. Young and Others, Lords, 1864, p. 25, Record of Trial

Stuart on 1 June, 1864 gave his judgment in favour of Young and his partners.[1]

Fernie and his partners appealed against this judgment to the House of Lords, on the grounds that it was against the weight of evidence and wrong in law. Two cases pending, those of Young and his partners against the Wareham Oil and Candle Company, and against the Canneline Oil Company Ltd., were set over until this appeal was heard.[2] However, Stuart's judgment was enrolled in Chancery on 18 June, 1864. On 25 June, 1864 Fernie and his partners applied that all proœedings under this decree should be stayed until the appeal to the House of Lords had been disposed of. This application was refused, and Fernie and his partners were ordered to pay all costs. Against this order Fernie and his partners appealed to the Lords Justices, and, by an order dated 19 July, 1864, it was ordered that they should pay £10,000 for costs to Young and his partners before 1August, 1864. In addition, they were to pay a royalty of 3d per gallon upon all crude oil up to the date of the order. A sum of £11,422. 14. 6d. was paid on this account, a royalty equivalent to 913,818 gallons.[3] The Appeal to the House of Lords was not heard until 19 April, 1866 and, after four hearing days, was dismissed on 24 April,

1. Young and Others v. Fernie and Others, Chancery, 1864, 29 February - 1 June, passim
2. Young and Others v. Wareham Oil and Candle Company, Chancery, 1864; and Young and Others v. Canneline Oil Company, Chancery, 1864
3. Fernie and Others v. Young and Others, Lords, 1864, vol. ii., Case of Appellants, p. 108

1866. By then Young's patent had run its natural course, and wisely there was no application from the partnership for its extension. But then, the partnership went out of existance also in October 1864.

1. Fernie and Others v. Young and Others, Appeal to House of Lords, 19 April - 24 April 1866

4. Tribute from the American Coal-Oil Industry and Challenge from the American Petroleum Industry.

By the middle of the 1850s there was a flourishing but small coal-oil industry in the United States. To this Young and his partners turned increasing attention as they became more and more aware of its income-potential. For Young's American patent of 1852 was just as binding upon that continent as his British patent of 1850 proved to be in Britain.

But around the American coal-oil industry has grown a delightful legend which historical scholarship has done little to dissipate; indeed recent authoritative articles have reinforced it. The story goes that the Canadian doctor, Abraham Gesner, was the father of the American oil industry.[1] In fact, Young's patent was the first in the United States to have the force of law.[2] Gesner disputed its validity for material reasons and in the process created the myth which has since acquired gospel force.

From his home in Halifax, Nova Scotia, Gesner operated as chemical consultant to Thomas Cochrane, Lord Dundonald,[3] and at Cochrane's request he produced a method of distilling Trinidad bitumen which he patented in New York on 29 January,

1. Business History Review, vol. xxix, 1955, pp. 28-53, Kendall Beaton, Dr. Gesner's Kerosene: The Start of American Oil Refining. Beaton seems to have ignored Gesner's vested interest in the coal-oil industry and also his known plagiarism in his work on The Geology of Nova Scotia. Vide also H.F. Williamson and A.R. Daum, op. cit., pp. 44 sqq.
2. American Patent No. 8833, 23 March 1852
3. Dundonald and H.R. Fox-Bourne, The Life of Thomas, Lord Cochrane, Tenth Earl of Dundonald, London, 1869, pp. 332 sqq.; c.f. also British Patent No. 656, 5 November 1852.

1850.[1] First he clarified the Trinidad bitumen and from the pitch he produced an illuminating gas called kerosene. This term, now pppularly applied to lamp oils and burning fluids, was first used to describe the clarified pitch which reminded Gesner of a mixture of bees wax and turpentine. By concentrating upon the patenting of a gas process, Gesner displayed a recognition of realities for he could not have produced an effective light burning oil from clarified pitch. Indeed, his product was known as "Kerosene Gas Light".[2]

Finding Trinidad bitumen to be an exceedingly variable raw material, difficult to handle on shipboard, Gesner and his associates tried to find an alternative. In 1850 the exploitation of a new bituminous mineral began in Albert County, New Brunswick. Albert coal - Albertite, as it was later called - was exactly suitable, and Gesner had grandoise schemes for making his fortune from it. These were frustrated in 1852 by the Albert Mine Case[3] similar in significance to the Torbanehill Mineral Case. Gesner took Gillespie's stand: he claimed Albert coal was shale or asphaltum, but the court ruled against him.

1. American Patent No. 7052, 29 January 1850. This makes nonsense of Gesner's claim that his first purpose was to make oil from Trinidad pitch, A. Gesner, A Practical Treatise om Coal, Petroleum and Other distilled Oils, New York, 1861, pp. 26-27.
   Gesner's version was repeated by Kendall Beaton, op. cit., p. 34 and first questioned by Owen Colverd "Pitch and Gloss", Institute of Petroleum Review, March 1961, vol. 15, No. 171.
2. American Patent No. 7052, 29 January 1850, "Manufacture of Illuminating Gas from Bitumen"; c.f. also the article "Kerosene Gas - Nova Scotia Going A-Head of 'Old Mother'" in Scientific American, 7 December 1850
3. Kendall Beaton, op. cit., p. 37; A. Gesner, op. cit., (2nd Edition 1865) p. 49

News of the Torbanehill Mineral case decision reached the United States in 1853, and it seems likely that Gesner decided deliberately to make burning oils but he could not use Albert coal since this was covered by Young's patent after the Albert Mine Case decision. He, therefore, tried to imitate camphene, a burning oil patented by Isaiah Jennings in 1830 and made from rectified oil of turpentine and alcohol;[1] this was selling very well in the American market in the early 1850s. Gesner took out three patents in June, 1854 for three different burning oils.[2] These were all called "Kerocene" for good marketing reasons. The "ene" ending cashed in on the similarity with camphene and the idea of spelling the brand name with a 'c' and not an 's' was intended to differentiate the oils from the gas. None of these oils were, in fact, so effective as Young's paraffin burning oil nor were they so cheap to produce. But Gesner's associates in the Asphalt Mining and Kerosene Gas Company of New York credited him with over 12,000 dollars in 1854 and in exchange he assigned his patents to the company.[3]

Gesner was given a job with this company, superintending the building of a new plant at Newton Quay on Long Island, New York. By the end of 1854 the company had decided to call

1. H.F. Williamson and A.R. Daum, op. cit., pp. 33 sq.
2. American Patents Nos. 11,203-11,205, June 1854; Kendall Beaton, op. cit., pp. 39-40.
3. Report of a Committee appointed by the creditors of the North American Kerosene Gas Light Company. Note the name of this company and its predecessor include Kerosene Gas, an indication of the origin of the word 'Kerosene'. The account of the origin of name in Engineering and Mining Journal, 9 February 1884, pp. 99-100 was possibly by Gesner's relatives, or a relative. C.f. Kendall Beation, op. cit., pp. 40-41.

their oils "kerosene" to gain continuity with their earliest product and in the hope that they would not have to pay Young a royalty. Later, this company became the North American Kerosene Gas-Light Company of New York and adopted Young's process using Albert coal and particularly Boghead coal exported from Glasgow. Gesner's process was abandoned although his kerosene oils were marketed for about a year. By 1860 Gesner was unemployed, and he decided to sell his knowledge to all and sundry in book form, his famous 'Treatise'. He may have been the American source of E.W. Fernie's technical knowledge on refining coal oils. He certainly was the source of much misleading information on the history of coal-oil distillation. He claimed to have been the first to manufacture coal-oils in the United States; he claimed to have produced burning oil in 1846 and to have documentary proof of this.[1] His version of later events was that he had attempted to produce improvements of his 1846 burning oil which he called kerosene. But his Treatise published in New York in 1861 was a piece of propaganda designed to get people to believe that he had been constantly interested in inventing burning oil from 1846 to 1854. He omitted to mention that kerosene had first been used to describe an illuminating gas. He said that the name was a combination of the Greek words Keros and Elaion (i.e. wax and oil) but he did not explain the

1. A. Gesner, op. cit., (1st edition) p. 9. No independent documentary proof has ever been produced to support Gesner's claim.

transformation of Elaion into "ene". But then he needed to rationalise his position as an opponent of Young's patent which occupied him through much of 1859 and 1860.

Apart from the metropolitan market of New York by 1859 the coal-oil industry was well entrenched in several states, but particularly in Kentucky, Virginia, Ohio, Pennsylvania and Illinois, where local cannel coals, suitable for oil-making, were available in quantity.[1] Young and his partners from 26 November, 1856 had Benedict and Boardman of Broadway looking in their interests, in particular securing settlements with infringers.[2] But Binney and Young received many letters from American coal-oil manufacturers which, unfortunately, were generally sent back to the United States to aid Benedict and Boardman. Binney gives details of all these correspondents in a letter to Young: I. Bigelow wrote from Washington D.C. in September 1855; James Cuddy from the Alkali Works, Pittsburgh, Pennsylvania in December 1855; Newbery or Norbury from Cincinnatti in 1856; Cairns and Gillespie from West Virginia and Kentucky in 1856; "... Old Glover the man who was six weeks at Bathgate I think also came from Cloverport ...",

1. Thomas Antisell, The Manufacture of Photogenic or Hydro-Carbon Oils ... New York, 1860, pp. 133-135; see list of 37 works most of them recent ventures; A. Gesner, A practical Treatise on Coal, Petroleum, and other distilled oils, New York, 1861, lists 56 by end of 1860. P.H. Giddens, The Birth of the Oil Industry, New York, 1938, p. 23, estimates 50 to 60 firms by 1859. H.F. Williamson and A.R. Daum, op. cit., p. 56. Scientific American, 2 January 1860 "Coal Oil Manufacture ". See list of American firms in Appendix.
2. Copy, Benedict and Boardman to Binney, 15 July 1859, enclosing account from 26 November 1856 to 21 December 1858. H.F. Williamson and A.R. Daum, op. cit., p. 54 wrongly suggest that Young made little attempt before 1858 to enforce his American patent.

Kentucky; Ezra Goring of Glanville, Ohio "... in August 1857 wrote to you as to coal oil and the best way of making it ..."; L.K. Taylor of Philadelphia wrote in February 1858. He also mentions letters from "Gessner" - almost certain to have been Dr. Abraham Gesner - from Campbell, likely to have been James Campbell of Charleston, Virginia and from W.R. Hibbard of Montreal, Canada.[1]

The financial scale of operations was often large. The assets of the Breckenridge Cannel Coal Company were valued at four million dollars in February, 1854. In the Autumn of 1855 the building of the works began and by April, 1856 there were twelve retorts in operation producing 600/700 gallons of crude oil per day. A second company had come into existence in March, 1856: the Breckenridge Coal Oil Company. However, in June, 1856 both companies were consolidated without any increase in the total share capital. The works were then extended and by the time of the Annual Report on 13 January, 1857 there were thirty retorts in all:

> "... These works will then consist of fire-proof buildings, separated from each other, and containing 30 retorts, 12 stills, and accommodation for 100,000 gallons ... When future extension is resolved upon, the works can be doubled at comparatively little additional cost ..."

1. M.S. Letter, Binney to Young, 6 March 1860. The Reverend H.C.D. Twining of Halifax, Nova Scotia was reporting to Binney on Canadian Infringers. Binney sent copies of his letters to Young. The earliest was dated 6 April, 1857, Young chose to ignore Canadian infringements which were apparently on a small scale.

The profit prospects for the company in 1857 were thought to be bright. The works, worth 285,000 dallars, were turning out more than 1,000 gallons of oil per day. Most of this had been sold in New York but it was thought that the West would be the main market in the future: the railways and the 700 steamers plying on the Mississippi. In the future "... large semi-annual dividends may be regularly expected ..."[1]

Young hoped to secure a royalty on production especially since by December, 1859 total United States production was estimated at over 20,000 gallons per day.[2] An agreement had been made between Young and his partners and two of the largest American coal-oil companies headed by Samuel Downer on 5 November, 1858,[3] but representatives of American companies were generally most anxious for Young to sell his American patent rights outright. This Young refused to do and he was

1. Annual Report of the Breckenridge Coal-Oil Company, 13 January, 1857.
   The development of this company in Kentucky was independent of Gesner's operations in New York. According to P.H. Giddens, The Birth of the Oil Industry, New York, 1938, p. 22, this company was the model for 25 others in Ohio alone by 1860 (each with 300 gallons per day capacity), but no adequate research has been done into the American coal-oil industry which allows firm statistical conclusions to be drawn.
2. Hunt's Merchants' Magazine and Commercial Review, vol. 42, New York, 1860, p. 245
3. Account from Benedict and Boardman, 26 November 1856 - 21 December 1858. A draft of 1 March 1860 mentions this agreement and specifies the following Americans as parties to it: Philo F. Ruggles, Horatio Eagle, David Austen junior, William H. Hazard, Lorenzo Delmonico, Andrew Barley, Samuel Downer and Samuel P. Philbrick. This agreement of 5 November 1858 has never been precisely dated by American historians. C.f. H.F. Williamson and A.R. Daum, op. cit., p. 54

also slow to grant licences until 1858-1859.[1] After November, 1858 the two American Companies were anxious to secure supplies of Scottish cannel coal as the market in New York was expanding rapidly and they also were anxious to bring infringers to book because they hoped to reduce the opportunities for competition. They pressed Benedict and Boardman to sign a notice cautioning would-be infringers:

> "... The result has been to bring on us an extensive correspondence and many interviews some of the correspondents assume a tone of indignation alleging that Oil has been made from coal <u>in this country</u> for <u>twenty years</u> as they can prove!" [2]

Benedict and Boardman were using their influence to achieve peaceful settlements with infringers and were considerably aided by the adherence of Samuel Downer and his associates. The logic of this was inexorable for the worst possible tactic would be to combine the infringers into a unified opposition; every company that came to terms was an additional source of strength for Young's patent.

Young was not anxious to be bound by the agreement made on the partnership's behalf by Benedict and Boardman on 5 November, 1858 because they had signed away the Canadian oil trade. But Young realised that this was likely to mean a loss

1. This criticism was made by Thomas Antisell (Antisell, op. cit., p. 15) who was a patent examiner employed by United States Patent Office as well as the author of the best contemporary account of the American coal-oil industry.
2. This notice appeared in the New York press on 10 November 1858, Binney to Young, 5 December 1858; Benedict and Boardman to Binney, 20 November 1858.

of turnover worth about £12,500 per annum or 100,000 gallons, as John Livingstone was to prove in 1859. Binney quarrelled with Young on this point:

> "... When we first instructed Mr. Lincoln to dispose of the American patent we lumped the Colonial one in with it ..." [1]

In his last instruction to Benedict and Boardman Binney had mentioned only the American patent, but it had been understood that the Colonial patent was also included. Young insisted on abiding by the letter of those instructions and not by its spirit.[2] This further provoked Binney's anger:

> "... No doubt a good Canadian trade has sprung up but this has not right to alter our contract with respect to our agents. In this I think we have not done right however much we may seem to profit by failing to confirm our Agent's bargain ..." [3]

However, Young's materialist view prevailed. He stood to gain £5,000 to £10,000 per year from the agreement made with Gesner's old company, the North American Kerosene Company of New York[4] and he knew that the expansion of the American market would deaden all screams about the loss of the Canadian concession. However, Binney's point of view was more moral and more reciprocal, since the Americans had agreed not to export oil to Briain. Yet he realised that Young was right in assessing American reactions to the amendment of the agreement.[5]

1. Binney to Young, 5 January 1859. Writing to E. Meldrum, Binney voiced his sneaking fears of rebellion by the American patentees: "... It is evident that the fat will be in the fire when the Agreement gets to New York ..." Binney to Meldrum, 5 December 1858.
2. Young to Binney, 4 January 1859
3. Binney to Young, 5 January 1859
4. Copy, Ezra Lincoln to Binney, 22 November 1858
5. Binney to Young, 6 January 1859

From December, 1858 the partners were buying Boghead coal for Samuel Downer's Boston Company, after Downer had satisfied them[1] about his financial integrity. They wisely refused to give the same service to the North American Kerosene Gas Light Company of New York.[2] Early in 1859 representatives of American coal-oil companies were in Britain, bypassing Benedict and Boardman and hoping to secure a better settlement by dealing directly with the principals. They also hoped to bargain for Scottish cannel coals since supplies from the Albert Mine were inadequate to meet demand nor was it normal to receive winter deliveries; they even hoped to persuade Young to change his mind about the Colonial patent, giving them a free hand in the Canadian market.

Binney fixed speculatively a meeting with Messrs. Philbrick and Hyde of Boston for Meldrum and Young on 8 January, 1859 but the meeting was delayed until 10 January.[3] Binney was in ill-health;[4] he was also in some doubt as to whether Young would meet the Americans. This conference "to meet Yankies" was long and inconclusive. Binney had already got the Americans to write their own agenda for the meeting. They wanted aid in arranging contracts for Boghead coal; they

1. Copy, Benedict and Boardman to Binney, 20 November 1858, enclosing references on Downer's behalf by Waldo Flint and William H. Macey, two bank presidents. For Downer's career, see Kendall Beaton, op. cit., pp. 45 sqq., and P.H. Giddens, op. cit., pp. 20 sqq.
2. Copy, Binney to Benedict and Boardman, 3 December 1858
3. Binney tn Young (second letter) 6 January, 1859; Binney to Young, 8 January 1859
4. Binney to Young, 7 January 1859

wanted complete control of the Colonial patent. In return, they were prepared to prevent the introduction of American processes into Britain without Young's consent. According to Young, the two Americans talked of making two million gallons of coal-oil in 1859 rising to five or eight million gallons in the years afterwards. Their objective of securing Young's colonial patent was not conceded but despite this, they offered to take half a million gallons of Scottish Oil in 1859 if the price was right and deliveries could be spaced equally throughout the year. Their interest in Boghead coal was understandable for although they and their associates controlled the Albert Mine by a contract lasting until 1864, this was worth only 25,00 tons per annum to the consortium.[1]

Before the Americans met Young, Meldrum and Binney in Glasgow, they had "... purchased all the burning oil Price's Candle Company were making ..." from Burma petroleum. American interference in the British market had two effects both with outstanding long-term consequences. Binney's assessment of one was exactly precise: "... I think it is likely that the Yankees will purchase of all our opponents and thus set them on their legs ..."[2] The other was the inflation of Boghead coal prices in 1859 caused by American buying and the stimulus this gave to the transfer of the oil industry from dependence upon cannel coal to shale.

1. Binney to Young, 8 January 1859. Business Journal and Laboratory Notebook, 1856-61, 10 January 1859
2. Binney to Meldrum, 11 January 1859

Meanwhile in the United States resistance was growing to Young's patent. On 27 December, 1858 the first briefing of counsel for a suit against the Columbian Oil Company took place in Benedict and Boardman's offices. By the end of January, 1859 notice of prosecution had been sent to five manufacturers.[1] Young did not like the thought of the expense, believing it to be yet another example of lawyer's avarice:

"... it appears the lawyers there are as fond of money as those at home ..."[2] Binney instructed Benedict and Boardman "... to pay for law as it goes on" but he was anxious for Young to go to America to watch their interests, an undoubted compliment to Young's commercial acumen.[3] Young was not keen:

> "... I am quite unprepaired indeed never gave the subject of going to America more than a passing thought and do not see the use of my going ..."[4]

Relations between Young and Binney were not good at this stage; Binney was convinced that their differences were serving their case badly:

> "... Just now is a most critical time and we all should determine on what is best to be done. At the present time we are acting in the most strange and stupid manner possible. Surely all of us having interest in common and none of us wishing I believe to do the other wrong we might hit upon a joint action ..."[5]

Young, self-righteously, insisted that he was in the right and that there was no point in his going to the United States; he added: "... Your statement that we are acting in the most strange and stupid manner possible does not apply to me ..."[6]

1. Account by Benedict and Boardman, 27 December 1858- 1 March 1860
2. Young to Binney, 14 February 1859
3. Binney to Young, 15 February 1859
4. Young to Binney, 17 February 1859
5. Binney to Young, 15 February 1859
6. Young to Binney, 17 February 1859

Binney, therefore, continued to conduct the partnership's relations with the American coal-oil industry by remote control. On 18 February, 1859 he wrote to Samuel Downer asking about future coal demand in Boston and New York. Downer replied on 8 March that his last order for 1,000 tons of Boghead coal was now complete - 500 tons at 36/- and 500 at 45/- - and this would suffice until May when coal from the Albert Mine would arrive. Binney had told Downer that American buying had smashed the stability of the Scottish cannel coal market. Downer in three months had bought 4,000 tons but he put the sharp price rise down to speculation in coal futures on the New York Exchange and heavy buying by New York manufacturers, particularly by the New York Kerosene Company who were very large consumers and had sent one of their directors, Mr. Eagle, to Glasgow. Downer hoped that Eagle and Young would come to some understanding about coal-buying.[1]

Binney had also sought information from Benedict and Boardman. They had been paid 1,000 dollars by 8 March, 1859 in preparation for litigation, chiefly in counsel fees. This sum had been supplied by the licensees who had "... the greatest desire to sustain Mr. Young's Patent." Downer's views about the Scottish coal market were corroborated, in particular that the New York Kerosene Company had disturbed the coal market by buying through Scottish agents, after Young had refused to act for them. Great expansion was occurring: existing works were being extended; another company had been

1. Copy, Downer to Binney, 8 March 1859. For Horatio Eagle, and Philo F. Ruggles see Kendall Beaton, op. cit., pp. 41 sqq.

formed in Portland, Maine to work under licence from Young. Prospects were good for "... the demand for the oil greatly exceeds the supply ..." Benedict and Boardman advised Binney and his partners to put up with the temporary rise in coal prices in the hope that the receipts in royalties from the American coal-oil industry would be a sufficient recompense. But this hope depended upon the success or failure with the lawsuit just begun against the Columbian Oil Company of New York. "... at the head of which is our old correspondent Dr. Gesner ..." Benedict and Boardman wanted further copies of his letters to Binney and Young: "... They may be very useful to us ..."[1]

Meanwhile, Eagle, the New York Kerosene Company's representative in Britain, was conducting his own survey of the British oil industry, its production and commercial organisation. On 7 April, 1859 he wrote to Binney asking for his help. His associates in New York had heard that James Young was preparing to ship German-made oil in large quantities to the United States. Was this rumour true? Binney denied it, but he thought it sufficiently important to get Young to issue a denial in the United States.[2] Someone thought it necessary to unite American coal-oil manufacturers against James Young and his partners. What better method could be found than by producing a scare about competition.

1. Copy, Benedict and Boardman to Binney, 8 March 1859
2. Binney to Young, 9 April 1859

Gesner's letters had been sent to the United States on 5 April, 1859; Benedict and Boardman acknowledged their receipt on 22 April, by which time they knew of the main points of Gesner's defence. He was intending to rely upon:

> "... Mr. Young not having complied with that clause of the statute which provides that it shall be a defence to shew that the patentee, if an alien at the time the patent was granted, had failed and neglected for the space of eighteen months from the date of the patent to put and continue on sale to the public on reasonable terms the invention or disoovery for which the patent was issued ..."

But this plea was stymied by Young's having granted an agency to James Lee and Company of New York, who advertised his oil in several papers.[1]

When this became known in New York the counsel for the Columbian Oil Company sought to delay. Binney did magnificent work supplying information and patents to Benedict and Boardman for this enabled them to prosecute infringers more confidently. They preferred the cast-iron case. The Glendon Oil Company of Boston were using Albert coal for distillation; the argument about whether it was a shale or a coal would be a liability; it was better to wait until they used a cannel coal. Breaking the infringers was likely to be a very slow business, especially if Young did not go to the United States,

1. Copy, Benedict and Boardman to Binney, 22 April 1859; Binney to Young, 6 May 1859. Opinion of John L. Hayes on Extending Young's Patent ... 1864, p. 11.

since a commission would have to come to Europe - and an order for this could not be issued until the case went before a Judge. Benedict and Boardman thought Young's presence in the United States was essential.[1] Binney urged their view upon Young,[2] but Young was still unenthusiastic.

In the United States by July, 1859 Benedict and Boardman had collected 2,500 dollars, from Samuel Downer and Philo F. Ruggles, as half-yearly royalty for their two companies. Downer and Ruggles had also paid 2,000 dollars in fees for counsel and retainers for scientific witnesses, for they were anxious to secure a legal decision about Young's patent. That decision would either improve their competitive position by removing rivals or relieve them "... from a Tax which others do not pay". Their reasons for urgency in dealing with infringers did not apply to Young, Meldrum and Binney. Benedict and Boardman advised delay until they had a year's royalty in hand;[3] Young certainly agreed with this analysis.[4]

By 6 October, 1859 the case was drawn up against the Glendon Coal Oil Company of Boston.[5] on 12 October, 1859 the Columbian Oil Company entered its defence in New York. This defence, ably conducted by Lucien Birdseye,[6] was even more thorough and oomprehensive than that drawn up by British

1. Copy, Benedict and Boardman to Binney, 21 May 1859
2. Binney to Young, 6 June 1859; Binney to Young, 10 June 1859
3. Copy, Benedict and Boardman to Binney, 15 July 1859
4. Young to Binney, 3 August 1859
5. Account by Benedict and Boardman, 27 December 1858 - 1 March 1860
6. Young later tried to secure Birdseye as his counsel. Copy Letter and Account, Benedict and Boardman to E.W. Binney, 26 June 1860

counsel. The defence was that Young was not the inventor of the process of distilling bituminous coals at low temperatures; that the process had been known and used before the date of his patent; that paraffin oil was in public use and on sale before that date; that other persons had published and patented the process before him; that Young, as an alien, failed to sell to the public his product for eighteen months after the date of his American patent; that the process was known in Britain, France, Germany and other parts of Europe and the United States and, in particular, was used by Abraham Gesner in New York and Brooklyn from 1848 to 1852, by Robert O. Dorennis in New York, in the same period, by James Campbell of Charleston from 1846 to 1852 and by Edward Stieren of Tarentum, Pennsylvania from 1849 to 1852. They produced extracts from 23 named works of reference and specified 49 British and 7 French patents varying in date from 1694 to 1851.[1] Benedict and Boardman were certainly impressed: "... The defence is to be of the most skilful and determined character regardless of expense ..." They had good reason to believe that infringers throughout the United States had combined to finance the defence and to make it as complete as possible. There were other definite disadvantages: the closeness of the shale patents to Young's coal process; the fact that Young

1. Copy M.S. of Defence of New York Columbian Oil Company against James Young entered 12 October 1859 in the second circuit court of New York.

himself was "... an Englishman with no interests in America beyond compelling it to pay tribute ..." But Benedict and Boardman expected to win despite the size and quality of the defence. They also gave the clue to Gesner's position: "... You will see that our old friend Gessner leads the van in the attack by witnesses ..."[1] How could he claim to be anything other than the father of the American coal-oil industry?

1859 saw a flood of blind capital into the American coal-oil industry: by the end of the year it was estimated that the companies in existence represented a total capital outlay of 8 million dollars.[2] But this industry, despite the greatness of demand, became the province of dishonest speculators and company promoters as well as honest manufacturers. Profit margins were remarkably great because the market was widening so rapidly. The coal-oil boom was aided by the prospect of the lawsuits brought on behalf of Young and his partners. Infringers expected the patent to be overthrown and, in order to be in on the ground floor, were pouring investment into a variety of coal-oil plants, some of which were never to exist. The licensees of Young's process apparently could not lose. Their profit opportunities would increase if Young's patent was upheld; if it was not, they would gain because they would not need to pay royalties.

1. Copy, Benedict and Boardman to Binney, 13 October 1859
2. H.F. Williamson and A.R. Daum, op. cit., p. 56; Hunt's Merchants' Magazine and Commercial Review, vol. 42, p. 245 (New York 1860).

The end of the "coal-oil bubble" was heralded by the financial collapse of Gesner's old company, the North American Kerosene Gas Light Company of New York, a licensed company.[1] Its business operations were not conducted with any sense of financial restraint: "... The Kerosen people have been prepairing for an immense business ..." Indeed they had. They bought about 20,000 tons of Boghead coal at extravagant prices in 1859 alone; they had spent, according to Benedict and Boardman, nearly a million dollars in expansion. On 13 October, 1859 Benedict and Boardman expressed the first doubts about their wisdom and stability: "... We are not at all satisffed that they have not invested more in buildings, machinery and coal than was safe ..." They thought it would have been wiser "... to grow up more slowly and solidly ..." This was confidential and inspired information for they had:

> "... heard nothing against their stability beyond what is inferrible from the above facts and this we get from one who would not like it to be known that he had made the disclosure ..." [2]

On 16 November, 1859 their financial vulnerability was publicly exposed but quickly denied. Nine days later they stopped payment. The directors had provided security for about half a million dollars, but confidence was broken. There were suspicions of "... foul play or gross mismanagement on

1. Kendall Beaton, op. cit., p. 53, mentions the tradition that this company failed but had no conclusive evidence. The Report of the Committee of Creditors and Young's Business Journal ... 1856-1861 provide this.
2. Copy, Benedict and Boardman to Binney, 13 October 1859

the part of some of the leading stockholders ..."[1] The failure of the New York Kerosene Gas Light Company complicated the payment of Young's royalties since Downer and his associate Philbrick, although they had no financial connection with the New York company, had joined with it to pay Young's royalty of 4 cents per gallon without making any provision for limited liability. When Philbrick died on 22 November, Downer was left solely responsible. Benedict and Boardman told Binney that they thought it wisest not to press Downer for payment of the New York Kerosene Company's debts but they expected him to be able to meet all his personal commitments. His company had sent in their acoount of oil sold from 6 November, 1858 to 6 November, 1859: 215,850½ gallons worth 8,634 dollars 2 cents in royalties to Young. No similar account had been rendered by the New York Kerosene Company.[2] Downer tampered with the idea of aligning himself with Young's opponents the Glendon Oil Company, in refusing to pay any further royalty.[3] He rejected this policy in favour of a more moderate alternative; he sought a reduction in the royalty from 4 cents to 2 cents per gallon and suggested that Young would ultimately gain from this since his patent would receive almost universal recognition.[4]

1. Copy, Benedict and Boardman to Binney, 25 November 1859
2. Ibid.
3. Draft M.S. Letter, Young to Meldrum, 3 May 1860
4. Copy, Benedict and Boardman to Binney, 25 November 1859

Binney urged Young to go to the United States to take personal control of their affairs there, while he acted as mentor to Benedict and Boardman in conducting the two cases already prepared.[1] Young finally agreed to Binney's arguments and left for the United States on 13 January, 1860, armed with letters of introduction and powers of attorney.[2] By 4 February, 1860 Young was in Boston and discussing a new oil which spelled disaster for his patent royalties in the United States: "... Dr. Hayes ... told me that the petrol springs of Pensylvania yealded 300 gals of Petrol per hour ..."[3] On 6 February Young met Hayes again to go with him to Samuel Downer's works. When they got there, Downer was missing, and Young "... saw a party named Merrill who Dr. Hayes told me was the principle man under Downer and had improved the purifying ...". Young, as usual, used his eyes and ears to good effect; as usual he noticed as much as he was allowed to, but he "...was not in the works only the office." He was particularly interested in the paraffin candles "made in moulds" - and in all prices. These candles sold at 37 cents a lb while the oil sold at 85 cents per gallon for up to 4 barrels and 80 cents a gallon for 5 barrels or more. Although he was told by Merrill, he did not remember the number of retorts in use, but Hayes told him that the plant produced 2,200 gallons of finished oil per day.

1. Binney to Young, 10 December 1859
2. M.S. Power of Attorney from E.W. Binney and E. Meldrum to James Young, 13 January 1860; also Binney to Young, 29 February 1860
3. Business Journal and Laboratory Notebook, 1856-1861, 4 February 1860

Young met Downer later the same day at his town office in Boston and from him he got the news that the New York Kerosene Gas Light Company had gone into liquidation the week previously. Downer knew little of this affair and was not very communicative. His opinion was that coal-oil bubble was beginning to burst because company promoters lacked technical knowledge. They had begun operations with any coal to hand "... and made bad oil ..." which they could not sell.[1]

Downer's opinion was certainly not the complete answer. On 4 February, 1860 the creditors of the New York Kerosene Gas Light Company had met, and appointed a committee to examine the company's books, after agreeing to liquidate.[2] An accountant's statement of the Company's position was completed on 27 February, 1860.[3] There was a total deficiency of 88,955 dollars and 57 cents, assuming that the valuation of fixed assets, raw materials and oil stocks were correct. The reason for this was not lack of technical knowledge but rather borrowing and raw material purchasing policies. Overall production showed a total surplus of 112,470 dollars and 45 cents. This was soon swallowed by interest on loans which amounted to 171,954 dollars and 93 cents. Paid-up capital amounted to 46,524 dollars and 19 cents. But to put the works in efficient

1. Ibid., 6 February 1860
2. Report of the Committee appointed by the Creditors of the North American Kerosene Gas Light Company, p. 1. (New York 1860)
3. Ibid., pp. 8-10

production had cost 396,970 dollars and 58 cents. Total turnover had been 568,951 dollars and 5 cents. Thus, there had been tremendous capital expenditure and extensive economic operations from a totally inadequate cash base.

To save as much as possible, the committee felt that the works should be sold to an oil manufacturer, since sale for any other purpose would mean a substantial loss. A substantial loss might occur anyway. Total Boghead coal stocks stood at 12,060 tons - of the 19,725 tons discharged at Newton Creek in 1859 alone, 7,837 tons was actually distilled at the works. These stocks listed at 226,032 dollars and 22 cents allowed for an average cost of 18 dollars 76 cents per ton,[1] but the market value, in February, 1860, was only 11 dollars per ton. But the works might appeal to an oil manufacturer, if this loss was recognised, for manufacturing costs would be 63 cents or less per gallon instead of 79 cents; with a daily capacity of nearly 4,000 gallons and a wholesale price of 80 cents per gallon, the daily profit would be 770 dollars at the minimum or an annual aggregate of 241,010 dollars. The earning capacity of the works was not merely the means of attracting a buyer but also the best guarantee that creditors would receive a substantial repayment of their capital.[2] Young as a creditor was owed 7,407 dollars and 19 cents; he was interested in the prospect of taking over the financial control of this

1. Report of Committee ... passim; A.Gesner, A Practical Treatise on Coal, Petroleum, and Other distilled Oils, New York, 1861, p. 20, (second edition 1865, p. 47) gives 20,000 tons of Boghead at 18 dollars per ton. His figure was slightly incorrect
2. Report of Committee ... passim

Company if the resale value of the works was greater than the price that he was expected to pay.

Philo T. Ruggles, the President of the Company and official receiver for the creditors, was anxious to dispose of the works quickly; a rapid sale was also advised by the committee appointed by the creditors, since the fixed assets would decline in value if a great time-lag occurred. They suggested that a reserve price for the oil-works should be fixed by the creditors. If this was not reached, the creditors should take over the oil-works and try for a resale later. Anything was better than selling lock, stock and barrel at a ruinously low rate. It is an interesting reflection of the real value of Gesner's Kerosene patents that the committee of creditors thought that they were hardly worth the paper they were printed upon.[1]

On 21 March, 1860 James Young met Cozzens, an oil agent in New York, and Cozzens suggested that Young should head the Board of Directors to take over the New York Kerosene Gas Light Company. Young was prepared to invest but not prepared to take an active part in management. Later, there were further discussions at Cozzens' house and the Century Club in New York. Cozzens offered to do what Young wished, even suggesting a joint enterprise with "a party with large capital". Young's natural acquisitive instinct opposed this:

> "... I said I did not like many parties or interests if we went into it lets go with our own capital and have it to ourselves ..."

1. Ibid., p. 11

Cozzens accepted the logic of this argument and then offered to direct sales of finished oil while Young or his son, James, controlled production. However, this discussion was indecisive.[1] The next day Young called on Cozzens and told him that "... the best way was for me to go and look into the works carefully and consider the whole matter..."[2]

After some small delay in obtaining a permit from Ruggles, on 23 March, 1860 Young went to see the works at Newton Quay, Long Island. He was certainly impressed by their lay-out technical efficiency and particularly by the 55 stills each holding 1,500 gallons of crude oil. The works covered eight acres[3] and had extensive docks. His second visit on the following day confirmed his initial impressions.[4] But, finally, he decided not to enter the American coal-oil industry. He lost a magnificent opportunity, since this plant was ideally arranged not so much for distilling as for refining oils. With this works he could have brought himself a new fortune in refining crude petroleum and anticipated Rockfeller's success by more than a decade. His decision was, perhaps, the result of the timidity of age or suspicion of Yankee 'bubble' promoters. More likely, he had made his money and did not need to summon new vitality to make more. Nor did he have the imagination to foresee the future for American pet-

1. Business Journal ... 1856-61, 21 March 1860
2. Ibid., 22 March 1860
3. Ibid., 23 March, 1860; Report of Committee ... p. 9
4. Business Journal ... 1856-1861, 24 March 1860

roleum. He thought the new industry launched by Drake was just as ephemeral as his oil-spring in the mine at Riddings in Derbyshire - and, mistakenly, said so![1]

Meanwhile, Young was constantly conferring with Andrew Boardman, of Benedict and Boardman, in an attempt to introduce order into the confusion of patent rights and royalties. Almost every day from 9 February to the end of the month was spent in this way.[2] A new settlement was reached with Samuel Downer, as a result of meetings on the 27 and 28 February 1860.[3] The earlier contract of 5 November, 1858 which covered several companies was cancelled. According to Young's notes, the new contract was with Downer as an individual. He was to pay 4 cents per gallon on all oil made and sold by his Company up to 6 November, 1859 and 1 cent per gallon on all products until the end of Young's patent. The rights of Young, Meldrum and Binney against the New York Kerosene Gas Light Company were reserved to them, but Downer was to continue to pay 4 cents per gallon until half the royalties due from the New York Kerosene Gas Light Company had been received. The next draft made 1 March, 1860 included all these points and detailed

1. J.D. Henry, History and Romance of the Petroleum Industry London, 1914, vol. 1., p. 84. Henry says Young visited Oil Creek in 1861 but is mistaken. Young was also speculating in Scottish lead mining at Wanlochhead and Leadhills with his friend, Alexander Bryson. (Bryson to Young, 23 May 1860).
2. Cozzens, apparently formed a Company to take the New York Kerosene Gas Light Company over but this was short-lived. K. Beaton, op. cit., p. 53. Account by Benedict and Boardman, 27 December 1858 - 1 March 1860.
3. Ibid., Young's notes of "What Smith wrote and Downer read and agreed to in Boardman's office on 28 February;" Rough Draft M.S.; "Minutes of Agreement between the parties to the Young agreement."

administrative arrangements for collecting royalties. Each company - Downer had two, the Portland Kerosene Oil Company and the Boston Kerosene Oil Company.- was to give on the first of the month an account of the oil sold in the previous month; Young's agents were to have the right to inspect the books. Upon this account - and no distinction was made between oil from Albert coal and any other - the royalty was to be fixed and paid monthly.[1]

The patentees had certain duties. They were to prosecute American infringers, but were not expected to fight more than two cases at any one time. Legal fees were to be met from royalties; but the licensees were to ensure that at least 5,000 dollars per annum went to Young and his partners, meeting any additional legal expenses themselves.[2] Unfortunately, it is impossible to get direct impressions of Young's attitude to this agreement for only one of his letters home has survived - and that only in draft. But he kept the replies to his letters:

> "... And so you think the Yankees descended from an ancient family residing between Jerico and Jerusalem if such were Jewish Yankees I have been endeavouring to fancy a Yankee Quaker but cannot realise it ..." [3]

Binney realised Young's difficulties and their source:

> "... You are on the spot and will know what is best to be done. I suspect that you will find Jonathan a very ugly fellow to deal with ..." [4]

1. Rough Draft M.S., Minutes of Agreement ...; "Draft of Agreement 1 March, 1860 between Young, Meldrum and Binney of the first part and Samuel Downer of Boston of 2nd part ..."
2. Ibid.
3. James Napier to Young, 16 March 1860
4. Binney to Young, 24 February 1860

> "... I fear that you find Mr. Downer and all the Kerosene folks nothing but a pack of unmitigated scoundrels and the questions for you to consider are what further can you do with them and whether your time is not more valuable in England than America ..." [1]

But before Young received this letter he had received 11,622 dollars and 93 cents from Downer under the new agreement for royalties from 6 November, 1859 to 1 March, 1860.[2] Binney still pressed him to return but was suitably pleased with the agreement of 1 March:

> "... You have had an awkward fellow to manage ... I don't wish to hurry you home but your time would be more valuable here than amongst the close shavers of the new world ..." [3]

This impression Binney shared with Meldrum: "... I am sorry to see you frittering away your valuable time among such a lot of scoundrels ..." Young, in his letter of 10 March, 1860, acknowledged by Meldrum, made it clear that Downer had been disgruntled by the effect of this new royalty agreement. After paying his 11,622 dollars and 93 cents, Downer had offered to buy Young's patent outright for 20,000 dollars or £5,000. Meldrum favoured accepting this offer, since, judging from Young's experiences, it would be difficult to collect American royalties:

1. Binney to Young, 21 March 1860
2. Account by Benedict and Boardman, 27 December 1858-1 March 1860
3. Binney to Young, 24 March 1860

> "... If he offers £5,000 I would take it were I in your place and come home <u>with the money in my pocket</u>. By a combination here of all our energies we'd make £1 at home for every cent we shall ever make out of Jonathan ... Now my dear Young dont let those American rogues & fools annoy you, do what you can with them only do it quickly ..." [1]

These placatory sentiments were made from Meldrum's knowledge of Young's letters and, even more, of Young's character. But the stakes were high:

> "... I see from the Scientific American that they have been making upward of 22,000 gallons daily of coal oil in the States 1d per gallon on that is worth looking after ..." [2]

Young settled the outstanding law-suits, after carefully sounding out the prospects. He ignored Binney's advice to "... take the £5,000 cash and leave the thieves as quick as I could ..." [3] He had discovered that the Columbian Oil Company of New York were financially weak; they had a mortgage on stock and plant of "... 5,000 dollars for Bills due in March and April ..." This tale of financial problems was corroborated by Cozzens who "... told me the Columbian folk were all weak short of cash no pluck amongst them ..." [4] By the end of April talks were proceeding between the respective lawyers to achieve a compromise. Andrew Boardman offered a settlement [5] based on a royalty of 2 cents per gallon. Lucien Birdseye of of Birdseye, Sommers and Johnson of 39 Wall Street, told the

1. Meldrum to Young, 2 April 1860
2. Napier to Young, 23 March 1860
3. Binney to Young, 4 April 1860
4. Business Journal ... 1856-1861, Side note 24 March 1860
5. Andrew Boardman to Young, 23 April 1860

President of the Columbian Oil Company of this proposition, but the President had reliable information that Downer was only paying 1 cent per gallon.[1] On these terms Young was prepared to settle.

There only remained the case against the Glendon Oil Company in Boston. Early in May, 1860 Young visited their works and, with more than passing interest, he took notice of their methods of refining and distilling. He was privately contemptuous of their plant structure: "... the retort house and other buildings were of wood and how they escape burning for a month is out of my comprehension ..." Young had a long talk with Jones, the owner of the works, about settling the case out of court, "... in which I talked big ..." Jones agreed to take a licence at 2 cents per gallon, provided that Young and his partners gave up their claim for payment on past production. Young agreed to this, and the case was settled out of court.[2]

From the Glendon oil-works, Young intended to go to see Downer's new purifying plant at Portland. However, he met Downer in Boston and stayed the night with him. Next morning, Downer persuaded Young to visit the cotton factories at Lowell. He tried to convince Young that this was part of his sight-seeing tour, but Young knew that Downer wanted him to "... tell the managers about our large sales of lubricating oil. The mill folks had got a dose of his coup oil and were suspicious of anything made from coal ..."

1. Copy, Lucien Birdseye to Boardman, 23 April 1860
2. Draft Letter, Young to Meldrum, 3 May 1860

Young's reaction to Downer, despite the difficulties in negotiating a royalty settlement, was one of reluctant admiration "... he is a deep one .." Young learned from Jones that Downer, after the failure of the New York Kerosene Gas Light Company, had declared "... that the oil-makers ought to combine and blow up Young's patent ..." But Young knew that Downer was seeking to make the best of both worlds at a particularly difficult time. He was licensed to make oil by Young's process but if he could not reduce Young's royalty from 4 cents per gallon, his purposes would be served by urging others to resist Young's patent rights. If Young's patent was invalidated at law, all would benefit, Downer more than most.

He had little to fear from ramshackle companies of New York or New England. Young's impression of his Portland works was especially favourable. His view was that Downer had the best capital equipment that he had seen in the United States. Stills, made of cast-iron with malleable iron bottoms 9/16 of an inch thick, held 850 gallons and never leaked. Young wanted Meldrum to get 6 or 8 made in Scotland for their own works. Downer's works at Portland produced 1,500 gallons of finished oil per day, 1,150 of which was lamp oil. Capacity was rapidly being increased and was expected to double by July, 1860, when, instead of 30 retorts and 10 stills, they expected to have 60 retorts and 22 stills.[1]

1. Ibid. According to Giddens, op. cit., p. 22, Downer had invested half a million dollars at Boston and a quarter of a million at Portland.

When Young left the United States in June, 1860, he assigned to Benedict and Boardman limited powers of attorney. They fulfilled two important functions. First, they were responsible for completing the outstanding legal negotiations with the Columbian Oil Company and the Glendon Coal Oil Company which Young had begun and partly carried through. Cozzens and his associates, who had taken over the New York Kerosene Gas Light Company, were not so easily brought to heel and, in fact, proceeded eventually to refine petroleum, before being taken over by the company that was to become Standard Oil. Secondly, Benedict and Boardman, for a 5% commission, continued to collect royalties.[1] The coal-oil companies of Pennsylvania made no attempt to come to terms, and as will be shown, the collection of royalties by 1865 proved to be no onerous task. The general scale of evasion of payment by American coal-oil companies was enormous.[2]

Although Young went over Downer's Portland works he did not see everything "... they kept me out of the purifying place ..." However, by talking to Downer, Young learned what he thought was the weakness of his patent specification, and he came to conclusions later to have special significance in the Fernie case:

> "... I see we must alter our tactics we must take the thing produced as well as the way of producing ..." [3]

1. Scottish Oils MSS., Copy Letter, Benedict and Boardman to E.W. Binney, 26 June, 1860
2. Vide infra. pp. 278 sq.
3. Draft Letter, Young to Meldrum, 3 May 1860

But this type of discussion was already becoming mere legal pedantry; it was being made so by the great development of the American petroleum industry. By the end of 1860, 74 new oil wells had been sunk since Young's departure from Liverpool and half a million barrels of petroleum produced; by 1863-64 543 oil companies had been promoted with a total capital of 360 million dollars.[1] American coal-oil manufacture was a victim of this flood of capital - and so was the commercial value of Young's patent. Some American coal-oil manufacturers survived as refiners of crude petroleum or manufacturers of paraffin wax; Samuel Downer was one of the most important. The American petroleum oil industry benefited greatly from the technical experience of the coal-oil industry - refining, in particular, rapidly became a separate industry involving no new basic principles.

In Europe an infant oil industry[2] was very largely unprepared for this immature giant competitor. In 1862 nearly 11 million gallons were exported to Europe and there seemed no end to the flood of petroleum.

Total Oil Exports from U.S.A. to Europe (1862-64)

	(gallons)
1862	10,887, 701
1863	8,703,117
1864	10,457,188

Source: Gesner, Treatise ... (2nd edition, 1865) p. 24.
C.f. also Williamson and Daum, op. cit., p. 740.

1. P.H. Giddens, The Birth of the Oil Industry, New York 1938, pp. xxi-xxii
2. This is best described by R.J. Forbes in the Fourth Biennial Dickinson Memorial Lecture, "Roots in the Past, The Prehistory of the Oil Industry", Transactions of Newcomen Society, vol. xxxii., 1959-60, pp. 111-122.

The first news of this natural source of oil reached Britain in the summer of 1860 but the scale of development was not at first apparent. However, in the spring of 1861, the trade journals were full of small newsitems indicating that events were untoward: in the Little Kanawha river of Virginia "... They are boring oil wells ... almost without number ..." and refined oil cost 65 cents a gallon to produce.[1] By the autumn news of the Canadian oil-field at Enniskillen was that 86 new wells had been drilled in six months.[2] In 1862 the first great imports were reaching British ports and became a competitive menace.

Export of American Petroleum Products (gallons) to British Ports (1863-64)

	1863	1864
Liverpool	2,156,851	734,755
London	2,576,331	1,430,710
Glasgow	414,943	368,402
Bristol	71,912	29,134
Bowling	-	87,164
Falmouth	623,176	316,402
Grangemouth	425,334	-

Source: Gesner, Treatise ... (2nd edition, 1865) p. 22.

American petroleum tended to take up the slack in the London market in 1863-64. According to estimates prepared for Young, their sale of refined burning oil rose from 47,370 gallons in 1863 to 71,271, gallons in 1864, while the sale of Young's parafffin burning oil fell slightly from 13,194 gallons

1. Journal of Gas Lighting, 23 April 1861
2. Ibid., 24 September 1861

TABLE 15

MONTHLY DELIVERIES OF PETROLEUM AND YOUNG'S OIL IN LONDON 1863-64 (gallons)

(Prices in brackets)

		JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1863	Petroleum	1200 (2/5)	1400 (2/1½)	2895 (1/8)	2955 (1/8½)	4153 (1/10½)	2177 (2/1)	3694 (2/3½)	5039 (2/8)	2310 (2/6)	6395 (2/2¼)	8070 (2/-)	7082 (2/-)
	Young's	2319 (2/6)	1653 (2/6)	1106 (2/6)	611 (2/6)	406 (2/6)	301 (2/6)	306 (2/6)	498 (2/6)	1057 (2/6)	1446 (2/6)	1656 (2/6)	1841 (2/6)
1864	Petroleum	8598 (2/-)	10525 (2/-)	5300 (1/10)	3885 (2/-)	3618 (2/2¼)	1314 (2/1½)	2041 (2/1¾)	3564 (2/2)	7830 (2/0½)	10321 (2/0¼)	7282 (2/0¼)	6992 (2/1)
	Young's	1814 (2/6)	1248 (2/6)	914 (2/6)	607 (2/6)	469 (2/3)	324 (2/3)	346 (2/3)	868 (2/3)	1050 (2/3)	1050 (2/3)	1770 (2/3)	2138 (2/3)

Totals	1863	% of Joint Total	1864	% of Joint Total
Petroleum	47,370	78.9	71,271	84.8
Young's	13,194	21.1	12,781	15.2
Joint Totals	60,564	100	84,052	100

Source:

Account of Valuation Book, 1865-1866

in 1863 to 12,781 gallons in 1864. But they did not seize the market entirely. Young's share of the joint market was 21.1% in 1863 and only 15.2% in 1864. No retail or wholesale price war occurred between the products. Young's oil was sold at 2/6d per gallon throughout 1863, while the price of American oil fluctuated from 1/8d in March to 2/8d in August, being generally below Young's. In May, 1864 Young's oil was reduced to 2/3d per gallon and stayed at that price for the rest of the year. Meanwhile American oil prices were becoming more stable and approaching Young's price, varying between 1/10d in March to 2/2¼ in May.[1]

There were several reasons why American petroleum did not capture the British market entirely. First the quality of American and Canadian oils varied greatly: they were often dangerously adulterated with light fractions; the crude was often mixed with water and brine; the smell of petroleum was often found to be objectionable. Standardised production and refining gradually reduced these practices and prejudices resulting from them. American oil producers combined for the first time in January 1862 and fixed the minimum price of crude at 4 dollars per barrel;[2] this tended to raise prices overseas, particularly as oil storage capacity increased and made combination effective. The Civil War affected the market indirectly for the sale of all oils, lubricants and fuel oils,

1. Account and Valuation Book, 1866. See Table No.15
2. P.H. Giddens, op. cit., p. 84

in British textile areas tended to fall because of the cotton "famine" and the consequent cut in purchasing power in these areas.[1] The small export of oil from the Southern States was also affected by the North's blockade. In 1864 war taxation affected the price of Northern oil when a tax of 1 dollar per barrel was imposed.[2]

Young's positive measures were not so important as the development of public pressure to restrict oil imports. He launched an advertising campaign in 1862 emphasizing the safety of his own oils and the hidden dangers of some American products. He, his partners and his agents assisted the growth of a newspaper lobby on parliament to secure legislation which had the effect of reducing competition. In March, 1862 he tried to obtain an injunction to prevent Andrew Macrae of the Liverpool Oil Refining Company, Bootle, from using the name 'paraffin oil' or "American Paraffin Oil" and failed![3] In November, 1862 he brought an action in the Queen's bench against Macrae for libel when Macrae issued a circular containing a certificate from Professor Sheridan Muspratt, stating that Young's oil was much inferior to Macrae's American oil in odour, colour, and performance. This action was also lost, since it was ruled that Macrae was applying a normal advertising technique. Young was advised by the Judge amid laughter:

1. Refer to Table on p. 257. Export of American Petroleum Products to British Ports (1863-64)
2. Giddens, op. cit., p. xxxv
3. Young v. Macrae, Chancery, 21 March 1862

"... You had better get another professor to give you a report in your favour ..."[1] Later, Young was very bitter about his failure to get legal support for his tradename, "paraffin":

> "... If I had given it a fancy name which meant nothing, I should have had the protection of the court ..."[2]

Nonetheless, public indignation increased in 1862 as the number of accidents with American burning oils mounted. These accidents, although often caused by bad refining, occasionally were the results of mixing petroleum with other oils, the fault of wholesalers and retailers, who at first were ignorant of the consequences. The coroner, in one case of death caused by the explosion of a lamp, agreed with the Jury's rider to their verdict that legislation should be introduced to restrict the sales of dangerous oils.[3] In March, April, and May the agitation outside parliament grew; a Bill was introduced "for the safe-keeping of petroleum to prevent accidents." It provided that any product that gives off an inflammable vapour at a temperature of less than 100° F should be classified as petroleum for the purposes of the Bill. Young's oils were excluded since their minimum safety factor was 130° F while several American burning oils exploded or ignited at below 50° F. Ships carrying petroleum were to be moored well away from other vessels or wharfs, according to the safety measures laid down by port authorities. Not more than 25 gallons of

1. Young v. Macrae, Queen's Bench, 14 November 1862, reported in Journal of Gas Lighting, 18 November 1862.
2. The Times, 8 February 1864
3. Coroner's Inquest on John Robert Cotherill, a London law-writer on 13 February 1862, reported in Journal of Gas Lighting, 11 March 1862

petroleum was to be kept within 100 yards of a dwelling house or warehouse unless licensed by the local authority. The Bill encountered little opposition except from importers and refiners of American petroleum, and when it became law at the end of July 1862, its intention was clear to those closely associated with the coal-oil trade:

> "... The petroleum Bill, even with the low standard of safety which the government have adopted, will tend naturally to check the large importation of American rock oil that has lately taken place ..." [1]

This Act was operated ruthlessly in London but much less vigorously in other ports. The Metropolitan Board of Works required refiners of Rangoon petroleum even, such as Price and Company, to apply for licences, and licences were occasionally refused outright. On Mersey-side the local authorities were not so insistent upon enforcement of the Act. But the local rate-payers attempted to take a hand. In October, 1862 there were complaints to the Town Council in Liverpool about the offensive vapours given off by Canadian petroleum, and on 17 November the ratepayers of Birkenhead held a public meeting to protest against the Mersey Board's decision to permit the storage of petroleum and the erection of a new refinery at Birkenhead.[2]

Even before the Act was introduced Young was being singled out, with good reason, and attacked by The Toronto Globe for lobbying against foreign petroleum:

1. Journal of Gas Lighting, 1 July - 29 July 1862
2. Ibid., 21 October and 2 December 1862

> "... The chief opposition to the introduction of the article into general use has been made by Mr. Young, the patentee of paraffin oil ... Mr. Young is reported to have been making a hundred thousand pounds a year by his patent, and is naturally unwilling to surrender his enormous gains without a struggle. It was he, or his agents, who spread abroad exaggerated reports of the dangerous nature of the American petroleum, and attempted to exclude it from the boundaries of the city of London ..." [1]

Young certainly had friends on the Metropolitan Board of Works but he did not need to use influence to get its support, since the number of accidents in London caused by petroleum was sufficient in itself to spur the Board into action. Elsewhere, the Act was virtually a dead-letter as Young pointed out in a long letter to The Times in February, 1864. By then Young was relying upon a campaign advertising the quality of his oils and guaranteeing their safety: every cask made at Bathgate was tested, and the purchaser given a guarantee that the oil would not give off vapours unless heated to at least 130° F.[2] But American petroleum was in the market to stay; once, there was a massive widening of capital at the expiration of Young's patent profit margins would inevitably fall. Before that factor could operate, pressure of expanding demand kept up prices; prices were also kept up by a vast heterogeneous number of small retailers and dealers in oils who had come into existence in the late 50s to supply the market at

1. The Toronto Globe, 2 May 1862
2. The Times, 8 February 1864

unusually high prices. As yet there was little cut-throat retail competition; even American "crystal oil" was advertised at 3/- per gallon retail and more. Those days of high retail margins were also ending as distribution became more efficient.

5. The Transfer of the Industry from Cannel Coal to Shale

Even before Young took out his patent, he knew that there were oil-shales in Scotland suitable for distillation;[1] but he also wanted to keep that information dark as long as possible. He had several pieces of luck which assisted his success in this objective. First, Boghead cannel coal was the finest raw material in the world - with the possible exception of American Breckenridge cannel - and the prices prevailing before 1859 made it also the most economic. Secondly, the Torbanehill Mineral Case favoured the maintenance of his patent and occupied the Russels and Gillespie until 1860. There were other minor fortuitous advantages. Shales elsewhere were not worked with any great success before 1860 and, therefore, prosperity in the Lothians did not assume any great significance until the turn of the decade. Young was also quietly buying his way into the shale districts, particularly with his great purchase of the Addiewell estates. These contained a valuable seam of oil-shale rich in ammonia. A valuable insight into the additional reasons for Young's prospecting success from 1858 onwards is given by Geikie, who from 1858 to 1861 undertook the first geological survey of the Lothians. According to Geikie, Young accompanied him in the field when the survey of the relevant areas was undertaken and consulted him about the extent of particular shale-beds.

1. Notebook 1850 and Notebook 1851.
He remained constantly interested in shales as his pocket books, notebooks and Business Journal, 1856-1861, show. For example, he was experimenting successfully with shales from Knightswood in September 1854. (Pocket Book 1854, 6 September 1854.)

Geikie showed him the outcrops and gave him rough indications of the extent of seams. Young, typically, "... did not say anything about the purport of his enquiry ..." Using the best scientific knowledge, he achieved valuable advance information, later made available to all and sundry by the map (1859) and geological memoir (1861) of the Lothians.[1]

Young's partners were also playing their part by taking the lease of the Methil coal, another very suitable raw material. They were able to exclude shale distillation until 1862 by a variety of tactics, but the chief one was silence.

Nonetheless, the partners were dogged with the fear that Young's patent would be bypassed by manufacturers' using shale and not coal. They were helped by the confusion which Young's patent seems to have engendered, for many would-be infringers simply tried to buy Boghead coal and not other materials. The sharp rise in Boghead cannel coal prices in 1859 stimulated the search for other materials just as additional knowledge was becoming available and, thus diminished the competitive advantage of using Boghead cannel. Earlier, Young had bought up shales as inquisitive visitors to the area tended to become interested. He did not then employ them in manufacture for he had a vested interest in maintaining the force of his patent which was for coal alone. His purpose was restriction for the present and investment for the future. He also adopted the policy of buying out shale patents,

1. Sir E. Bailey, The Geological Survey of Great Britain, London 1952, pp. 131 sq.

if they were sufficiently fundamental, not because he wanted to employ them in production but because he wanted to prevent anyone else from doing so. This was the technique which he employed, for example, with Parkin's patent.[1]

Meldrum and Binney did not altogether countenance Young's restrictionism. They did not think it possible to withstand the development of the oil-shale industry; they justifiably feared that piles of expensive Boghead cannel coal would be left on their hands, while their competitors took leases of cheaper shales. There was also the additional fear that Young's patent would be broken at law. Binney occasionally was pessimistic enough to suggest that they should sell Young's patent rights, and then open up shale for themselves. This was more an affront to Young's personal pride than to his pocket - but an affront, nonetheless!

The partners met in the Queen's Hotel, Glasgow, on 10 January, 1859 to confer with representatives from the New York Kerosene Gas Light Company and other American coal-oil firms. Before this conference there was a private meeting at which Binney suggested that the American and Colonial patents should be sold immediately, and that they should look for buyers for the English and Scottish patents. After the meeting at which Young had already scotched the first of these two proposals,

1. British Patent, No. 307, 4 February 1853. This was the case also with a "coup-oil" patent of 1853. Binney to Young, 29 January 1859 and 2 February 1859; c.f. British Patent, No. 1897, 13 August 1853.

Meldrum talked of breaking up the partnership, and each of them doing what he thought best in reference to shale. For himself, Meldrum was content with what they had made from the patent.[1] Young also gave short shrift to this idea.

Two months later, Young met Meldrum, and they again discussed their best course of action. Young's view was that they should make all their coal into oil as quickly as possible "... and get it off ..." Then, they would be free of the danger of being undercut by shale oil. After pondering for a time, Meldrum agreed and decided to secure delivery of coal due on contracts as fast as possible.[2] This policy was partly frustrated by Russel who refused to upset existing contracts or to inconvenience his other customers. Meanwhile, thinking that this policy would be implemented, Young had his agents, particularly Thomas Rowatt, in the West Calder area, looking at shales and securing leases on Young's behalf. This activity came to Meldrum's notice, and he drew Binney's attention to it. Binney was furious, since secrecy was essential to the partnership's position. However, Young attempted to placate his partners by saying that Rowatt's function was to "... try to keep the thing quite as long as possible ..."[3] There may have been something in this, since Russel and other coal-masters in the course of 1859 began to take an interest in shale leases. But Young was also certainly preparing for the day when his patent collapsed.

1. Business Journal and Laboratory Notebook, 1856-61, 10 January 1859
2. Ibid., 15 March 1859
3. Ibid., 22 March 1859

While Young favoured a holding policy for the partnership, Binney favoured a more positive approach. Apart from extending the works and increasing productive capacity, he was recommending that they should "... have a piece of land with Shale in it quietly purchased to be ready for any emergency," that they should ask Russel to deliver their contract coal more quickly and that they should reduce the risks of litigation by licensing their competitors.[1]

Young was apparently less concerned with the future of the partnership than with his own entrepreneurial future. He was just as suspicious of his partners as they were of him. He knew Binney had taken a lease of the Methil minerals and he had heard that Miller and Company were using Fife "shale" at Aberdeen; naturally, he wondered who was supplying it. Meldrum and Binney denied any connection with the Aberdeen firm.[2] The partners, then, discussed shales. Young told Meldrum and Binney that a number of people had been enquiring about shales and that he had ordered Rowatt to do what he could to cloud the issue with obscurity "... by shoving them off ...," but, if nothing else would serve, he was to pay a lordship "... rather than let the matter make a noise ..." Meldrum's reaction was that this policy might prove very expensive. At this point Young made it clear that what he was doing, he was doing for himself alone and not for the partnership and that it was not the first time he had acted alone:

1. Business Journal and Laboratory Notebook, 1856-61, 10 January, 1859
2. Business Journal ... 1856-1861, 12 April 1859

"... I had paid a lot of money two years ago and kept a shale story quite ..." Binney preferred to buy land with shale in it "... to start on when the shale blew us up ..." But Young would not support such a policy. He maintained a consistent opposition to buying land as a partnership:

> "... I said what I had said before when it was proposed to buy Seafield that I was not inclined to buy land as a company and I was still of the same opinion land held by the coy. would be an aquard thing and would be still more aquard to leave to my family ..."

Apart from his obsession with his own health, which was certainly causing him some concern in 1859-60, Young's attitude may well have been determined by his desire to be rid of his partners. As Meldrum rightly pointed out, "... others would work shales and we would be cut out ..." To this, Young said nothing, encouraging Meldrum to add that he did not care too much, since he had made "... as much money as he cared for ..."[1]

Young was keeping his own counsel; he had no intention of being cut out of the oil-shale industry; he was privately following the policy that Binney was publicly recommending. In the process, he was making his own position in the partnership unassailable. If the partnership was faced with competition from shale-oil, he had the shale leases, which he could either furnish or not depending upon his partner's responses to his dictation. If they opted to leave the partnership, he was best equipped to buy the Bathgate plant at his own price. Had the partnership secured shale leases, this advantageous personal position would be lost.

1. Ibid.

Finally, the partners could agree on only one point: that Binney should call on Russel and try to obtain faster coal deliveries.[1] This was still the position in June, 1859 when Binney asked Young to send him a copy of their original contract of 1856 with Russel.[2] Shortly afterwards, Binney received an enquiry about Pirnie coal from George Bower, a gas equipment manufacturer of St. Neots, Huntingdonshire. Bower wanted to set up a factory near Pirnie - the partners had a contract giving them a monopoly of this coal - and produce "oil manures", as he had been doing from Kimmeridge shale. He had been corresponding with a German chemist who was prepared to come to Scotland to manage this venture if a licence and a contract for 50,000 tons of Pirnie coal per annum for a fixed number of years could be obtained from Young and his partners.[3] In fact, this was a large-scale venture in oil manufacture for "oil manures" would be a by-product for Pirnie coal or shale was one of the most productive bituminous substances available for oil distillation, as Young had discovered in 1850. Binney frightened Bower off:

> "... You well know that Mr. James Young has a Patent for making Paraffine Oil and Paraffine from coal and if he catches you or your friend infringing his patent by using Pirnie coal or Kimmeridge coal he will very soon bring actions against you ..." [4]

1. Ibid.
2. Binney to Young, 6 June 1859; Binney to Young, 10 June 1859
3. Copy, Bower to Binney, 8 June 1859
4. Copy, Binney to Bower, 9 June 1859

The stern threat was effective. Bower built plants in Italy and Germany and exported Boghead coal and Kimmeridge shale to them. At home he became one of the staunchest supporters of Young's patent.

On 29 June, 1859 Binney met Russel in Ilkley but had no immediate success in his objective of securing faster deliveries of coal. Russel mentioned that:

> "... he feared the Shales breaking out. He knew one that would yield half as much as his coal and the whole country was full of it ..." [1]

Young, in acknowledging this letter, studiously chose to ignore Binney's references to shale and merely commiserated with his failure to secure Russel's support for faster coal deliveries.[2]

But in November, 1859 the partners were successful in this enterprise, mainly because of Meldrum's diplomatic intervention.[3]

Young's reaction to Russel's views of June, 1859 was to seek additional shale rights. Rowatt approached James Mungall for his shales in which Russel was himself interested. This came to Meldrum's ears from McKinlay, Russel's manager, but to his queries, Young did nothing more than repeat his version that Rowatt was trying to prevent shale rights coming onto the market by paying lordships. Meldrum seemed satisfied for the moment:

1. Binney to Young, 30 June 1859; Binney to Young, 11 July 1859 enclosing copy of Binney to Russel and Son of same date.
2. Young to Binney (draft), 1 July 1859
3. Binney to Young, 16 November 1859; With this letter was enclosed copy of Russel and Son to Binney and Company, 14 November 1859 and of Meldrum's reply, 14 November 1859.

> "... if this was done judiciously it was all right but if he agreed for a high lordship it would be bad ..." [1]

But, unfortunately for Young, Meldrum had written to Binney who was not so easily placated:

> "... I think you ought not to allow Mr Rowatt as your servant to open the Shale question which our firm has been doing its best to keep quiet so many years. What object you can have in doing so I cannot imagine .." [2]

Young, naturally, continued to deny that his actions were anything other than preventive measures. He had instructed Rowatt to pay a small fixed lordship "... rather than have the matter in the market ..." No objection had been made to Young's paying lordships out of his own pocket, when shale leases were likely to come on the open market earlier, except Meldrum's "... saying if I paid rent on all the shales that were offered I might soon have a lot of rents to pay ..." Why should Binney object now? It was Young's own money with which he was playing this restrictionist game.[3]

Binney realised that verbal duelling would achieve little. Instead, in November, 1859, he attempted to match Young's tactics by taking up Russel's offer of an additional coal lease at Methil.[4] In March, 1860 he was using his control over Methil coal, the second best Scottish coal to Boghead cannel for oil distillation, as a bargaining counter with Young.

1. Business Journal ..., 1856-1861, 19 July 1859
2. Binney to Young, 20 July 1859
3. Young to Binney, 22 July 1859
4. Business Journal ..., 1856-1861, 1 November 1859

Meldrum had calculated that between March, 1860 and October, 1864, when the partnership was due to end, an additional 25,000 tons of Boghead - apart from existing contracts - would be needed to supply the Bathgate plant. But if new works were built, a further 50,000 tons would be necessary. This expansion of productive capacity could not be matched, in Binney's view, by an expansion of Boghead coal supplies without paying unduly high prices.[1] There would be such a shift in the demand curve for Boghead coal that fixing contracts would be a dangerous speculation. If there happened to be a sudden release of oil-shales onto the market, he felt that he and his partners would be left, rather like the North American Kerosene Gas Light Company of New York, with an uncompetitive raw material ordered for years ahead. Binney's alternative policy to buying Boghead coal on contract was to work his Methil coal at 5/6 to 6/- per ton and be "... master of any Shale that may spring up .."[2]

But Binney's information, even though he did not know it, could be faulted by Young's knowledge of the American coal-oil industry. The great rise in Boghead coal prices in 1859 had occurred because of buying by Americans - 4,000 tons by Downer and 20,000 tons by the defunct North American Kerosene Gas Light Company.[3] All this coal would be available to British buyers in 1860; Downer would buy cheaper American cannels

1. Binney to Young, 6 March 1860
2. Ibid.
3. Vide infra., p. 233 et seq.

and refine petroleum and the North American Kerosene Gas Light Company would be reformed to refine petroleum exclusively. Indeed, Boghead coal prices fell in 1860 and remained signif-
icantly lower than their 1859 peak.[1] This was also a result of a change in gas company economics; the few remaining in 1859 who used Boghead coal were turned from it to other cheaper coals by the price inflation and never returned to it, but
rather began to experiment with making gas from petroleum![2]

However, although the immediate stimulus to open up Scottish oil shales was reduced, greater awareness of the limits of Young's patent was induced by the Clydesdale Chemical Company case in November, 1860. Fernie knew that Young's patent did not cover shale and he, with Wanostrocht of the Wareham Oil and Candle Company, began to take an interest in the Broxburn area in 1861. Throughout 1862 there was a great opening of the shales of Broxburn and a widening of capital
in the shale-oil industry.[3] This occurred in spite of Young and his partners not because of them. They had financed re-
search in shale distillation;[4] individually, they had tried to come to terms with the widening of competition from shale-

1. See Appendix: Boghead coal prices at the pit-head (1850-1864)
2. The Trade Journals particularly the British and American Journals of Gas-Lighting show increasing experimentation with oil by gas companies in 1860-61
3. The Valuation Records for the 1860s for Uphall Parish, in which Broxburn village was, show evidence of this; c.f. also "... This small village (i.e. Broxburn) is now rapidly growing into importance, chiefly owing to the extensive paraffin oilworks lately commenced upon the Earl of Buchan's property ..." The Scotsman, 11 June 1862.
4. Vide infra.pp125 sqq; Laboratory Notebook 1857-62 has many entries relating to the distillation of shale; c.f. also William McIvor's Notebook 1863-1865 which was exclusively concerned with this problem

oil. They were fortunate to have expanded, indeed, doubled their capacity in 1862.[1] But they still worked coal not shale; it would have meant playing into Fernie's hands to have abandoned the patent in 1862. They continued to work Boghead cannel as long as it remained economic to do so and this certainly was the case until after 1864. But both Meldrum and Young were preparing for the day of separation, Young by building additional works and Meldrum by seeking future alliance with shale masters. Binney, eventually, decided to become a rentier.

Despite the growth of the shale-oil industry at Broxburn,[2] the flood of capital into the Lothians was delayed, until Young's patent was about to expire without hope of extension. This flood was controlled because of the local ignorance of many Scottish entrepreneurs who imagined that shales could never be effective competitors with Boghead and Methil cannel coals in an industry subject to competition from Rangoon and American petroleum. Better to build works ready to begin when Young's patent expired; better to use the same material as Young and his partners used; better to imitate than to initiate.

1. M.S. Memorandum for week ending 6 December 1862, mentions coals only not shales. I suspect that E.M. Bailey and R.J. Conacher in their earlier accounts when they say that Young used shale from 1859 are mistaking experiment and lordship policy for actual operations. Had Boghead coal prices risen beyond their 1859 peak, the partnership might have worked shales instead of coal.
2. According to The Scotsman, 4 October 1864, oil works were being erected or had been erected in many different parts of the Lothians within the year, because it was known that Young's patent was not to be extended.

TABLE 16

YOUNG'S PERSONAL RECEIPTS FROM E. MELDRUM & CO. (1852-1855)

Date	Amount	Source
July 1852	£1,033. 14. -.	Pocket Book, 1851-52
31 October 1852	£300. -. -.	Pocket Book, 1852
May 1853	£307. -. -.	Pocket Book, 1853
June 1855	£2,037. 9. 2.	Pocket Book, 1855
November 1855	£3,000. -. -.	Pocket Book, 1855

Notes:

1. This Table is based on Young's notes in his Pocket Books and is very incomplete.
2. The figure of £2,037. 9.2. was £2,000 by bill and £37. 9. 2. in cash, possibly for expenses.

6. Returns

A survey, such as this, would not be complete without some attempt to assess the inventor's rewards and the returns upon the operations of the partnership. But the business records of the partnership are no where so lacking as in the financial details of turnover and profits. The partners seem to have been coy about the production of balance sheets; only four copies seem ever to have been made, at first half-yearly and then quarterly. The partners received a balance sheet each; and one was kept for reference at Bathgate. Tantalisingly, the partners mention receipt of their balance sheets but never comment except perhaps, as Binney occasionally did, to remark on trading circumstances. Young occasionally noted, in the period up to the end of 1855, his receipts from E. Meldrum and Company, and these jottings are summarised in Table No.16. Meldrum mentioned in a letter of 1860 to Young that for the first quarter of the year he had paid £6,000 into Young's account.[1] This was more in one quarter than Young appeared to receive in the whole of the year 1855. When Young was floating his limited liability company, the valuation book recorded, from balance sheets extant then, that Bathgate Chemical Works in the three years ending December, 1864 had shown an annual average profit of £57,000 and that Young's ten Paraffin Light stations showed a profit of £12,000 for the year April, 1864 to April, 1865.[2]

1. Meldrum to Young, 2 April 1860. Binney elsewhere indicates that 1859-60 was the best year of trading so far. Binney to Young, 24 February 1860
2. Account and Valuation Book, 1865-67. Minute of Agreement.

TABLE 17

FINANICAL ESTIMATES FOR OPERATIONS AT BATHGATE
(1851-64)

Period	Total Turnover	Annual Average Turnover	% increase in growth of annual average turnover	Profit on total turnover	Annual Average Profit	Average Profit/ Average Turnover %	% increase in growth of annual average profit
1851-56	£57,000	£11,500	-	£25,000	£5,000	43.5%	-
1856-61	£440,000	£88,000	768.7%	£165,000	£33,000	37.5%	660%
1861-64	£385,000	£130,000	147.7%	£156,750	£57,000	43.84%	172.7%

Notes:

1. Year runs February to February until last period which begins February 1861 and ends October 1864
2. Estimates are computed on consumption of Boghead coal and other evidence given in the text.
3. Period 1856-61 includes one bad year, 1858, when capital equipment was replaced and production was below normal capacity.
4. Period 1861-62 includes period from 1862 when capacity was greatly increased as a result of works extensions and new plant.

Taking this scanty miscellaneous information into account, Table No. 17 was drawn up as a conjectural estimate of the financial results of operations at Bathgate. Known quantities of Boghead coal were delivered and made up into oils, sometimes mixed with other natural oils and sometimes sold as coal-oils. An estimate of the total value of products was given on oath by William McLintock in 1853.[1] This has been used as a multiplier against known consumption of Boghead coal to give an approximation to total turnover. His estimate of profits has been reduced, since he made no allowance for technical losses of any kind or depreciation charges; neither did he allow for the differences between retail prices - which he quoted - and wholesale prices, which Young and his partners could expect to receive, less a discount. For the late 50s and early 60s the estimate of Benjamin Horatio Paul can be similarly used, since it was made on a number of occasions without contradiction.[2] Total turnover from 1856 has been calculated using this multiplier, allowing for 1864 being an incomplete business year and for 1858 being a year of temporary recession with reduction of capacity. Figures for total profits have been calculated in the same fashion, bearing in mind the known figures for 1861-1864.

1. Gillespies v. Russels, Edinburgh 1853, p. 90, Evidence of William McLintock
2. Affidavits of R.H. Paul, Chancery, 1862, Fernie and Others v. Young and Others, Lords, 1864, p. 806, Evidence of Benjamin Horatio Paul.

TABLE 18

ROUGH ESTIMATE : ROYALTY POTENTIAL FROM U.S.A. (1860-61)

Year	Number of Companies	Total Daily Capacity gallons	Annual (300 days) Royalty at 1 cent per gallon
1859-60[1]	37	22,750	68,250 dollars
1860-61[2]	56	40,000	120,000 dollars

Sources:

1. Hunt's Merchants' Magazine, December 1859
   T. Antisell, The Manufacture of Photogenic or Hydro-Carbon Oils, 1860
2. A. Gesner, Treatise ... 1861

The Toronto Globe's estimate of 1862[1] that Young personally was making £100,000 per annum appears at first glance to be wildly inaccurate, but, of course, we have to take into account his returns from royalties and legal damages which were very considerable. However, this source did not grow in significance until 1859-60.[2] One reasonably authoritative estimate was that 8 million gallons of burning oil were being made per annum, according to Young's process, in Britain alone in the early 1860s. Total demand for burning oil was thought to be 12 million gallons per annum.[3] Making the reasonably conservative assumption that from 1860-1864 the partnership was accounting for about 25% of total production, then, at a royalty of 3d per gallon, royalties would show a return of £75,000 per annum. Legal damages assessed by British courts also showed a remarkable return in the period from 1860 to 1864.

There is much less known about receipts from American royalties. Potentially, these were a great source of wealth for a short time, but, apart from payments by Samuel Downer and his associates in the period 1858-60, nothing exact is known. When in 1864 Young's American patent was extended, despite the opposition of the Union Coal and Oil Company, of Maysville, Kentucky, it was stated authoritatively that

if Young had been able in 1860 to collect 2 cents per gallon

1. The Toronto Globe, 2 May 1862
2. The Journal of Gas Lighting, 6 May 1862
3. Fernie and Others v. Young and Others, Lords, 1864, vol. ii., Joint Appendix, Answer of E.W. Fernie, para. 96 given in Chancery, 29 January 1863

TABLE 19

KNOWN ROYALTY RECEIPTS FROM THE UNITED STATES
(1858-60)

Date	Amount (dollars)	Payees
1 July 1859[1]	2,500	S. Downer & P. Ruggles
1 March 1860[2]	11,622.93	S. Downer
10 April 1860	437# 42 cents	Samuel Downer
10 May 1860	257# 78 cents	S. Downer
14 May 1860	236# 4 cents	Portland Kerosene Oil Company
12 June 1860	196# 1 cent	Downer
14 June 1860[3]	249# 15 cents	Portland Kerosene Oil Company
Total	15,499# 33 cents	

Sources:

1. Benedict and Boardman in account with James Young, Edward Meldrum and E.W. Binney, 1857-1859
2. Benedict and Boardman in account with James Young, Edward Meldrum and E.W. Binney, 27 November 1858- 1 March 1860
3. Letter and Balance Sheet, Benedict and Boardman to E.W. Binney, 20 March-26 May, 1860, dated 26 June 1860

from the total production of the coal-oil industry in the one state of Ohio, this royalty would have been worth 45,000 dollars per annum. Young filed an account in support of his application for an extension in which he stated that he had received £5,518. 16. 9d. or about 27,000 dollars, but this sum was a net gain. He had received an additional £2,765. 19. 4d. or about 13,359 dollars which had been spent on legal expenses during his visit to the United States in 1860. This was regarded by the Court as inadequate remuneration for so valuable an invention.[1] Even if Young's own account of moneys received from the American coal-oil industry was not accurate - and he had an interest in returning a low figure - this statement destroys the story that he financed his later operations from American royalties. For the false assumption has been made that Young benefited considerably from American royalties, at least sufficiently to buy out his partners in October, 1864.[2] But Young's displacing his partners had a prehistory of a few years even before the expansion of the American coal-oil industry and his visit to the United States.

Nor should it be forgotten that his partners shared in any

1. Scottish Oils MSS., Opinion of John L. Hayes, Acting Commissioner of Patents, on Extending Young's Patent for seven years from 7 October 1864, privately printed 1865, pp. 21-23; Report by B.S. Hedrick on Young's Patent, 3 October 1864; c.f. also the inconsistency between text and note in H,F. Williamson and A.R. Daum, op. cit., p. 56 and p. 56 n; c.f.also Scientific American, 25 February 1865
2. D. Murray, "Paraffin Young ..."; R.J. Conacher, "The Birth of the Petroleum Industry", A.P.O.C. Magazine January 1925; (Anglo Persian Oil Company Magazine); E.M. Bailey, The Young Memorial Lecture, 1948.

TABLE 20

RECEIPTS FROM ROYALTIES AND DAMAGES IMPOSED BY LAW
(1860-1864)

Period/Date	Amount (£)	Case/Nature of Award
January 1861	7,500	Damages
Nov. 1860 - June 1864	8,000	Royalties at 4d. per gallon THE CLYDESDALE CHEMICAL CO.
1861	5,000	Damages
1861-1864	2,500	Royalties at 3d. per gallon MILLERS OF ABERDEEN AND GLASGOW
1864	10,000	Damages
	11,422. 14. 6.	Royalties at 3d. per gallon E.W. FERNIE AND PARTNERS
1864	400	Damages WAREHAM OIL AND CANDLE AND CANELINE OIL COMPANY
Total for Damages	22,900	
GRAND TOTAL	£ 44,822. 14. 6.	

returns that he received. His individual profit from the Paraffin Light stations has not been included in the rough estimate of his consolidated receipts[1] which over the period 1851-64 appear to have been in the order of £220,000. Over all his total profits from all sources but not counting the liquidation value of the business, probably did not exceed £300,000. He was so modest a man that to our great loss he never revealed his income in recorded conversations or letters. Many newspapers sensationally revealed it for him and made him the object of admiration and envy:

> "... While his patent lasted Mr. Young had all but a monopoly of the paraffin trade, and he and his partners were enabled to realise enormous profits ..." [2]

1. See Tables No. 18 and 21.
2. The Glasgow News, 15 May 1883

TABLE 21

ROUGH ESTIMATE : CONSOLIDATED TABLES OF RECEIPTS

Nature	Amounts (£)	Comments
Total Profits 1851-64	£326,750	Annual Average Receipt from this source: over 13 years £25,135 Average Receipt over last 4 years: £57,000
Total from Damages 1860-64	22,900	Annual Average Receipt from this source over 4 years: £5,725
Total from British Royalties 1860-64	300,000	Annual Average Receipt from this source over 4 years: £75,000
American Royalties 1858-64	8,284. 16. 1.	Known receipts: 40,359 dollars [1] This figure included in Grand Total
GRAND TOTAL	£ 657,934. 16. 1.	At equal shares, Young receives £219,311. 12. 0. over the whole period 1851-64

Note:

1. Young's figure prepared for American Patent Commissioners, October 1864

YOUNG'S PARAFFIN LIGHT AND MINERAL OIL COMPANY LIMITED (1864-70)

"No branch of industry has risen more rapidly in Scotland than the manufacture of oils and other products from native shales, nor has any been brought to such a high degree of perfection within an equal time."

David Bremner,
The Industries of Scotland,
Edinburgh, 1869, p. 482.

1. The Formation of the Company (1864-66)

Even before the personal tensions between Young, Binney and Meldrum could have become publicly known, there were rumours in the press that Young intended to form a limited liability company, after the patent and the partnership ended.[1] Binney had virtually retired already, and the dissolution of the partnership simply formalised his life as a rentier commuting between Manchester and the Isle of Man, which Angus Smith described.[2] However, it seems possible that it was Binney's lease of a Methil colliery in which the Pirnie Parrot coal seam was discovered that led to the foundation of the Methil Paraffin Oil Works in 1864 by Messrs. R. Carrick and Arnott. This works, situated on land owned by "Mr. Binney" at the northeast corner of Methil old harbour in Fife, made and refined oil, generally for local sale. In 1868 the firm failed, and a Mr. Binney carried on the business until 1870 when he

1. The Scotsman, 4 October 1864
2. R. Angus Smith, A Centenary of Science in Manchester, London 1883, p. 464.

gave it up as unprofitable.[1] Although Meldrum had talked earlier of retiring from business[2] - and had bought several farms in the Bathgate area by 1864 - in the event, he formed a new partnership with George Simpson, a coalmaster of Benhar.

Young's intentions must have been clear to his partners for he had shown his hand by beginning the new plant at Addiewell in the summer of 1864. Although Addiewell was better placed to exploit the shales of the Lothians than the Bathgate works, one result of the building of Addiewell was to increase Bathgate's integration value to Young but to devalue it for others. Much capital had already been committed, particularly to oil-works in the parish of Uphall, so that when the Bathgate works were auctioned in October,[3] 1864, the upset price was not reached. On 16 December,[4] 1864 the partners met again in the Royal Hotel in Edinburgh:

> "... After discussion and explanation between the partners, Messrs Meldrum & Binney offered to sell the whole works and Plant and subjects of every kind included in the Articles of Roup under which the subjects have already been offered for public sale ... to their partner Mr Young at the price of thirty eight thousand six hundred and eighty pounds ..."

This figure was calculated on the estimated break-up value of the Bathgate works, the value of additional improvements recently made, the purchase price of feu duties and half:

1. I.I. Redwood, A Practical Treatise on Mineral Oils and their By-Products ..., London 1897, p. 11 and p. 24.
2. Business Journal and Laboratory Notebook, 1856-61, 10 January and 12 April 1859
3. Morning Journal, 3 March 1866
4. Scottish Oils, MSS., Copy Minute of Meeting of the partners of E.W. Binney and Co. held at Edinburgh on 16 December 1864. This document (6 fo.) is the basis for much that follows.

"... of the difference between the above sum and the sum at which Messrs Meldrum & Binney have hitherto estimated the value of works ..."

Purchase Price

Break up Value	£23,180
Recent Improvements	4,500
Feu Duties	4,000
Half the difference etc.	7,000
Total	£38,680

From this it is reasonable to suppose that Young had been offered the works at about £45,000 and refused them. He also would not pay £38,680 "... but in order to get rid of the difficulties in the way of an amicable mode of winding up the concern ...", he offered £32,000. This offer was taken up by Meldrum and Binney, and this was the price paid by Young and not the generally stated price of £25,000.[1]

Entry was to be at 1 January, 1865, and the full price was due on 1 February, 1865 and was to bear an interest of 5% per annum from that date. On 10 February, 1866 Young made the entry in his pocket diary:

"	Meldrum	17744 - 16 - 2	1st April
	Binney	13152 - 15 - 2	7 June
		30897 - 11 - 4	..." [2]

and these mathematics clearly relate to the payment for E.W. Binney and Company. Payment was completed on 7 June, 1866.[3]

1. Ibid., and Morning Journal, 3 March 1866, gives price as £25,000
2. Pocket Diary, 10 February 1866
3. Ibid., 7 June 1866

Young was to allow the use of the works to his former partners for working up and purifying the oils in hand for two months and storage capacity, cooperage and loading facilities for six months from 31 December, 1864; he was to collect the outstanding debts of the Company and these were to be divided between the partners when £3,000 had been brought in.[1]

Naturally, we must expect that £32,000 did not represent the real value or even the purchase price of the Bathgate concern. In fact, Young's share in the co-partnery is not represented by any figure, and therefore, he paid £32,000 to buy out his partners. Nonetheless, he secured a bargain, which he was able to capitalise on later.

In 1865, while negotiations were proceeding between the main parties interested in the formation of a limited liability company, Young was busy improving his concern's position. On 22 April, 1865 he bought the farm of Inchcross with its mineral rights for £3,000 from Alexander Simpson, a Bathgate banker.[2] This, ten years later, he leased to his company - excluding the mineral rights - for £130 per annum on a ten-year lease.[3] On 16 August, 1865 Young leased from James McCall of Glasgow business premises in Bachelor's Walk, Dublin for a paraffin light station.[4]

1. Scottish Oils MSS., Copy Minute of Meeting ... 16 December 1864
2. Scottish Oils MSS., Copy Minute of Agreement between Simpson and Young, 22 April 1865
3. Scottish Oils MSS., Lease of Inchcross, 11 November 1875
4. Scottish Oils MSS., Indenture, 16 August 1865 between James McCall and James Young

The negotiations relating to the formation of the limited liability company are fortunately well documented. One can compare draft with final agreement.[1] There was no public appeal for subscribers and no advertisement by company prospectus. In Young's favourite fashion "... everything was done with quietness and privacy, and in a perfectly satisfactory manner ..."[2] It seems possible from remarks made by Young at a directors' meeting in 1868 that he was approached first by his fellow chief investors and that he did not seek them.[3] Whoever made the first approaches is relatively unimportant compared with the result of a number of informal meetings between the interested parties in Glasgow, Edinburgh and Manchester. On 28 and 29 December, 1865 the main parties met in the Clydesdale Bank's chambers and signed an agreement to purchase Young's assets on behalf of the future Company which was to be formed and registered under the terms of the 1862 Act.[4]

Under the first provision of this agreement Young agreed to sell the Bathgate sibe, with its buildings, machinery, horses and carts but not its casks nor its oil products, for £100,000.[5] Addiewell works with all its fixed assets was to be valued by accountants representing Young and the other

1. Account and Valuation Book, 1865-67, contains a Draft in the opening pages and a copy of the minute of agreement fastened to the back leaf.
2. Morning Journal, 3 March 1866
3. Pocket Diary, 1868, lead papers passim
4. Account and Valuation Book, 1865-67, Minute of Agreement ...
5. Minute of Agreement ... p. 3

three parties; Young was, then, to receive this price. In addition, he was to receive a feu duty of £8 per acre per annum to be reviewed every 19 years.[1] Transfer prices were fixed for all oil-products at Bathgate, Addiewell, Craignestock, and at the ten Paraffin Light stations scattered throughout Britain.[2]

Transfer of Stock : Agreed Price-List 1865-66

Item	Price
Brown Paraffin Wax	3d per lb.
White Paraffin Wax	6d per lb.
Refined Oil	1/6d per gallon
Unfinished Oil	2/- per gallon
Crude Oil	1/- per gallon

Source: Minute of Agreement ... 1865-66, pp. 4-5.

By the fourth provision, Young guaranteed that the oil-shale in the lands held by him, either as landlord or lessee, at Addiewell, Breichmill, Muirhall and Baads would produce a total of 30 million gallons of crude oil: 9 million gallons from Muirhall and Breichmill; the rest was to come from Addiewell and Baads or, if need be, from the estates of Polbeth and Limefield. For this facility, Young was to receive fixed lordships and rents.[3] Later provisions fixed the legal details, arranging the assignment of the necessary leases of land and business premises. Mining leases on Young's estates at Polbeth and Limefield were fixed at £1 per acre per annum for 28 years or, if Young thought desirable, for a royalty of

1. Ibid., p. 4.
2. Ibid., pp. 4-5
3. Ibid., p. 5.

6d per ton of shale raised and 1d per gallon of crude oil made. These leases were to be worked as soon as other shale reserves had been exhausted.[1]

The eighth provision arranged for the sale of the fittings and the good-will of Young's business for £150,000 - Young's trade-marks were included in the business's good-will - and from this sum it was left to him to recompense Alexander Kirk for his joint-patent for the refrigerator.[2] Young agreed that he would not join nor would he promote any other oil company, except in the United States where his American patent had been renewed for seven years from 7 October, 1864;[3] nor was he to offer land or leases of minerals within twenty miles of the Bathgate-Addiewell complex to others.[4] He was also to provide any land required for works extension at Bathgate and Addiewell up to a limit of 50 acres at £8 per acre feu duty, per annum, this obligation not to extend beyond 15 years. Similarly, land for access roads to workings and extensions was to be provided without payment of way-leaves.[5]

Several provisions related to mining and mineral rights. Young's friends, David Landale and James Napier, were to estimate for all parties how much coal and shale there was in the land owned or leased by Young. Young was not to be responsible[6]

1. Ibid., pp. 5-7
2. Ibid., p. 7 and p. 10
3. Scottish Oils, MSS., Opinion of John L. Hayes on Extending Young's patent ... Edinburgh 1865; M.S. Report by B.S. Hedrick on Young's Patent, 3 October 1864.
4. Minute of Agreement ... p. 8
5. Ibid., pp. 8-9. In Scottish Oils, MSS., there is one lease between Young and another Oil Company, the West Calder Mineral Oil Company. Copy of Lease of the farm of Langside, 3 January 1876.
6. Minute of Agreement ... pp. 7-8

for mining costs nor for any structural changes in mining plant. The purchasers did not agree to mine deeper than 110 fathoms nor to work shale which yielded less than 1 gallon of crude oil per hundredweight. Young was free to work any shales rejected on these or other grounds.[1]

The continuity of the business was to be maintained. Contracts and agreements, entered into by Young before the transfer, were to be honoured by the new company. Debts due to Young were to be collected without charge and paid into his account. The liabilities of his business up to 31 December, 1865 were to be met by him just as he was to receive any moneys due to it. Settlement of purchase costs was arranged by paying Young £50,000 in cash on 2 January, 1866 and £50,000 every six months from 31 December, 1866, until the price was paid. On outstanding sums 5% compound interest was to be paid to Young, and bills were to be assigned to him for the outstanding amounts. Until these bills were redeemed, dividends on the new company's trading operations were to be limited to 5% per annum.[2]

Disputes between the signatories were to be settled by arbitration, a wise, albeit ineffectual, precaution.[3] Young agreed to provide satisfactory evidence that the profits at Bathgate over the period 1861-64 had averaged £57,000 per

1. Ibid., p. 9
2. Ibid., pp. 9-10
3. Ibid., p. 11

annum, and that his ten paraffin light stations had netted £12,000 in the year ending 29 April, 1865.[1] To ensure executive stability and to avoid the effects of speculative mania, it was agreed that during the first four years of its existence, none of the directors should sell any of his shares in the new company.[2] On 4 January, 1866 the new company had been registered as Young's Paraffin Light and Mineral Oil Company, Limited; on the following day a memorandum was added to the agreement making it a final settlement signed by Young and five of the new directors.[3]

There is a fairly clear evidence that Young had bought well. In December, 1865, David Landale, accompanied by James Napier, surveyed the mineral reserves and estimated that Young controlled 5,659,200 tons of shale and 2,001,000 tons of cannel and other coals in the Addiewell area.[4] This estimate was later revised by James McCreath, a Glasgow mining engineer, on 26 January, 1867, acting on the directors' instructions. By then, information from borings and sinkings not open to Landale was available. During these mining operations a seam of "Thick Shale" had been struck, and this proved to be so valuable a raw material that proposals to mine other shales were shelved. The Thick Shale seam had a greater extent in the properties of Polbeth and Limefield than Landale had imagined. McCreath was highly impressed with the commercial possibilities of this seam:

1. Ibid.
2. Ibid., p. 11
3. Ibid., p. 12
4. Account and Valuation Book, 1865-67, Report of David Landale, 30 December 1865

"... So far as I have been able to learn in the visits which I have had occasion to make to almost all the principal fields hitherto opened up in the Country it is superior to any other yet found in other localities. So long as the Company's works can be supplied from this seam from the present fields or adjoining fields which may be leased it would be more profitable to work it paying Lordship than the other seams mentioned ..."

Varying from 2 feet 3 inches to 2 feet 9 inches this Thick Shale seam contained at least 12 years supply at the rate of 170,000 tons per year. On the other hand, the Dam Shale seam at Addiewell which had promised so well before mining actually began, was not so valuable, especially "... in the present state of depression and uncertainty in the oil trade ..." But overall, the total assets of the best shale amounted to £209,986. 3. 6d. at the depressed rates of early 1867, and, assuming a 5% compound interest charge, working over fifteen years shale worth exploiting was valued at £142,474. 14. 9d. a year, if markets could be found for its products.[1]

Because 1866 turned out to be a bad trading year for this new company, there was considerable bickering about the price of the assets transferred by Young for which no exact valuation had been agreed. This embittered directors' meetings and poisoned relations in the Works Committee, a Board sub-committee concerned with the completion of the Addiewell project.

1. Ibid., "Report on the Mineral Fields leased or belonging to Young's Paraffin Light and Mineral Oil Company by James McCreath ... 26 January, 1867".

2. Bathgate and Addiewell: An Integrated Industrial Complex

Because it was rapidly growing in the 1860s, the shale oil industry attracted considerable public attention, especially in the Scottish press. Fortunately, this has the advantage of leaving permanent contemporary impressions of Young's Paraffin Light and Mineral Oil Company and of the great topographical change in the Broxburn-West Calder area of the Lothians, apparent by 1866:

> "... this new manufacture has taken firm hold at all the places just named, for we perceive lofty chimneys and great volumes of smoke, and retorts, and greasy oil casks ..." [1]

The same observer, later, remarked upon his first sight of the Bathgate works from the train: "... we see half a mile or so to the left some fifteen or twenty massive chimneys belching forth their smoke ..." [2]

Most people who visited Bathgate and Addiewell noticed a prime difference in layout between the two. Although it was not without rational organisation, there were many signs of ex tempore improvisation at Bathgate. The process was, nonetheless, continuous. First, the shale or cannel coal went by conveyor to the crushing mill which subjected these blocks to 30 tons pressure. The broken coal and dust fell from the crusher to the floor below where it was sprayed constantly with water to safeguard the workers from chest and lung diseases.

1. The Daily Review, 13 March 1866
2. Ibid.

These unskilled labourers shovelled the prepared raw material into barrows which were raised by machinery to an elevated platform running at the same height as the hoppers on the necks of the retorts. From the barrows the coal and shale was emptied into these hoppers by more unskilled labourers. Beneath these hoppers, arranged vertically in benches of four were the retorts, ten to twelve feet long, each bench being heated by one furnace. A retortman at Bathgate was in charge of each bench and its firing; by continuous distillation each retort consumed 15 cwt. of coal or shale every twenty four hours.[1] Total available capacity early in 1866 at Bathgate and Addiewell was not far short of 500 retorts but generally, more than a hundred were either standbys or in need of repair.[2]

The gas given off by the process was stored in gas-holders for lighting the works. The waste ash was piled in bings which had already by 1866 spread over several acres. The crude oil ran off into an underground tank holding 40,000 to 50,000 gallons. From this underground tank the crude was pumped into 70 malleable iron refining stills, each weighing 5 tons and holding 700 gallons. This development of storage and refining capacity at Bathgate was a prelude to its specialisation as a refinery in the 70s - and also it provided the company with a factor for stability in bad trading circumstances.

1. Ibid.
2. The industrial correspondent of the Morning Journal, 17 February 1866, estimated the number of retorts in production at between 250 and 300, but this was certainly low.

In these stills distillation proceeded, using superheated steam, until a black shining coke was left instead of oil. Since this coke residue (3-7% of the crude oil) was almost entirely pure carbon it was very valuable as a fuel, often bringing as much as £1 a ton. Removing the coke from the stills was essential to the success of later refining, but the labour costs for this part of the process must have been quite high, since the workmen had to climb into the stills and remove the coke with hand-picks.

This "once-run" oil was run into more storage tanks and refined according to demand. Tanking space for this oil, therefore, had to be great: there were six small tanks holding 60,000 gallons each; there were seven larger tanks holding 117,000 gallons each; and there was a monster tank holding 140,000 gallons. From these storage tanks, the "once-run" oil passed to be refined with sulphuric acid and then caustic soda. Both these refining agents were produced in bulk at Bathgate. Eventually, four commercial products resulted: volatile naphtha or turpentine substitute of specific gravity 0.750, burning oil of specific gravity 0.825, the heavier lubricating oil and also crude paraffin wax.[1]

1. Ibid., c.f. also Glasgow Morning Journal, 17 February 1866, which from the style and wording was probably written by David Bremner, the celebrated author of The Industries of Scotland: Their Rise, Progress and Present Condition, Edinburgh, 1869.

One of the most impressive features of the Bathgate works was Kirk's refrigerator. This came into play after the heavy lubricating oil had been drained from the crude paraffin wax through heavy sacks, and the sacks had been subject in the paraffin house, to pressure from powerful hydraulic presses to express the liquid oil not previously drained off. The crude paraffin wax was cooled and solidified by this refrigerator ready for purification. Upon all these operations about 500 men were employed; many of them were formerly handloom weavers in Bathgate living a hand-to-mouth existence.[1]

Situated about five miles from Bathgate was the new incomplete works of West Calder or Addiewell. In the spring of 1866 the cart roads and railways were still being built, although the private telegraph line from Young's residence at Limefield via the Addiewell and Bathgate Offices to the public system was already operational. Great numbers of skilled and unskilled constructional workers had been attracted into this boom area. They were building cart-roads from the shale mines to rail-heads; they were constructing the railway branch lines from the pits to the two public systems, the North British and the Caledonian railways; they were connecting Bathgate and Addiewell. By 5 February, 1866 locomotives could run through to Bathgate.[2]

1. Morning Journal, 17 February 1866
2. Pocket Diary, 1866, 5 February 1866

By the end of February there were already four shale pits working;[1] by an unspecified date in May, 1866 three drift mines and nine pits were open, and two promising seams of "Thick Shale" had been struck at 8 and 11 fathoms respectively;[2] by 21 November, 74,007 tons of shale had been mined, mostly from Breichmill, and over 15,000 tons of cannel coal.[3] The area owned and leased by the Company from Young amounted to between four and five thousand acres, and in addition to raw materials for oil production, it was rich in furnace coal, fire-clay and limestone; it was sometimes good farming land; where it was poor land it could still be used for house-building. Thus, there was the ideal basis for an integrated industrial unit of great size.

The arrangement of the means of production at Addiewell had clearly benefited from Young's experience gained at Bathgate. John Scott of Inverkeithing had supplied the shale crushers and they were so installed that the broken raw material fell into waggons through a hopper without requiring any manual labour. The rail-road from the shale-crushers ran on a slight downward gradient so that any haulage would be of empty waggons. The retorts served by these waggons were, in March, 1866, set in a long bench of 144 in multiples of three for furnace-heating, each retort man having control of six retorts; according to Young's diary, these 144 retorts were

1. Morning Journal, 3 March 1866
2. Account and Valuation Book, 1865-67, "Assessment of pits, May, 1866"
3. Ibid., "Memo. of output at pits to 21 November, 1866"

all in action by 5 February, 1866.[1] Two and a quarter miles of 4" cast-iron tubing acting as condensers connected these retorts to two underground tanks holding 12,000 gallons each. From the storage tanks the crude oil could be pumped into 16 2,000 gallon malleable iron stills already fully erected and ready. The "once-run" oil was to be finally refined at Bathgate, where it was to be sent in tank waggons holding 1,500 gallons - these mobile tanks were not seen elsewhere in Scotland. Only the wheels and the frames of these tank waggons had been bought for the bodywork was made in the boiler shop at Addiewell.

Ultimately, it was intended to erect retorts at Polbeth close to the new shale pits and to transport the crude oil in tank waggons to the stills. This would have the advantage of increasing the specialisation of production, enabling both the Bathgate and Addiewell plants to concentrate upon refining. This would reduce costs by transporting the liquid products instead of the bulkier raw materials and help to reduce storage problems by disposing of the main effluents away from the chief plants. This general intention made it necessary to build a number of additional refining stills at Addiewell. There were fifteen refining stills of malleable iron, each holding 4,000 gallons but not in use at the time of this visit in March, 1866; these had been made by the Company's machine shops - and it was intended to make others. Sunk into the

1. Pocket Diary, 1866, 5 February 1866

ground ten to twelve feet were 19 storage tanks holding 15,000 gallons each, placed to take the flow from the refining stills and isolated to reduce the damage of widening fires. It was also intended to build 8 or 9 large storage tanks to hold thousands of gallons of finished oil.

Although unfinished in March, 1866, one of the most conspicuous buildings was the oil refinery at Addiewell; it was four hundred feet long and eight feet wide and divided into three sections by a centrally placed engine house cut off from the two production units by fire-proof gables. The engine house contained one of Norman's 20 H.P. steam engines, already erected. Each production unit housed 100 large cast-iron vessels, some having a capacity of 1,000 gallons, others of 2,000 gallons. These had been made by a Glasgow firm of iron-founders.

For the paraffin house two of Kirk's refrigerators had been ordered from Messrs. Norman and Company. A small refrigerator of this type cost between £800 and £900 but could make up to 3 tons of ice in 24 hours. No wonder that Kirk's machine was in demand from the tropics as an ice-maker now that one of the Midland breweries had agreed to try it. Kirk, in fact, was the general engineer for both Bathgate and Addiewell, being generally at Addiewell during this planning and construction phase.

Apart from the significance as a growth point of a new plant like Addiewell, with Bathgate plant it represented a co-ordinated attempt at economic integration. There was a large

smith's shop, a large engineering and fitting shop, a turning shop with boring, planing and punching machines, a boiler-making shop which could and did turn its hand to malleable iron tank making. It was also intended to establish a large cooperage so that more manageable containers for commercial use could be manufactured. With its facilities for the production of oils, paraffin, and chemicals, this unit was virtually self-sufficient when the Addiewell plant was finished. Office and laboratory staff, draughtsmen and managerial employees at Addiewell were housed in temporary wooden sheds awaiting their turn for permanent accommodation in this vast complex.

Such a great new industrial enterprise had to recruit, train and retain, its labour force. There was no suitable accommodation as there had been when Young and his partners had first begun at Bathgate. West Calder, the nearest village, could not house a vast industrial army without extensive new buildings. In fact, a new village had to be built. From the bed of clay and fireclay on the site at Addiewell the main raw materials came. A brickfield was begun and a highly mechanised brickworks built. One hundred and twenty new houses were built in the existing nucleus of West Calder; by March, 1866 contracts had been placed for 300 more on land nearer the works; thus arose the new village of Addiewell.[1]

1. Morning Journal, 3 March 1866

As time passed Addiewell village and works became more and more complete, and the industrial organisation of Bathgate and Addiewell became unitary. But Addiewell it was that caught the imagination of men like David Bremner who visited it in 1868. When he was writing his magnum opus on Scottish industry in 1869, he clearly regarded Bathgate as a monument to industrial archaeology:

> "... From a distance, the establishment had the appearance of a village of irregularly built grimy houses. A nearer view reveals a series of broad thoroughfares lined with retorts, stills, boilers, tanks, & c., some under iron roofs, and other exposed to the weather ..." 1

But in 1868, Bathgate plant alone was still much more effective than many other Scottish oil companies.

On the other hand, Addiewell works amazed him by its general scale; it occupied a seventy acre site, one third of which was covered by buildings, tanks and condensers. Rather than one works it reminded Bremner of a whole series of factories.

> "... The system of iron pipes which passes overhead, beneath the feet, and crops up in all quarters, would be sufficient, one would think to carry the gas and water supply of a large town. The retort sheds, taken together, are upwards of 200 yards in length, and each contains a double row of retorts. The main pipe which collects the vapour from the retorts and conducts it to the condensers is nearly a yard in diameter. The condensers are on a like gigantic scale, each containing several miles of piping ..." 2

1. D. Bremner, op. cit., p. 486. The earliest extant map of the Bathgate works dates from 1868 and does not substantiate Bremner's concept of irregularity. There was clearly method in Bathgate's organisation, but, perhaps, it appeared to have less uniformity than Addiewell.
2. Ibid., p. 489

Apart from the standard commercial products, already discussed, three others had been added, two by design and the third by a fortunate accident. A small candle-making department was started on 9th April, 1866 on a budget of £2,000, although each of the 24 machines would cost £40.[1] This was a practical application of the earlier experiments with paraffin shapes and candles in the laboratory at Bathgate, and more recent experiments by Young himself and Walker, one of the staff at Edinburgh Paraffin Light station, who made candles as good, so Young believed, as those sold by Fields.[2] The cold Addiewell water - Young found it to be generally 46^{o} F - helped the manufacture, since one of the obstacles to using paraffin wax was getting the candles to leave the moulds without breaking.[3] This was solved by using a little strearine; and full-scale production began on 23 April, 1866.[4] The following week, showing his friend, Dr. Robert Angus Smith, round the candle-making department, Young was struck in the face by the handle of a candle machine. He was badly cut and did not attend the next meeting of the Directors "... on account of black eyes ..."[5]

The second commercial project concerned the supply of gas to Bathgate which Young favoured so much that he was prepared to finance the venture personally. However, this was not necessary for a sum of £700 was allocated to it at the Direc-

1. Pocket Diary, 1866, 8-9 April 1866; also Account and Valuation Book, 1865-67, "Candle Manufacture"
2. Vide infra., pp. 140-141
3. Pocket Diary, 1866, 31 January 1866; c.f. also Ibid., 8 March 1866 et. seq.
4. Ibid., 19 April 1866
5. Ibid., 22-23 April 1866
6. Ibid., 28 May - 1 June 1866

tors' meeting on 6 April, 1866.[1] By 1869, this project was well established, and the people of West Calder were considering lighting "... their new rapidly increasing village with gas from Addiewell ..." One and a quarter million cubic feet of gas was being made every day at Addiewell, and from December, 1867 Young had been trying to sell it to the Edinburgh Gas Committees; in 1869 the Company were offering it to Edinburgh at 1/6d per thousand cubic feet.[2] By 1872 plans were afoot for lighting Addiewell village from the gas produced at Addiewell works; it was expected that in nine years the Company would recover more than the total cost of the installation.[3]

The third product resulted from the accidental discovery, probably by Robert Bell, that the shale, when distilled, gave off water containing a trace of ammonia - there was much less in cannel coal. In 1865 Bell was summoned by the River Commissioners for polluting a small stream with retort water effluent - all the oil-works disposed of this effluent in this manner. Bell, to avoid expensive litigation, turned the effluent into a field instead of into the stream and later noticed how quickly the grass grew. This led him to investigate the chemical nature of the retort water effluent and from these investigations the manufacture of sulphate of ammonia as a by-product began in May 1865.[4] According to Young's

1. Ibid., 6 April 1866
2. Pocket Diary, 1867, 11 December 1867; D. Bremner, op. cit., p. 490
3. Scottish Oils MSS., Letter Copybook 1872, R. Scott to Secretary of Company, 1 February 1872
4. I.I. Redwood, Mineral Oils and their By- Products, London, 1897, pp. 169-170

calculations made on 29 April, 1866 11 gallons of this retort water produced 1 lb. of sulphate of ammonia.[1] This was made by adding sulphuric acid to the water and then evaporating the liquid until sulphate of ammonia was precipitated. By 1868 it had become an important product - it was a cheap substitute for guano - with a growing demand from farmers.[2] By 1869 Bremner commented on the price of £16. 10. 0d. per ton,[3] but little did he know that this fortunate accident was to be the later saviour of the Scottish oil-shale industry from the dissolution threatened by the world's petroleum industry.

By late 1869 when Young retired, Bathgate and Addiewell were the largest employers of labour in the Lothians. Out of a total of 3,000 people estimated, conservatively, by Bremner to be employed in the oil-works, Young's Paraffin Light and Mineral Oil Company employed one third.[4] In addition, the shalemines owned by the Company employed 400 miners in 1872, and a network of branch railway lines stretched from Bathgate to Addiewell and diffused to the pits. Five locomotives were owned by the Company and these were regularly employed in the transit of minerals.[5] Total real capacity for the distillation of crude oil by 1869 was just over 600 retorts, 354 at Addiewell and 250 at Bathgate.[6] In 1872 the capacity of Addiewell

1. Small Notebook, 1866, 29 April 1866
2. Geological Survey Memoirs: The Oil Shales of the Lothians, 1927, p. 255
3. D. Bremner, op. cit., p. 489
4. Ibid., pp. 489-490
5. J.S. Jeans, Western Worthies, 1880, p. 66
6. Ibid., Morning Journal, 17 February 1866

alone was estimated at 3,000 tons of shale per week or 120,000 gallons of crude oil from which 50,000 to 60,000 gallons of burning oil could be obtained, 12 tons of paraffin wax and an unspecified large quantity of lubricating oil. The effective operation of this industrial complex depended upon many factors varying from the quality of the Board of Directors to the state of the market.

1. J.S. Jeans, op. cit., p. 66

TABLE 22

ANALYSIS OF SHAREHOLDERS BY HOLDINGS, 1868-69

Number of shares held	Number of Share-holders	Nominal Value of Shares held
5	2	1,000
9	1	900
10	13	13,000
13	1	1,300
15	4	6,000
18	1	1,800
20	13	26,000
25	4	10,000
30	4	12,000
40	1	4,000
45	1	4,500
50	13	65,000
60	3	18,000
75	1	7,500
100	4	40,000
150	1	15,000
200	3	60,000
250	2	50,000
500	1	50,000
750	1	75,000
1,000	1	100,000
TOTALS 5,600	75	£ 560,000

3. Operations of the Company (1866-70)

a. Ownership of the Capital

Few details of the capital structure and ownership of the Company are available before 1868. A return[1] made to the House of Commons regarding Joint Stock Companies in 1866 gives very brief details of Young's Paraffin Light and Mineral Oil Company. Seven people had signed the memorandum of association and taken up 1,850 shares between them. These 1,850 shares were all that had been taken up of a total of 6,000 representing a nominal capital of £600,000.

However, a complete list of shareholders was returned to the County Assessors of Linlithgowshire in 1868 and printed by them in the Valuation Roll for 1868-69.[2] A full list is given in the Appendix, but the accompanying tables analysing shareholders by holdings and residence give some indication of the ownership of the capital. Seventy five shareholders held 5,600 shares of a nominal value of £560,000. But control of the company rested firmly with those holding 100 shares or more: thirteen shareholders controlled 3,900 shares, and 2,700 of these were held by five people. James Young had taken 1,000, his son, James, 500, his wife Mary Ann, 100, and his daughter, Annette, 50, making a family holding of 1,650 shares or 29.46% of the total share capital. To this family holding Young could reasonably expect to add the voting power of the shares of Alexander Moore, his accountant, of his

1. House of Commons Return regarding Joint Stock Companies, Parliamentary Paper No. 420, 20 July 1866
2. Valuation Roll for the County of Linlithgow, 1868-69, p. 31

friends Lyon Playfair, Robert Angus Smith, Hugh Bartholomew, A.G. Kidston, Secretary of the Andersonian University and of his former preceptor, Thomas Graham, and Graham's brother, John. Finally, he could probably count on his intellectual acquaintances, Robert Christison formerly of the University of Edinburgh and Professor A.W. Williamson, of University College, London. These together held another 530 shares, which, added to Young's family holding, accounted for 39% of the total share capital. Since all the other directors could only muster 1,850 shares or 33% of the total share capital, even in the unlikely event of their united opposition to Young and his associates, he still was likely to have the support of a controlling interest. But the margin was very narrow and likely to be the occasion for acrimonious disputes in times of exceptional stress for the Company. Otherwise, the Directors certainly controlled the Company.

TABLE 23

DIRECTORS' HOLDING, 1868-69. (Excluding Young and his family)

Name	Shareholding	
John Pender	750	
John Orr Ewing	250	
John Moffat	250	Total
James Arthur	200	1,850
W.G. Simpson	200	
John Fleming	200	
Lyon Playfair	150	
Hugh Bartholomew	100	

After considering the investors by their normal residence returned to the County Assessors for Linlithgowshire, Table.

TABLE 24

SHAREHOLDERS BY RESIDENCE

Normal Residence	Number of Shareholders
Glasgow	38
Paisley	6
Hamilton	2
Alexandria	2
Helensburgh	1
Ardrossan	1
Edinburgh	7
Selkirk	1
West Calder	4
Manchester	3
London	9
Kent	1

No. 24 was drawn up indicating their predominantly Scottish nature, and this does not take into account emigré Scots and those investors who owned property in Scotland but normally lived in England.

b. Relationship within the Board of Directors

If the structure of ownership of the share capital was a possible source of conflict within the Board of Directors, there were other and probably more significant causes of dispute. First, James Young found it difficult to adjust to the personal relationships imposed upon him by the company structure. By temperament, he was inclined to take violent likes and dislikes to people, and this led him often to attempt either a bull-dozing tactic or by contrast a sullen taciturn passivity when faced with opposition within the Board. Both these moods he records in his diaries. Neither did he care for the delay and discussion which government by executive committee often necessitated. Convinced himself that a certain objective was desirable, he often lacked the patience or finesse to persuade others and once he had good grounds for disliking a colleague on the Board, he consistently maintained an unforgiving attitude, which despite its moral rectitude was not likely to be conducive to business efficiency.

Personal acrimony within the Board could not be avoided, because no matter how well the business was managed trading circumstances were bad in the opening years of the Company's operations. This embittered discussions about the value of

Young's assets transferred to the Company and slowed down the completion of Addiewell.

From the beginning of 1866 Young's particular enemy was John Moffat. They disagreed first about the question of housing the Company's workers. Moffat wanted to pare down costs by jerry-building which Young resisted. However, Moffat was so strong a character that other members of the Board tended to defer to him, particularly since he seemed to be reducing their secondary costs. Young was incensed by what he considered to be the poor economics of jerry-building and by Moffat's failure to recognise the urgency of the problem:

> "... Meeting of works com. Playfair & Bartholomew there but not Moffat so we got nothing of his plans for cheap hous es which he promised all we could do was to fix on sites ..." [1]

Young was even more exasperated when Moffat turned up at the next meeting of the Directors with a sketch ground-plan of a cottage which he refused to leave with Young.[2]

Even allowing for Young's personal failings, we must recognise that his position as general manager was not made any easier by Moffat's attitude. Young, it was, who had to tackle the practical problem of recruiting and retaining a large labour force for an inaccessible site in wintry conditions without accommodation. Clearly, he had good grounds

1. Pocket Diary, 1866, 1 January 1866
2. Ibid., 11 January 1866

for his annoyance, especially since four days later, Moffat, under pressure from Young, still could not supply the plans for his cheap cottages.[1] The following day, 16 January 1866, Young arranged for Mr. Thomson, the architect, to meet the Board. Young then received two plans of cottages from Mr. Moffat, both saving the cost of slating by using roofing felt. Neither Thomson nor Young liked this, and Thomson conveniently provided Young with the best line upon which to attack Moffat: "... he said the felt roof was as dear in six years as Slate and not near so good ..."[2] By 1 February, 1866 Young and Thomson had settled that the cottages were to be built in Addiewell according to the specifications previously used in West Calder.[3] The following day, this particular episode came to an end with Young getting his own way at the Board meeting and quietly teasing Moffat into such a rage that he had to admit defeat "... by talking of something else ..."[4]

There were other, more important, occasions for mutual irritation. On 18 January, 1866 Young recorded that he had "... a very disagreeable meeting ..." with the other Directors, mainly because Moffat complained that the transfer of Young's assets had been so arranged that the amount of oil on hand had been carefully concealed. There was considerable disagreement about the value of Young's assets to the Company, and Moffat was certainly voicing more opinions than his own.

1. Ibid., 15 January 1866
2. Ibid., 19 January 1866
3. Ibid., 1 February 1866
4. Ibid., 2 February 1866

John Pender did not attend this meeting but he sent a letter in which he stated that he would make no further payment on his shares, the second largest holding after Young's until the transfer of Young's assets had been completed.[1]

As trading circumstances prevailed in 1866 the oil-shale industry faced a great recession which as time passed was likely to reduce the value of Young's assets. If they were transferred as rapidly as Pender deemed necessary, the company was likely to be over-capitalised, since the transfer of Young's assets was the material basis for the issue of share capital. This, in fact, occurred, but neither Young nor his fellow-directors could foresee it. Moffat and Pender was justifably alarmed about the amount of oil on hand which, they recognised, could fluctuate greatly in price. Young had a vested interest in overcapitalising the Company, since this raised his own returns; on the other hand, Pender and Moffat stood to gain with all the other shareholders if the Company gained Young's assets for much less than their market value.

Thus, there was room for mutual recrimination, and little opportunity for this seems to have been lost. Young believed that Pender and Moffat were attempting to withdraw from a section of their earlier agreement. He was reinforced in this opinion when he discovered that the valuation of the oil and paraffin wax at Bathgate had been written up but not,

1. Ibid., 18 January 1866

in fact, completed.[1] On 25 January, 1866 the Board met and appointed a committee of Bartholomew, Arthur and King to meet Young on the 26th to settle the differences about the transfer of stock.[2] Young had clearly indicated how affronted he was by attempts to write down the value of his assets.

When he met the committee on 26 January, 1866 they discussed the dispute for four hours. At last Young agreed to let the stock at Bathgate pass to the Company for the round sum of £100,000. Since the valuation of Bathgate's stock showed £113,443 and, in addition, a possible loss to Young of £1,200 on lamps, Young expected that there would be no further argument about stock or the valuation of casks and he insisted that "... questions about the agreement were taken in the plain meaning and that Addiewell was taken as shewn by the books without question ..." But Young's suspicions were not entirely allayed by the committee's acceptance of his enunciated conditions: "... a rather strange thing took place the committee were to report but they settled the question who gave them that power? Moffat eh?"

Young feared the clique operating on, and outside, the Board - and it was not merely an example of persecution mania; he felt he had been subject to sharp business practice:

> "... as it now stands they have got excess in the three main things in the shale more than five times the oil agreed to in deed in profitts a third more in the stock £13,443 more and the lamps at their own price ..."

1. Ibid., 22 January 1866
2. Ibid., 25 January 1866

It was at this meeting that Arthur suggested that Young should accept £450,000 for the whole business. This was, in fact, the price finally agreed on, but Young's impression was that he had not done particularly well out of the deal:

> "... As the matter is now settled they have got the stock at about the price that we are now paying for the coals that would produce it so that all the other expenses of production they have got for nothing ..." [1]

He might have been more cheerful, had he realised what a disasterous year 1866 was to be. As it was, both sides ultimately felt they had lost, although Young certainly gained.

The following Monday, 29 January, 1866, the Board met and endorsed the committee's decisions in a flow of compliments amid a jolly atmosphere entirely wasted on Young "... they came out in soft soder dodge and all was confirmed ..." He felt that their report "... which they wished me to understand was a compliment to me ..." was really intended to pin him down about costs of production from the shales which he had leased to the Company.[2]

Moffat, then, wanted to know what Addiewell would cost to finish. Apparently, he had been chivvying Kirk, the resident engineer, and received a short, vague answer. He had also indicated to Lyon Playfair that Young's capacity to supervise the building of the works was in some doubt, that there seemed to be little method in the priority of buildings:

1. Ibid., 26 January 1866. The figures for the valuation of Bathgate are also given in the Account and Valuation Book, 1865-67
2. Pocket Diary, 1866, 29 January 1866

the works were based on one simple principle "... a brick here and a brick there ..." When Playfair leaked Moffat's sarcasm back to Young, this did not help relationships within the Board. Nor[1] on 5 February, 1866 did Kirk's giving two months notice "... he spoke strongly against Moffat but gave no particular reason for leaving ..." That same evening Young travelled into Edinburgh to meet Playfair, who allowed Young to read a letter from Moffat in which Moffat spoke disparagingly of Young's managerial capacities:

> "... Moffat talks of me being a bad or dear Manager of a work. Something about the directors feeling so. Who the directors are that feel so he does not say. from the letter I conclude that Moffat wants to be manager of the works as he is now manager of the directors (got copy of letter from Playfair ..." [2]

On the morning of 22 February, 1866 Young met Arthur, King and Readman, the latter a new director, in Arthur's warehouse in Glasgow; Young attempted to safeguard his position by stating that he thought it wrong to meet in such an irregular fashion, but they explained that they were seeking his advice before the meeting of the Board. The directors met at 2 o'clock the same afternoon. Kirk was present and reported that he thought it would cost a further £70,000 for retorts to make four million gallons of finished oil per annum in the the two works, and £30,000 for buildings. "Moffat was as usual nasty"[3], and grumbled about the expense.

1. Ibid., 2 February 1866
2. Ibid., 5 February 1866
3. Ibid., 22 February 1866

At the Board meeting on 8 March, 1866 the question of replacing Kirk arose. Young tried to explain his new arrangement of managerial responsibilities; he intended to bring James Napier from Bathgate to Addiewell to leave his son James in charge at Bathgate and personally to supervise the completion of Addiewell. Before he could get beyond the first point, Moffat intemupted him and attacked his choice of Napier "... Napier might be a Chemist but they wanted some one to build a work ..." Young's reaction was predictable "... I felt annoyed at the fault finding before I got my plan told so I said nothing more about it ..." Ominously, Readman paved the way for Moffat by hinting about the need for a general manager for the business, but Young's silence on this point was more astute than predictable.[1]

By the next Board meeting on 16 March, 1866 peace had been temporarily restored. Young laconically recorded, "... a little sense talked for the first time ..."[2] When on 22 March, 1866 the question of a successor to Kirk again arose, Moffat refused to allow Young to finish a sentence:

> "... When I talked my way I was interupted by Moffat it seemed as if nothing I can propose would do I talked of taking James over to Addiewell but that was interupted what the game is I dont quite see ..."[3]

Such moments of mystification were bound to occur to all the members of the Board, depending upon which clique they joined and what moves were afoot outside the Boardroom.

1. Ibid., 8 March 1866
2. Ibid., 16 March 1866
3. Ibid., 22 March 1866

ENROLMENTS[1] (1858-1883)

1870/1	1871/2	1872/3	1873/4	1874/5	1875/6	1876/7	1877/8	1882/3
2640	2214	2506	2499	2275	2230	2059	1939	2600
+ 199	- 426[3]	+ 292	- 7	- 224	- 45	- 181	- 110	+ 661[4]

In April, 1866 Young's attempts to capitalise on complementary products were delayed by Moffat. He only secured the Board's support for selling gas to Bathgate and for a candle-making Department at Addiewell after considerable opposition.[1] On 15 May, 1866 Young went to Glasgow to get estimates for additional retorts and he happened to meet Readman and Orr Ewing in the Clydesdale Bank. Readman revealed that Moffat had been proposing, because of the prevailing high rate of interest, to stop the ordering of retorts for the moment. Forewarned, Young was able to scotch this proposal.[2]

At intervals Young continued to complain about Moffat's machinations inside and outside the Boardroom, but, unfortunately, his pocket diaries for 1867 and 1868 are rarely more than appointment books, and, thus, the running commentary available for early 1866 is lacking for the later period. On 7 May, 1867 he notes that at the Board meeting "... every thing proposed jamed by Moffat ..."[3] on 23 May, 1867 in Glasgow, they "... got through some work Moffat being absent ..."[4] At the next meeting on 6 June, 1867, Moffat was again absent, "... so all quiet and business done ..."[5] On 10 January, 1868 Moffat and Young were for the first time in agreement; both opposed the idea of giving the North British Railway Company all their business.[6]

1. Ibid., 6 April 1866
2. Ibid., 15 and 18 May 1866
3. Pocket Diary 1867, 7 May 1867
4. Ibid., 23 May 1867
5. Ibid., 6 June 1867
6. Pocket Diary 1868, 10 January 1868

But this rare example of agreement was not typical of 1868. The failure of the Company to produce vast profits led to general accusations that Young had misrepresented the profit potential of the business during the negotiations involving the transfer of his assets and thereby perpetrated a fraud. This he hotly denied. It is exceedingly doubtful whether such an occasion would have arisen but for the adverse trading circumstances operating until the end of 1867. Young prepared notes for a speech clearing himself on the lead papers of his pocket diary for 1868 but, unfortunately, no definite date can be ascribed to this nor to the copy of his letter to Orr-Ewing, the chairman of the Board, asking for a public retraction of the accusations "... this is an imputation I cannot & will not lie under ..." As trading circumstancesimproved, and Young himself proved ready to make concessions, relations within the Board improved. By this time Young's son, James, was recognised as joint-general manager with Young himself, and the question of the succession when Young felt ready to retire was not in real doubt.

Moffat's back-biting techniques did not entirely disappear. On 15 October, 1868, when Young arrived at the Board meeting, Moffat was in the Chair and attempting from this elevated position to embarrass Young. He was pretending to believe that Young had told them that the works would make four mill-

1. Draft M.S. Letter, Young to Chairman of Paraffin Light Company, (5 fo.) no date but almost certainly 1868.

ion gallons of burning oil - and not of all finished oils - a year. Young retorted that he had never promised anything of the sort. The chairman, Orr-Ewing, came in at this point and completed Moffat's demolition. But Young was never free from anxiety about intrigues. He had noticed Moffat and Arthur leaving the Board meeting together and later, undetected himself, he saw Moffat in earnest conversation with Orr-Ewing. Naturally, he was suspicious "... What plot is in hand now? "[1] A year later, he did not need to be anxious any more for in the autumn of 1869 he handed over control to his son, James.

The personal relationships within the Board of Young's Company illustrate the old adage that team work is often a more important contribution to the success of limited liability companies than commercial brilliance. And yet this Board appeared to contain such a well balanced galaxy of talent that one can only be surprised at their disjointed failure to buckle to the problems of trading in adverse circumstances. John Orr-Ewing of Levenfield, James Arthur of Barshaw, John Pender of Minard had made fortunes in industries ranging from turkey-red dyestuffs to drapery and the new world of the electric telegraph. James Young, his son, Hugh Bartholomew and John Moffat had wide practical experience in the chemical industry. Lyon Playfair was a brilliant theoretical chemist with a background of experience in business consultancy.

1. Pocket Diary, 1868, 15 October 1868

Perhaps, there were too many individuals with entrepreneurial energies on this Board attempting to work a system which allowed too little scope for strong wills.

c. Trading Circumstances

Young's success in limiting the development of the shale-oil industry during the operation of his patent of October, 1850 was to react with other factors to produce many problems for his company. To establish the model for the interpretation of the development of the oil-shale industry in the last half of the 60s a few crude generalisations are necessary. First, the effect of Young's patent was to establish a virtual monopoly which at first restrained capital investment in the oil-industry and directed the capital flow elsewhere. With the rise in Boghead cannel coal prices it became increasingly economic to operate on the oil-shales which, although free of Young's patent, were less productive than Boghead cannel coal. Thus, there was a gradual flow of capital into the oil-shale industry from 1861 but not a flood. As the end of Young's patent approached, this gradual flow of capital increased particularly with the discovery of rich shale fields near the surface in the Broxburn area. After Young's patent ceased in 1864, the flow of capital into the industry amounted to an oil mania and as John Mayer, a teacher of chemistry in Glasgow and an exceedingly well informed observer, noticed[1] the result was that a number of speculators without technical knowledge were ruined. The effect of such a speculative boom was likely to be the development of increased competition, greater costs

1. The Mining Magazine and Review, 1872, pp. 118-128

TABLE 25

NUMBERS OF SCOTTISH OIL CONCERNS
(1851-1870)

Year	Number of Firms founded between 1851-70
1851	1
1853	1
1857	1
1860	3
1861	5
1862	7
1863	8
1864	38
1865	11
1866	17
1867	1
1868	0
1869	1
1870	2
TOTAL	97 firms

Source:

I.I. Redwood, op. cit., pp. 7 sqq., and pp. 20-25

1. Redwood does not take into account firms transferring from other activities
2. Small one-man concerns are not given
3. The total of 97, is, therefore, likely to be too low. I am suspicious of his figure of 11 for 1865

for capital equipment and labour, and the demolition of profit margins. This would be followed by bankruptcies and a period when the supply side would lead to even lower prices. Gradually, the reduction in the number of firms operating and other factors such as increased technical and commercial efficiency stimulated by competition would begin to restore the position, and this would be accompanied by attempts to limit competition and to return to wider profit margins.

This model must be modified in two specific ways. First, it is necessary to take into account foreign investment in the American petroleum industry and, less important, in Burma oil. Secondly, the widening of capital in the gas industry in the early 60s was likely to affect the demand for the main products of the oil-shale industry. The first stages, outlined in the model, have already been discussed, when the transfer of the oil-shale industry from cannel coal to shale was considered.[1]

Apart from the small one-retort-oil-works and the earlier shale oil ventures before Young's patent ended, there were 38 new works in 1864 alone, most of them anticipating that Young's patent would not be renewed; in 1865 there were about 120 works of all sizes in existence.[2] From Bo'ness and Queensferry

1. Vide infra., pp. 264 sqq.
2. I.I. Redwood, op. cit., p. 11. But Redwood's table on his p. 28, is quite inaccurate. Geological Survey: The Oil-Shales of the Lothians, 1927. pp. 242-245 passim

on the Forth to West Calder and Bathgate, the new industry based upon shale had begun to dominate the landscape. Industrial correspondents were noting the spread of the industry to Ayrshire and Renfrewshire and comparing the discovery of oil-shale with David Mushet's discovery of black-band ironstone.[1] Early in 1866 many recently erected small works were dotted along the railway line from Broxburn to Bathgate:

> "... Their existence affords more evidence, if that were wanting, of the widespread desire on the part of capitalists and speculators to secure a share in the scramble for wealth which is to be made in the oil trade; and they indicate, likewise, that the said speculators and capitalists are determined not to lose the benefit of the present golden opportunity ..." [2]

There were many small oil-works, often operating not more than a dozen retorts. The erection of such a works not far from Loanhead, at Straiton, with twelve retorts, nine of which were operational, was reported in May, 1866; it had been built in two months.[3] Some of these works were subsidiaries of collieries with suitable cannel coals available for distillation; sometimes they were only equipped to distil crude oil which they then sold to refineries. Few were so well integrated as Young's company; many did not survive for long. However by 1869 there were five works near Addiewell and another five surrounding Bathgate.[4]

1. Morning Journal, February 1866, passim
2. Morning Journal, 17 February 1866
3. The Scotsman, 12 May 1866. This works is not given in I.I. Redwood's estimates for this year
4. The Scotsman, 1 February 1869

The real pace-makers in this new industry were admirably described in contemporary press articles.[1] Two miles from Bathgate was the Bathville Chemical Works, owned by Messrs. John Watson and Son, Glasgow coalmasters, who had access to Boghead cannel coal on the Bathville estate. One of the 38 new-comers in 1864, this works covered six acres and had 130 retorts. Fortunately for its owners, this firm had not merely the wasting asset of Boghead coal at 70/- per ton but also a wide range of other minerals: coal, ironstone, limestone, fireclay - a brickworks was already in production by 1866. But the collieries absorbed most of the firm's labour force: of a total of about 580 men about 100 were employed in the oil works, 80 in the brickworks and 400 in the mines. By 1869 capacity had increased to 150 retorts with a labour force of between 300 and 400 geared to oil production and shale mining. By them Boghead coal had become a geological curiosity and even Young's company was using shale exclusively.[2]

The sign that forthcoming trading circumstances presented no long term "golden opportunity" was most obvious in the refinery of George Shand and Company. This, the Forth Bank Chemical Works, was situated on seven acres of river bank in Stirling. The Forth was to become the traffic lane for great quantities of imported crude oil from the United States and Burma, which already in February, 1866 were being refined in

1. Morning Journal, February 1866 passim.
   The Scotsman, 1 and 8 February 1869
2. Morning Journal, 14 February 1866;
   The Scotsman, 8 February 1869

Shand's works. Crude shale-oil from the Broxburn area - from the works of Robert Bell, Dr. Steele and John Poynter - was also being refined for export.

Shand's firm is an interesting example of purposeful industrial inertia. It had begun by refining the waste liquid products from gas-works and from Young's first Bathgate works and, despite opposition from Stirling Burgh on the ground of nuisance, by 1866 had boomed with the Scottish shale-oil industry, providing the refining capacity and experience often lacking in the new industry. There were 36 stills each with a capacity of between 1,500 and 2,500 gallons; the plant could refine at least 40,000-45,000 gallons of crude oil (1,200-1,500 barrels) per week, handle 200,000 to 220,000 gallons of burning oil (6,000-7,000 barrels) per month and manufacture 200 tons of paraffin wax, worth about £20,000, every year. It had a labour force of 250, many of whom were ex-soldiers from the local barracks; barrel-making was an important by-industry employing 50-70 out of the total of 250. The products, particularly burning oil, were exported in vast quantities to France, the Netherlands and especially to Eastern and Northern Europe.

For commercial and social reasons George Shand and Company had tackled the problem of effluents as scientifically as possible. Naturally, there was every precaution to prevent leakages of crude oil into the river, since this represented an avoidable loss and was an obvious instance of "nuisance", which burgh authorities were likely to seize on.

The sulphuric acid sludge, a common refinery effluent, was purified and made into sulphate of ammonia and lamp-black. The former was sold as a fertiliser while the latter, according to quality, had a number of outlets varying from rubber manufacture through printing and leather currying to paint manufacture for prices ranging from £7 to £50 per ton.[1]

Another ambitious and rapidly growing concern was the Forth and Clyde Paraffine Oil and Chemical Works, of Kirkintilloch and Bathgate. This firm was of more recent origin, having been begun by Messrs. Lester, Wyllie and Company in July, 1865 and completed the following October. By February, 1866 its buildings occupied two acres of an eight acre site at Kirkintilloch on the south bank of the Forth and Clyde canal. Messrs. George Bennie and Company of Kinning Park Foundry, Glasgow, had supplied the twenty five large oval retorts, and Messrs. Lester, Wyllie and Company attempted to escape the main effects of the price inflation and exhaustion of Boghead cannel coal. First, they had taken a long-term contract with Russel and Son, and, secondly, they had leased a large shale-field at Drumcross, near Livingston, an area of 700 to 800 acres from the estate of Captain Hart and Andrew Kerr. There they intended to erect a further 200 retorts to distil crude oil which would be sent by rail to Kirkintilloch for refining.

1. Morning Journal, 21 February 1866

Within the terms of the lease of Drumcross, Messrs. Lester, Wyllie and Company were also authorised to mine the prolific coal seams of the area - and the bed of fire-clay. A brickworks was being built early in 1866 with an intended capacity of between 5,000 and 6,000 bricks a day; a market for those surplus to the Company's own requirements was to be sought in Edinburgh as well as in the immediate locality. Houses were to be built in the Bathgate area for incoming workers:

> "... It is thus that the efforts to supply human wants at home and abroad bring about radical changes in the features of our land, causing the quiet and almost dreamy operations of the husbandmen to give place to the busy and noisy processes of mining and manufacturing industry ..." 1

Apart from Young's company there were six other limited liability companies in the shale oil industry by May, 1866. The oldest, the Midcalder Mineral Oil Company, had been founded by Sir James Young Simpson in 1860 at Oakbank and was registered on 11 June, 1864 after passing through the private company stage. Its nominal capital had been increased progressively from £10,000 to £15,000 and then on 23 April, 1866 to £25,000. But by May, 1866 only £13,300 of this had been called up. The Bothwell Land and Petroleum Company was registered on 24 March, 1865 with a nominal capital of £100,000. The Capeldrae Oil and Coal Company was registered on 5 January, 1866 with a very small nominal capital of £1,400; this Fife concern soon increased its capital to £5,000 on 8 June, 1866.

1. Morning Journal, 28 February 1866

The Airdrie Mineral Oil Company began its works in 1864 but did not become a company until 13 March, 1866, when it was registered with a nominal capital of £10,000. A month later, on 12 April, 1866, the Scottish Oil Company was registered with a nominal capital of £20,000 and failed almost immediately; the Monkland Oil Refining Company, registered on 18 May, 1866 with a nominal capital of £10,000, was the only specialised refinery among these six - and among its objects was the development of oil-wells in Burma.[1]

Other companies were slower to become limited liability companies, remaining partnerships. Foremost among these was the partnership between George Simpson, Peter McLagan and Edward Meldrum, Young's former partner. They were trading under a number of names of which the one with greatest historical significance and commercial strength was E. Meldrum and Company. Meldrum and Simpson had taken a 21 year lease from 1 February, 1866 from McLagan at a fixed rent of £1,200 per annum and royalties on production. A later lease of 27 March, 1866 involved the Uphall Mineral Oil Company (Meldrum and Simpson, under another name) in an investment of £30,000 in sinking pits and establishing works on McLagan's land. There were other leases also, dated 17 July and 26 November, 1866 from the Earl of Rosebery.[2]

1. House of Commons, Return regarding Joint Stock Companies, Parliamentary Paper No. 429, 20 July 1866; Account and Valuation Book, 1865-67, contains name of shareholders in these companies and gives a few additional details. I.I. Redwood, op. cit., pp. 14-15 and pp. 20-25
2. Scottish Oils MSS., Copy Minute of lease between Peter McLagan and The Uphall Mineral Oil Company, 27 March 1866. Copy Agreement between Peter McLagan and others and James Wyllie Guild, undated but probably 1866

The Uphall works, erected in 1866, had 60 vertical and 138 horizontal retorts for distilling crude oil, buildings and machinery for refining oil, for making lubricating oil, for freezing and pressing solid paraffin, for making sulphate of ammonia, many workers' houses and shale pits. By 31 January, 1870 when it became a joint stock company, the total sum spent on property and plant amounted to £66,685. 7. 7d., the works occupied $36\frac{1}{2}$ acres held on a 99 years lease, and the shale fields leased extended to 2,000 acres. At Boghall, the same company by 31 January, 1870 had erected 66 vertical and 33 horizontal retorts in a total works expenditure of £29,415. 12. 8d. and taken mineral leases for 3,00 acres. The amalgamation of these works and partnerships with a nominal capital of £250,000 was the largest single Scottish competitor to Young's company.[1]

Despite the intense competition within the shale-oil industry likely to be produced by the existence of so many companies, since Young's company was by far the largest, both in capital resources, degree of integration and capacity, it was most capable of resilience in the face of adverse trading circumstances. While other companies were being promoted several smaller fry were failing. Easily the most important of the early failures, the Broxburn Shale Oil Company, registered on 26 March, 1862 with a capital of £20,000 was wound up on 13 February, 1866.[2] There had been earlier failures;

1. Scottish Oils, MSS., Prospectus of Uphall Mineral Oil Company, August 1870; c.f. also The Scotsman, 1 and 8 February 1869
2. Account and Valuation Book, 1865-67

Dougal and Brothers, iron-founders in Bathgate, began an oil-work near Blackburn House, Blackburn, Linlithgowshire in 1860. They installed thirty retorts but reputedly the venture failed because their supply of shale did not last more than three months.[1] However, the greatest rate of failure was after 1864. Between 1864 and 1870, apart from the many one-retort concerns, about thirty firms failed, most of them small.

Estimate of Failures among Scottish oil firms (1864-70)

1864	1
1865	3
1866	3
1867	7
1868	2
1869	7
1870	7

Sources:
I.I. Redwood, op. cit., pp. 20-25;
The Scotsman, 1866-1870;
The Glasgow Herald, 1866-1870;
Valuation Rolls of Linlithgowshire, 1864-1870.

On 20 March, 1866 Young met Sir James Young Simpson and learned that Baird's Kilwinning oil-works with its 32 retorts and 2 refining stills was to be sold. Young was down at Kilwinning the following day to see what bargains were going but the Company did not, sensibly, make any offer for this oil-works.[2]

By 1868 many of the smaller firms in West Lothian had disappeared; and all the one-retort concerns; others had disappeared or changed hands. The Paraffin Oil-Works at Grangepans owned by John Nimmo, coal-master of Edinburgh, was unlet.[3] So were the Westwood Oil-works, West Calder belonging to Stewart and Company, Roman Camp and Almondfield Shale Oil-[4]

1. I.I. Redwood, op. cit., p. 9
2. Pocket Diary, 1866, 20 March - 18 May 1866, passim
3. I.I. Redwood, op. cit., p. 12. Valuation Roll of the County of Linlithgowshire, 1868-69, p. 48. Annual Value £15.
4. Valuation Roll of the County of Linlithgow, 1868-69, p. 67, Annual Value £100

works belonging to William Fraser, manufacturer of Broxburn,[1] Thomas Hutchison's refinery near Broxburn,[2] Stewartfield Shale-Oil Works,[3] the chemical works at Uphall station and the Ammondfield Paraffin Oil Refinery.[4] But these were all insignificantly small firms.[5] But strong competition still existed from William Dixon's Caledonian Oil Company at Whitburn, from the Dundas Shale Oil Company at Kirkliston, from Robert Bell's Glasgow Oil Company works at Stewartfield and Greendykes, from the works of Young's old enemies, John Edgar Poynter and Son and James Miller in Broxburn, and especially from the works at Starlaw, Boghall and Uphall, owned by Edward Meldrum and his associates, later to become the Uphall Mineral Oil Company with a capacity in 1870 of two million gallons of crude oil per annum.[6] Even though this domestic competition existed, the number of firms in the Scottish shale-oil industry had fallen from about 120 in 1865 to 65 by 1872.[7]

The collapse of the Scottish oil mania in 1866-67 was caused by more general factors than the specific trading circumstances of the shale-oil industry. Over-investment was likely to lead to the diminution of the profit margins, and

1. Ibid., p. 77, Annual Values £145 and £50 respectively.
2. Ibid., p. 77 Annual Value £200
3. Ibid., p. 79 Annual Value £50
4. Ibid., p. 79 Annual Value £100
5. Ibid., p. 80 Annual Value £20
6. Valuation Roll of the County of Linlithgow, 1868-69, passim; The Scotsman, 1 and 8 February 1869; Scottish Oils, MSS., Prospectus of Uphall Mineral Oil Company, 1870.
7. J.S. Jeans, Western Worthies, Glasgow 1880, p. 67. I.I. Redwood, op. cit., p. 28 gives 61 in 1870

this was certainly noted by contemporary Scottish observers, who suggested that new uses ought to be found for Scottish crude mineral oil.[1] But the depression in the oil trade in late 1866 and early 1867 was general. Ebenezer Fernie's old Welsh company, the Leeswood Cannel and Gas Coal Company Limited reported for the six months of 1867 a very small profit of £2,493. 18. 4d., hardly sufficient to pay the 5% dividend:

> "... not withstanding the extremely depressed state of trade throughout the country, the high price of labour, and the almost total collapse of the oil manufacture ..."[2]

The American crude oil producers were similarly affected.[3] In Britain there was a general crisis in confidence and a number of bank failures, resulting in a sharp restriction of credit sufficient to destroy many of the under-capitalised firms in the Scottish shale-oil industry.

American competition certainly presented many problems, although most of the Scottish firms in 1872 were crude-oil producers:[4] only 16 of the 65 were exclusively refineries, but some of these were large. In 1865 Young's Company felt no great pressure from American crude or refined oil and most new entrants to the Scottish industry had no great impact on

1. John Mayer, The Mining Magazine and Review, 1872, p. 118 and especially Andrew Taylor "On the Past, Present and Future of the Scottish and Welsh Mineral Oil Trades, in Transactinns of the Edinburgh Geological Society, 1866-1869, p. 20, 7 February 1867
2. The Colliery Guardian, 17 August 1867. For the Welsh Trade c.f. H.P.W. Giffard, The former Cannel Oil Industry in North Wales and Staffordshire, in Oil Shale and Cannel Coal (Institute of Petroleum) London 1938, pp. 78-92
3. H.F. Williamson and A.R. Daum, the American Petroleum Industry: The Age of Illumination, 1859-1899, Evanston, 1959, pp. 126 sq.
4. J.S. Jeans, op. cit., p. 67

established markets. In 1866 the fall in American and British crude oil prices was about 50%.[1] Bankruptcies in Scotland put further oil stocks on the market and depressed British prices to their lowest point from October, 1866 onwards. The evasion of the Petroleum Act of 1862 was widespread, and American exports of dangerous fractions were further encouraged by the comparative strictness of the American law. Large-scale American oil exports were often accompanied and, occasionally, preceded, by exports of cheap and improved American versions of the "Vienna" lamp.[2] American currency inflation during and after the Civil War, among many other less important factors, also encouraged the foreign sale of oil, and since refined oil exports were exempt from the tax on domestic refined oils, a further factor favourable to American burning oil exports operated.[3] Europe by 1866 had become the major attraction to American exporters, and Britain appeared to be the best European market.

TABLE 26

AMERICAN OIL EXPORTS TO BRITAIN (1864-1866) 40 gallon barrels.

Year Ending June 30		Total to World	Total to Europe	Total to Britain	% Britain of European Tl.
1864	Crude Oil	249,516	237,104	109,598	49.9%
	Illuminating Oil	291,189	238,433	88,167	36.9%
1865	Crude Oil	307,347	287,404	101,280	35.2%
	Illuminating Oil	292,363	233,017	76,631	32.8%
1866	Crude Oil	401,448	372,099	128,364	34.4%
	Illuminating Oil	837,747	711,540	230,853	32.4%

Extract from General Table: Williamson and Daum, op. cit., p. 328.

1. Williamson and Daum, op. cit., p. 126; c.f. also Table giving state of London Market, 1865-1866
2. Ibid., p. 324
3. Ibid., p. 235

TABLE 27

AMERICAN EXPORTS TO BRITAIN
(1867-72)

Year Ending June 30		Total to World	Total to Europe	% to Europe	Total to Britain	% to Britain
1867	Crude Oil	183,606	176,357	96%	35,142	19.9%
	Illuminating Oil	1,553,137	1,382,663	89%	428,917	31%
1868	Crude Oil	250,741	248,579	99%	60,529	24.3%
	Illuminating Oil	1,680,333	1,479,299	88%	202,653	13.7%
1869	Crude Oil	322,612	321,804	99.7%	9,550	2.9%
	Illuminating Oil	2,110,086	1,951,901	93%	276,002	14.1%
1870	Crude Oil	248,876	248,769	99.9%	4,714	1.8%
	Illuminating Oil	2,447,561	2,212,112	90%	209,653	9.5%
1871	Crude Oil	236,520	228,381	97%	28,197	12,3%
	Illuminating Oil	3,171,144	2,885,950	91%	378,617	13.1%
1872	Crude Oil	338,994	330,594	98%	5,435	1.6%
	Illuminating Oil	3,063,488	2,759,951	90%	252,203	9.1%

This Table adapted from General Table given by Williamson and Daum, op. cit., p. 335.
The last column, % Britain, gives Britain's oil imports in terms of American exports to Europe.

From 1861 onwards the London investment house of Peto and Betts began to take an increasing share in sponsoring the development of the American oil industry with a view to making Britain the main refining entre-pôt for American crude oil on its way to Europe; this firm had the first real tankers built in 1863.[1] But the boom in the Scottish shale-oil industry in 1865 made these plans less likely to succeed, and the British and American financial crises of 1866 completed the process by demolishing Peto and Betts.[2]

But American exporters were to remain permanent competitors of the Scottish shale-oil industry. Improvements in American refining methods, particularly by Joshua Merrill in 1868 lessened the risks from dangerous fractions and established confidence in American oil products which, occasionally, faltered, as in 1871-2, but was never broken.[3]

With the development of continental markets especially in France, Belgium and Germany, the American petroleum industry did not require to expand its exports to Britain and did not, in the 1860s, return to the high-water mark of 1867:[4] refined burning oil became the staple export to Britain; crude oil declined in significance from 1866. The shale-oil industry was beginning to recover in 1868 and was holding its own by 1870.

1. Ibid., p. 329
2. Ibid., p. 330
3. Ibid., p. 246; c.f. also P.H. Giddens, op. cit., p. xxxviii, states that foreign buyers in 1872, bought 5 million gallons less of American refined oil than in 1871; Williamson and Daum, op. cit., p. 335, give a fall of 107,656 barrels or 4,306,240 gallons (c.f. Table No. 27)
4. See Tables No. 26 and No. 27; c.f. Williamson and Daum, op. cit., p. 328 and p. 335

The great inrush of petroleum and refined kerosene in 1866-67, with the return of fire hazards and accidents provoked by unsafe oils, revived the agitation against dangerous oils.[1] It could be easily demonstrated that American law, under which it was illegal to offer for sale burning oil which ignited at less that 110° F., was more rigorous than British law. A Select Committee of the House of Commons on Fire Protection was set up and reported in July, 1867; Peter McLagan, M.P. for Linlithgow and a man directly concerned with the Scottish shale-oil industry, was appointed chairman.[2] Lyon Playfair was one of many oilmen who gave evidence and attacked the operation of the Petroleum Act of 1862.[3] This, the Select Committee found for itself having 65 specimens of lamp oil from different London retailers, analysed; only 19 were legally safe under the terms of the Act of 1862.[4] When Playfair was asked what oil was sold by Young's Company, he replied that Young's was guaranteed not to explode or ignite at a temperature less than 130° F. He added that Young employed his solicitor to check all stories alleging that his oil had caused fire, and so far no such story had been true.[5] Young himself attended at least one meeting of the Select Committee but did not give evidence.[6]

1. The Times, 3 June 1866; Chemical News, vol. xiv., pp. 257 sq., 30 November 1866
2. House of Commons, Report from the Select Committee on Fire Protection, 25 July 1867, passim
3. Ibid., pp. 120-127, Evidence of Lyon Playfair
4. Ibid., p. 278, Appendix No. 6
5. Ibid., 124, Evidence of Lyon Playfair
6. Pocket Diary, 1867, 27 June 1867 "went into McLagan's comm."

Privately, he was encouraging McLagan and sending slips about petroleum disasters from newspapers.[1] He was hoping for a stricter law. The Select Committee recommended the introduction of a more effective Petroleum Bill, and a new Petroleum Act was passed in 1868, becoming operative in February, 1869. It did not affect trading circumstances greatly during Young's tenure of the office of General Manager; indeed it was just as much a dead letter as its predecessor of 1862.[2] It placed no real responsibility on the retailer - Young favoured making the retailer financially responsible for damages caused by unsafe oils.[3]

A more significant development for the future of the shale-oil industry was the formation of a previously unrecorded trade association of crude-oil makers which first met in February, 1867. Young's Company was represented and presented to the meeting estimated costing details, both primary and secondary, of the American petroleum industry.[4] The operations of this association may be one more reason why American crude made no immediate inroads in the British market after 1866. Certainly, by 1870 most of the crude oil made in Scotland was

1. Ibid., 14 May 1867 "saw McLagan at the house of commons;" Letter Copybook, 1867-73, Young to Peter McLagan, M.P., 15 July 1867
2. Williamson and Daum, op. cit., p. 333.
3. Letter Copybook, 1867-73. Young to Mr. Love, 15 July 1867, "... I believe that a man selling oil that gave of explosive vapours under 100° Fahr should be liable for damages if an explosion took place & injury done to life & property ..."
4. Ibid. Young was in doubt in this letter to Love whether such an association was legal. The costing is done in the Account and Valuation Book, 1865-67, "Memo. of Cost of Petroleum taken from information communicated to meeting of Crude Oil Makers in Febry. 1867."

channelled to refineries financially associated with, or owned by, the companies who made the crude oil.

d. Young as General Manager (1865-70)

As General Manager, James Young was constantly concerned with a range of problems varying from the implementation of decisions of the Board of Directors to solving problems of production, stimulating the development of new products and outlets for existing products, checking the commercial organisation and supervising a very varied labour force. He had a group of able men beneath him generally recruited for works management at Bathgate and Addiewell, the Company laboratories, the Company Offices in Glasgow, the Company mines and the Company building programme at Addiewell. The Company structure was from this immediate management level to Young; from Young to the Works Committee or to the General Board of Directors.

The problems were immense as well as wide-ranging. At Addiewell he had the problem of completing and supervising a plant which, in full production was to have 354 retorts. He had to be constantly on the move, since at Bathgate he was faced with the problems of a well-established business, less admirably planned than Addiewell, but almost as large in retort capacity. Small details such as ordering retorts and other equipment, checking the results achieved from shale samples from Midcälder and Polbeth, consulting with architects, research staff and production workers fill his small notebook for 1866.[1]

1. Small Notebook 1866, passim

This little book is full of tasks to be done, equipment to be inspected or bought, names of people to be seen or written to, houses to be checked to make sure only employees live or lodge in them.[1] He was attempting to negotiate with the railway companies to arrange tolls for using their lines. He discussed details of paraffin house construction with Playfair; he tried to extend the shale reserves of the Company by arranging talks about a lease of the Hopetoun estate's mineral rights.[2] He was concerned with production, sales, public and industrial relations. He notes the needs of customers, the contracts already settled, his fears of strike action.[3] He felt he had to master broad issues of policy and intricate petty details.

1866 appears to have been not so bad a year as might have been expected. Total crude-oil production was over three million gallons:

TABLE 28

OIL PRODUCTION 1866

Place	Raw Materials (tons)		Crude Oil in Gallons
Addiewell	Shale:	34,165	1,127,246
Bathgate	Shale:	25,599. 10 cwts	984,665
Bathgate	Cannel Coal:	8,857. 7 cwts	1,062,880
	Total		3,174,791

Bathgate provided two-thirds of the total output, more than a third from Boghead cannel coal. The through-put of

1. Ibid., c.f. also Pocket Diary 1866, 2, 5 and 6 June 1866
2. Pocket Diary 1866, 17 January 1866; 12-14 February, 2 March and 5 March 1866; 24 March 1866
3. Small Notebook and Pocket Diary 1866, passim

8,857 tons 7 cwts., of coal and 25,599 tons 10 cwts., of shale was far short of what was required to produce 4 million gallons of finished oil. The coal, on average, produced 120 gallons of crude oil to the ton; at Addiewell the shale averaged 32.99 gallons to the ton.[1] During the late spring and early summer of 1866 the "Thick Shale" seam was opened and in May, 1866 the first comparisons in production from Dam Shale were being made by Young. Six weeks production from Dam Shale, the inferior raw material, gave 25,93 gallons of crude oil to the ton over a run of 16,070 tons in six weeks. At Bathgate 42 gallons of crude oil was obtained from experiments with "Thick Shale".[2]

The primary costs of production for distilling shale in 1866 were also known.[3] One ton cost 7/6d. to the works, the fuel for distilling it 2/7d., wages 3/9d., stores and salaries 7d. This produced about 35 gallons of crude oil at almost 5d. per gallon, this production process costing 14/5d. Refining costs for fuel, sulphuric acid and caustic soda cost 3/6d. and wages and salaries at this stage cost 2/7d. 35 gallons of crude oil produced 20 gallons of finished oil products: 3 gallons of lubricating oil, 13½ gallons of lamp oil, 1 gallon of light naphtha and 2½ gallons or 20 lbs of crude paraffin wax. No allowance was made for gas products, sulphate of ammonia or coke residue from the refining stills.

1. Account and Valuation Book, 1865-67. "Quantities of Cannel Coal & Shale distilled in 1866"
2. Pocket Diary, 1866, 23 May 1866
3. Account and Valuation Book, 1865-67, "Cost of Distilling Shale", 1866

TABLE 29

COSTS FOR SHALE (per ton) 1866

	s.	d.	
Raw Material Costs			
1 ton shale	7	6	
Distillation Costs			
Coal	2	7	
Wages	3	9	
Stores & Salaries	-	7	
	14	5	for 35 gallons
Refining Costs			
Coal, Sulphuric Acid & Caustic	3	6	
Wages & Salaries (Soda	2	7	
Grand Total	20	6	for 20 gallons

TABLE 30

CRUDE OIL UNIT COSTS FOR SHALE 1866

Unit Costs	Per Gallon (d) of Crude Oil
Raw Material	2.571
Labour Costs	1.2885
Fuel Costs	0.885
Stores and Salaries	0.2
Total	4.9445 d.

Crude Oil unit costs are a significant indication of general levels of productive efficiency but of little else because of the loss of three sevenths of the crude in the refining process. But American unit costs by the time the crude oil was unshipped in London were estimated at little more than 6d. per gallon in February, 1867.[1] More significant were unit

1. Ibid., "Memo. of Cost of Petroleum".

costs for all commercial products.

TABLE 31

FINISHED OIL UNIT COSTS FROM SHALE 1866

Unit Costs	Per Gallon (d) of Finished Products
Raw Materials	8.65
Refining Agents	2.1
Labour Costs	1.55
Total	12.30 d

Twenty gallons of finished oil products cost 20/6d. to produce giving a total unit cost of 1s. 0.3d.

The commercial value of the finished oil products in 1866 can be reasonably estimated, but, unfortunately, there is no indication anywhere of what distribution costs amounted to. Hurst and Company were paying 3/2d. to 3/6d. per gallon for lubricating oil, depending upon its specific gravity; Price and other candle firms were paying 9d. per lb. for crude paraffin; naphtha was selling at 10d. to 1/- per gallon; the price of burning oil varied considerably as the table of metropolitan prices reveals, but an estimate of 2/- per gallon would appear not to be over-generous. The value of products costing 20/6d. to produce would be about 53/-, and that makes no allowance for complementary products such as gas, coke, candles or sulphate of ammonia.

TABLE 32

TO ILLUSTRATE COSTS AND SALES VALUE OF PRODUCTS FROM 1 TON OF SHALE

Total Production Costs	Commercial Value		Profit at Works
20/6d. for 20 gallons of finished products	1 gallon Naphtha	1/-	
	13½ gallon Burning Oil	27/-	
	3 gallons Lubricating Oil	10/-	
	2½ gallons (20 lbs.) Paraffin	15/-	
	Total	53/-	32/6d.

Profit to Costs Ratio at the works was 158.53% a margin remarkably wide, even when prices were subject to downward pressure resulting from a great shift in the supply curve.

There are indications that this profit margin at the works was being extended by the development of sales of gas and paraffin wax candles. Unfortunately, few details exist. Candles which sold at 1/2d. to 1/6d. per lb. in Glasgow could be made at Addiewell for about 9d. per lb. The main cost here was the raw material - wages cost 1/16d. per lb. and paraffin wax 8d per lb.

TABLE 33

UNIT COSTS FOR CANDLES (per lb) 1866 [1]

Paraffin	8d
Wages	1/16d
Wick	1/8d
Interest on Cost	5/8d
Total	8/15/16d

1. Ibid., "Candle Manufacture"

TABLE 35

MONTHLY DELIVERIES AND PRICES OF PETROLEUM AND YOUNG'S OIL IN LONDON

	JAN.	FEB.	MARCH.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	Totals (gallons)
1865													
Petroleum	(2/2)	(1/11¾)	(2/-)	(2/0½)	(2/1½)	(2/5½)	(2/5½)	(2/6¾)	(3/-)	(3/0¾)	(3/3¼)	(3/6½)	
	7460	6523	5680	3161	3683	3665	1651	2469	3099	5062	9740	8019	60,212
Young's Oil	(2/3)	(2/3)	(2/3)	(2/3)	(2/3)	(2/3)	(2/3)	(2/3)	(3/-)	(3/4)	(3/4)	(3/6)	
	2058	1521	1168	646	472	377	486	1219	1451	1787	1810	1872	14,867
1866													
Petroleum	(3/0½)	(2/3¾)	(2/1½)	(2/2)	(2/2¼)	(2/1½)	(1/11¾)	(1/11½)	(1/11¼)	(1/9¾)	(1/6½)	(1/5¼)	
	6114	7000	7140	5295	2825	3137	4901	10865	10276	17303	12392	12668	99,906
Young's Oil	(3/6)	(3/-)	(2/6)	(2/3)	(2/3)	(2/3)	(2/3)	(2/3)	(2/3)	(1/11)	(1/8)	(1/8)	
	1413	1110	919	534	432	200	284	956	799	852	1734	1299	10,632

There was also some safety in supplying markets not so competitive as the metropolitan lamp-oil market. Using the proportion of 20 gallons of finished oil products obtained from 35 gallons of crude oil, the total production for 1866 of 3,174,791 gallons of crude oil would produce 1,814,166 2/7 gallons of finished oil products. Profits and Costs at the works can be estimated, but this will not give any more than a commercial value and an artificial profit at the works.

TABLE 34

ESTIMATE COSTS AND SALE VALUE 1866

Costs at Works	Sales Value	Profit at Works
£92,975. 14. 0.	£240,376. 4. 0.	£147,400. 10. 0.

Stock piling did occur at Addiewell, Bathgate and Craignestock and because of falling prices at the end of 1866 depreciation in value was rapid: total stock was valued at £66,518. 14. 0. in December, 1866 and the assessor gave it a value in 1865 terms of £92,264. 8. 4. showing a fall of about 28% in all prices.[1]

The burning oil market was certainly the most competitive, and this is most clearly revealed by a comparison of American sales with those of Young's company in London in 1865-66.

1. Ibid., "Difference in Value of Products at 31 Decr. 1866 if the same had been taken at prices of purchase 31 Decr. 1865"

TABLE 36

LONDON TURNOVER (1865-66) Burning Oil

	1865	1866
January	£231. 10. 6.	£247. 5. 6.
February	171. 2. 3.	166. 10. -.
March	131. 8. -.	114. 17. 6.
April	72. 13. 6.	60. 1. 6.
May	53. 2. -.	48. 12. -.
June	42. 8. 3.	22. 10. -.
July	54. 13. 6.	31. 19. -.
August	137. 2. 9.	107. 11. -.
September	217. 13. -.	89. 17. 9.
October	297. 16. 8.	81. 13. -.
November	201. 16. 8.	142. 10. -.
December	327. 12. -.	116. 11. 8.
Totals	£2,038. 19. 1.	£1,229. 18. 11.

60,212 gallons of American burning oil were delivered in London in 1865 to 14,867 gallons of Young's oil; in 1866 the total of American oil rose to 99,906 gallons while the total of Young's oil fell to 10,632. Pricing differences were just as spectacular. American burning oil varied greatly in price in 1865, from 1/11¾d. per gallon in February to 3/6½d. a gallon in December. Young's oil prices were far more stable: 2/3d. per gallon from January to August and then moving up to 3/6d. by December. In 1866 this price structure collapsed totally: American oil was 1/5¼d. per gallon by December and Young's oil was priced at 1/8d. The share of the market enjoyed by Young's oil fell significantly: in 1865 it was 24.68% and in 1866 10.62%. Turnover in London in 1866 fell by £809 compared with 1865, a drop of about 40%.[1]

To some extent this collapse in prices was offset by contracts already in hand for the other products, particularly for paraffin wax; also, paraffin wax was easier to store than the bulkier oils. Lubricating oils were another less competitive market in which more long-standing contracts operated.

1. Account and Valuation Book, 1865-1867, "Monthly Deliveries of Petroleum & Young's oil in London 1863-1866." See Tables No. 35 and No. 36 based on this

Young noted the stock of paraffin wax on 28 April, 1866 and also the standing contracts.[1] As one might expect the largest quantity of paraffin wax in stock was the unrefined crude.

TABLE 37

STOCK OF PARAFFIN WAX, 28 April, 1866

Type	Quantity
Soft Crude	458 tons 1 cwt 12 lbs
Hard Crude	94 11 3 2 oz
Soft White	77 1 2 18
Hard White	226 4 - 19

The contracts operating from May, 1866 to May, 1867 with Price and Company, Field and Company and Rathbones were worth, in toto, £25,821. 5. 0d., allowing for the usual 2½% discount.

TABLE 38

CONTRACTS FOR PARAFFIN WAX, May 1866-67

Firm	Quality	Quantity	Price/lb.	Contract dates	Turnover (2½% disc.)
Price	Crude	150 tons	9d.	1 May 1866-1 May 1867	£12,285
Field	Refined	150 tons	8½d.	May 1866-March 1867	£11,602.10. -.
Rathbone	Refined	25 tons	8½d.	-	£ 1,933.15. -.
				Total	25,821. 5. -.

Hurst and Company of Manchester contracted to take 232,939 gallons of lubricating oil in 1866 worth, to Young's Company, £38,392. 12. $\frac{2}{8}$.

1. Small Notebook, 1866, 28 April 1866
2. Ibid.

TABLE 39

HURST'S CONTRACT FOR LUBRICATING OIL, 20th June, 1866

Specific Gravity	Price/Gallon	Quantity	Turnover
0.896	3/6d.	18,012gal.	£ 3,152. 2. -.
0.88	3/4d.	145,250	24,208. 6. 8.
0.88	3/2d.	69,677	11,032. 4. -.
		Total	£38,392. 12. 8.

Addiewell still absorbed much of his time because it remained incomplete - and there were ancillary problems of putting out tenders for buildings, houses and equipment; 50 workmen's houses were started at Polbeth in February, 1867 at a total cost of £1,418[1], and then the Manager's house was started.[2] Tenders were invited for the cooperage roof in May, 1867[3] and in June estimates for Paraffin Sheds 220 ft. long by 50 ft. wide were modified from £21,935 to £16,165 for work to be completed immediately.[4] These buildings were begun and much capital equipment was ordered. By 31 December, 1867 £10,250 had actually been spent on their construction.[5] On 13 June, 1867 work in progress by outside contractors was listed with its cost for the next four months; workmen's houses was

1. Scottish Oil, MSS., Addiewell Specifications and Estimates Book, No. 1., 1867-1879, pp. 1-3
2. Ibid., pp. 7-15
3. Ibid., pp. 47-50
4. Ibid., pp. 51-56
5. Ibid., pp. 68-69 and 120-121

the largest single item amounting to £3,950 - but these estimates naturally excluded the vast quantity of work being done by the company's own men. John Inglis and William Campbell, two of the building contractors engaged at Addiewell respectively received £1,227. 13. -. and £2,935 for work done up to 31 August, 1867.[1] Much of this work was inspected by Young and the architect Thomson.

There were other matters that engaged Young. His 1867 Pocket Diary has its lead pages covered with details regarding the supply of gas to Edinburgh, Leith and Glasgow - with supply costs and with the estimate that "capital would require to be raised to £1,300,000,000 in all", if the Company was to produce and market large quantities of gas.[2] On 12 April, 1867 he left Britain for the Paris Exhibition and was away until 27 April, returning to France for the month of July.[3] While he was in France, Young arranged the lease of a Paris shop and warehouse at a rent of 10,000 francs a years for seven years.[4]

There were many other duties which Young discharged with great energy. Mr. Payne of Price and Company was at Bathgate

1. Ibid., pp. 77-78
2. Pocket Diary, 1867, lead pages
3. Ibid., 12-27 April, 1867 and 28 June and 27 July 1867
4. Letter Copybook, 1867-73, Young to Hill, 6 July 1867; Young to Playfair same date

and Addiewell on 4 June, 1867, and Young showed him the paraffin sheds at Bathgate: "... Payne said our way of pressing paraffin was as good as any he knew ..."[1] Negotiations with two railway companies about use of tracks were concluded in May.[2] In October Young visited the various paraffin light stations going from Newcastle to Hull, from Hull to Manchester, from Manchester to Birmingham. He spent a day in each place and noted that the Birmingham station could sell more if allowed to give the local discount and not merely the Company's standard $2\frac{1}{2}\%$ "... in some cases 14 days too short time putting this in circular gives offence. No discretion allowed ..." He was finding that local initiative could be crushed by large-scale organisation; he favoured a commercial organisation that allowed the individual salesman to use his talents. There were a few bright spots in this tour: the agent in Bristol was impressive.[3] But, generally, he disapproved of the method of book-keeping; Orr-Ewing and Moore were in London when Young arrived and they, from their experience at the London station, agreed with Young's general criticism.[4]

1. Pocket Diary, 1867, 4 June 1867
2. Ibid., May 1867, passim
3. Ibid., 21-26 October 1867
4. Ibid., 29 October 1867

Trade was brisker in 1868, and Young's Company benefited greatly. Addiewell was virtually complete, and all processes were in full production by September. In 1868 the through-put of Thick Shale was 172,000 tons representing a production of just over 6 million gallons of crude oil or just over $3\frac{1}{2}$ million gallons of finished oil products.[1] But by 28 September Young found that the level of demand had risen so much that the Company "... were oversold 14,000 gall. per week till end of year ..."[2] This led to the buying of crude oil for refining and also burning oil. Young disapproved of the idea of buying American crude and on 18 December, 1868 sent a letter to the Company Secretary in Glasgow "... giving opinion against buying dangerous oils ..."[3] By 2 January, 1869, 1,018,850 gallons of burning oil had been refined at Addiewell.[4]

Young was still concerning himself with mineral rights. On 10 January, 1868 he was urging the directors to buy the estate of Auchenhard. When they refused he went ahead on his own.[5] This purchase was made on the understanding that the

1. Geological Survey: The Oil Shales of the Lothians, 1927, p. 262
2. Pocket Diary, 1868, 28 September 1868
3. Ibid., 18 December 1868
4. Scottish Oils, MSS., Letter Copy Book 1872, p. 368. John Paterson to R. Scott, 29 March 1872
5. Ibid., 10 and 29 January 1868; The property was returned in the Valuation Roll for the County of Linlithgow, 1868-69, p. 69 as owned by Young

Company should rent Auchenhard from Young at 7½% of the pur-[1]
chase price per annum. For a land rent of £50 and a mineral rent of £100 Tenant's Marsh and Burnbrae in the parish of West Calder were leased from James Bartholomew,[2] and about the same time the minerals of Burnhouse were leased.[3]

Information about financial policy and payment of dividends is, unfortunately, far from clear. Young generally opposed cutting the prices of products in 1866-67.[4] He preferred to consider the concentration of production at Addiewell, a more profitable unit than Bathgate - a report on this eventuality was, in fact, drawn up but not operated until 1887.[5] This concept of limiting production and competition and costs was apparent elsewhere by 1872, but the individualistic structure of the oil-shale industry was so strong that tendencies to larger units were slow to develop by commercial agreements. The Drumcross Oil work of Lester and Wyllie was bought by the Mid-Calder Mineral Oil Company in 1870 and pulled down.[6] In

1. Scottish Oils, MSS., Letter from Alexander Moore to T.B. Gardner, 12 March 1873
2. Scottish Oils, MSS., Tack between James Bartholomew and Young's Company, 21 March 1873
3. Scottish Oils, MSS., Copy Mineral Lease for 20 years between Agnes Aitken and Others and Young's Company, 29 October 1868
4. Pocket Diary, 1866, 25 January and 22 March 1866
5. Thom Collection: "Report on Stopping Retorts at Addiewell or Bathgate"; Scottish Oils, MSS., Closure of Bathgate 1887: A Valuation
6. I.I. Redwood, op. cit., p. 23

the period January to March, 1872 the pressure of the short-time agitation led to wage increases of over 12% for unskilled labourers and nearer 20% for skilled men in Young's Company; Employees and managers in competing firms expected their rivals' support to keep down labour costs, and meetings of works managers were held in Bathgate and Glasgow to attempt to agree on uniform wage scales for the industry. But so widely differing were the wage rates and working conditions within the industry that agreement was impossible, no matter how great the concord in principle.[1]

Little is known about trading results. Young notes that the directors met on 20 April, 1866 when:

> "... Moore read Balance Sheet for the three months it seemed much better than they expected so we had a harmonious meeting ..."[2]

£57,000 had been called up from shareholders at the rate of £10 per share. Young received £50,000 of the purchase money. Additions to the plant were valued at £10,033. 15. 5d.; coal oil and shale oil were valued at £15,985. 13. 8d. and stocks at paraffin light stations at £26,538. 2. 0d.; managers had a total cash holding of £2,497. 7. 11d. Liabilities totalled £105,356. 19. 0d. and these were balanced by the £57,000 called

1. Scottish Oils, MSS., Letter Copybook 1872, Numerous Letters 30 January - 18 March 1872
2. Pocket Diary, 1866, 20 April 1866

up, a credit at the Clydesdale Bank of £18,742. 11. 2d., £12,374. 10. 0d. from other debtors, and a balance on operations of £17,238. 18. 10d. This was achieved on a turnover of £31,629. 17. 1d. and a total production and stock worth £182,394. 12. 4d.[1] John Mayer analysed the returns for the first year of operations but in an incomplete fashion. The net profit, according to him, was £35,504. 13. 8d. on the turnover of £203,700. The total wage bill paid by the Company for all workers he put at nearly £100,000, but he seems to have included all the constructional labour and sub-contracting labour force at Addiewell as though they were direct employees - he put the total labour force engaged by the Company at 3,500. Allowing 800 as the number of miners engaged by the Company, he was still over-estimating since the direct labour force in 1866 was not more than 1,500, although it is certainly possible that sub-contractors were employing a substantial labour force of up to 1,200.[2]

By February, 1867, when the first annual general meeting was held, it was possible to pay the maximum dividend of 5%,

1. Account and Valuation Book, 1865-67, Statements to 31 March 1866
2. John Mayer, op. cit., p. 118

allowed under the purchase agreement of 1865. But since foreign competition and the compulsory sale of bankrupt stock had depressed prices, profit prospects were known not to be great. To help to improve this situation, Young was asked by his fellow-directors to gift to the Company shalefields worth £120,000. This, he did. He also agreed to accept a delay in the payment of £100,000 of the original purchase price for up to four years. The next annual meeting in May, 1868 was told of a loss of £13,026. A call was made on the shareholders to meet the payments due to Young, but he offered to pay the shareholders the equivalent of a 5% dividend. In 1869 the last instalment of the purchase price was paid, but Young was also owed £53,000 mainly for interest.[1] He waived his right to this sum. He also leased more mineral rights in Polbeth estate for a rent of £303. 8. 4d.[2]

Having succumbed to a sharp illness in the autumn of 1869, Young, after a long absence, resigned from the board after his return from a Mediterranean cruise - and there is no indication that he even attended Annual meeting after 1872, although his son James remained a member of the Board until his death in 1884.[3] Young's interest in his Company did not wane. In

1. Geological Survey Memoirs, The Oil Shales of the Lothians, 1927, p. 247. Unfortunately, the documents upon which H.R.J. Conacher based this section have disappeared.
2. Scottish Oils, MSS., Lease between James Young and Young's Company, 29 January and 4 February 1869
3. Geological Survey Memoirs, The Oil Shales of the Lothians, 1927, p. 247.

March, 1872, with Lyon Playfair he did a report on the quality of the Company's burning oil and suggested methods of improving it.[1] In August and September, 1872 Young was sufficiently angry about the company's method of working the shales on his property of Polbeth[2] to prepare a long letter of complaint; in March, 1873 the company started to build houses on his Auchenhard property without his permission.[3] To the end of his days, Young remained on guard for his own interests and just before he died in typical business fashion he put all his shale interests in order.[4] By 1883 his rents and shale royalties had been depleted by falls in shale production and uncertain trading circumstances for oil but by then his shrewd investments in land, in and out of Egyptian bonds in 1874-5 in American bonds and Indian railway shares had added to his fortune.

1. Scottish Oils, MSS., Letter Copybook, 1872, p. 268; W.T.B. Gardner to R. Scott, 19 March 1872
2. Letter Copybook, 1867-73, Young to Moore and Young to Brown with copy of proposed letter to the Company, 30 August, 1872; Young to Nicolson, 30 August - 11 September, 1872.
3. Scottish Oils, MSS., Letter Alex. Moore to T.B. Gardner, 21 March 1873
4. Scottish Oils, MSS., Copy Memo. of Heads of Agreement between James Young and his Company, 28 April 1881 and 13 February 1883

4. A Note on Labour (1851-72)

Good information about labour conditions in the early days of the shale oil industry is sadly lacking.[1] Apart from the size of the labour force employed by Young and his partners, little comment was made. 700 men were supposedly employed at Bathgate in 1862,[2] and by the Paris Exhibition of 1867, the Company was advertising its labour force as 1,500;[3] in 1869 Bremner estimated the total labour force in the Scottish shale-oil works at over 3,000, of which Young's Company employed over 1,000 - and about 400 shale miners;[4] in 1872 Jeans' estimate was much the same.[5]

The quality of the labour force varied considerably: on the one hand there were unskilled workers and, on the other, graduates in science and engineering; wage-rates, therefore, were likely to fluctuate as widely as the quality of the labour force. In addition, the commercial organisation required a number of clerks and warehouse staff.

What is certainly true is that wage-earners in the main shale oil area of the Lothians benefited from the rise of this new industry. Attractive rates in local agriculture in the 1840s varied from £14 to £20 with perquisites.[6] Young was

1. For this reason this section is included at this point.
2. The Scotsman, 10 December 1862
3. Young's Scrapbook contains this advertisement
4. D. Bremner, op. cit., pp. 490 sq.
5. J.S. Jeans, op. cit., p. 67
6. L.J. Saunders, Scottish Democracy, Edinburgh 1950, p. 42

estimating that his retortmen in 1851 might expect £1 per week.[1] But the level of industrial wages in the area was considerably depressed by the decline in handloom weaving - before the Bathgate oil-works opened, handloom weavers in the parish and town of Bathgate were paid as little as 4/- per week.[2] Young and his partners probably did not pay as much as £1 per week, although to attract men from the gas industry, where the best related experience could be obtained, would entail paying about 18/- per week.[3] As the Bathgate works grew and as the gas-making propensities of local Scottish cannel coals became obvious, the demand for labour also increased. With the widening of capital after 1860, this new industry set up a demand for a wide range of heavy engineering products - machinery, retorts, storage tanks, piping, bricks, coal - and this was likely to be a further stimulus to wage-rates. By 1869 unskilled labourers according to age could earn 16/- to 19/- per week,[4] but by that time retortmen had been reduced to the unskilled level by the advent of better retorts.

From the Addiewell managers' letter copybook for early 1872, some good information can be obtained about working conditions. Retortmen at Addiewell in 1872 began their week's work at 6 p.m. on Sunday and left off at 10 p.m. on Saturday.

1. C.f. Young's early costing attempts, 1850-51
2. The Scotsman, 1 February 1869
3. 18/- per week was the common wage for gas retortmen in urban Scotland and also industrial Lancashire in the early 50s. The Journal of Gas Lighting 1851, passim
4. D. Bremner, op. cit., p. 490

Two shifts operated: the day-workers alternating weekly with the night workers. Each shift normally worked 12 hours for six days but in order to allow the change from night work to day work the night shift did an extra half shift of six hours. Thus, retortmen worked 78 hours one week and 72 hours the next. For his 78 hour week in February, 1872 a retortman received 22/9d.; for the 72 hour week he received 21/-. He probably lived in a Company house with a rent of 2/-, leaving 19/- to 20/9d. per week.[1]

Attempts to reduce these hours had been made in 1866. On 21 April, 1866, Young noted after visiting Addiewell and Bathgate that he "... expected a strike of retort men at Bathgate but it passed over ..."[2] This flair for recognising signs of labour unrest was not apparent on 8 May, 1866 when the Addiewell retort men stopped work "... for 1/- a week and stop at 2 o'clock on Saturday ..."[3] If this strike was successful, its results were short-lived for these objectives recur as desiderata in 1872.

The retortmen's working conditions were far from pleasant, since the heat and chemical fumes must have been very great. Patrick Gallagher at the end of the 1880s remarks that at the age of 16 to 17 he was paid 4/- per day as a retortman

1. Scottish Oils, MSS., Letter Copybook, 1872, pp. 290 sq.
2. Pocket Diary, 1866, 21 April 1866
3. Ibid., 8 May, 1866

for seven days a week for very warm, thirst-creating work. He preferred shale-mining - and even more the life of "Paddy the Cope" in Newcastle.[1]

Young's attitude to labour was to eliminate effort and disease wherever this was practicable. Hence, the labour-saving devices at Bathgate and Addiewell; hence the water sprays beneath the shale crushers to reduce the dangers from dust. He believed in the social scientific improvement of the working classes - his efforts in establishing the company's school at Addiewell were well-rewarded. His insistence on good housing conditions for his workers was consistent with this attitude. By 1872 the Company also employed a works doctor, who, from the letter copybook, appeared to have been part of the organisation for sometime.[2] Serious accidents in Young's works before 1872 had been very few, despite the risks from fire. According to one reasonably authoritative source,[3] there were no fatal accidents from 1851 to 1862. By 1872 there was a voluntary and entirely arbitrary accident benefit paid by Young's Company to workers seriously injured.[4] The Company also paid for hospital expenses at the Edinburgh Royal Infirmary.[5]

1. I.I. Redwood, op. cit., p. 76 and P. Gallagher, My Story by Paddy the Cope, London 1939, pp. 56-62.
2. Letter Copybook, 1872, p. 296
3. The Scotsman, 10 December 1862
4. Early in 1872 there was one case of damaged eyesight, the result of an accident in Addiewell refinery. The company paid 5/- per week. (Letter Copybook, 1872 pp. 265 sqq.)
5. Letter Copybook, 1872, p. 317

Workers organisations appear to have been temporary, for limited objectives; there is no evidence of permanent trade union organisation except among the shale miners. There are several reasons which provide some explanation of this. The industry and Young's company attracted workers with prospects of better pay and housing which tended to dull discontent. There were widely differing standards prevailing in the industry which in a period of expansion allowed groups of workers successfully to play off one employer against another. Within the same works the proliferation of piece-rate scales divided workers according to age, process and skill; this gravitated against sentimental solidarity and unitary economic organisation. Workers often had to learn the habits of combination, since they were new to industry.

Some indication of the diversity of pay scales can be gained from the rates paid to four sons all working with their father in Addiewell refinery in 1872. The youngest received 6/- per week, and the three others received 14/-, 17/- and 17/6d.[1] per week. With their father's accident benefit of 5/-, this provided a total family income of 59/6d. per week, from which they paid 2/- in rent.

Labour relations in the shale-oil industry were affected by the widespread agitation early in 1872 for shorter hours and greater wages. There was a strike of all five coopers at John Watson's Bathville works in January 1872; this group

1. Ibid., p. 266, 22 February 1872

were a critical section in the labour force since they made the barrels in which the finished oil was transported for sale. They were a skilled group and in consequence received the local standard wage for their trade of 26/- per week. Watsons asked for the support of Young's Company and named the five coopers to enable employers to discriminate against them.[1] On 5 and 14 February, 1872 there were managers' and employers' meetings about the short-time agitation; these resulted from the obvious indications that groups of workers were clearly playing off one company's wage record against another in a period of labour shortage.[2] No agreement was reached about a standard wage structure for the industry, and, therefore, on 16 February, 1872 Young's Company decided, if pressed by the men, to reduce the standard working week from 60 hours to 57 hours, and in trades where this was impracticable to pay a 5% wage increase.[3] A fortnight later, the men working a 60 hour week at Addiewell - blacksmiths, engineers, boilermakers, plumbers, joiners, pattern-makers, coopers and masons - in a "memorial" to the manager requested a reduction from 60 to 51 hours. They were told then that the Company had anticipated the short-time agitation but were not prepared to reduce hours lower than 57 per week. On 2 March, 1872 the men wrote to the manager agreeing to accept the 57 hour week.[4]

1. Ibid., p. 248, 30 January 1872
2. Ibid., p. 272, p. 291, and pp. 304-305
3. Ibid., p. 300
4. Ibid., pp. 301-303

The men working a 60 hour week were a privileged number, whose activities stimulated other trades to agitate. Locomotive men at Addiewell normally worked a 72 hour week; they petitioned for the 10 hour day i.e. for 60 hours per week. The shiftmen who worked on the oil boilers had a working week of 84 hours; they asked for an "allowance" for what they worked more than 57 hours,[1] the Company simply agreed to pay 5% more for the same hours. But these increases were not granted to those who did not agitate: the workers in the candle department, in the paraffin houses and in the refinery received nothing. The total cost of these increases at Addiewell for one week in March, 1872 was only £17. -. 2d.[2]

Foremen were treated as far above even the most skilled workers. They signed individual contracts and often for a period of years, they lived in better type houses in a "gaffers' row", and naturally, their conditions of employment were generally better, although their contract tied them to their employer. The foremen in the paraffin houses at Addiewell received a minimum basic wage of 35/- per week with a bonus of 4d. per ton on the refined paraffin wax produced - over the year 1871-2 this tonnage bonus was worth, on an average, 4/10d. per week.[3]

1. Ibid., pp. 303-304
2. Ibid., pp. 305-307
3. Ibid., pp. 307-309

If the Lothians became a boom area in the 1850s and 1860s this is not to say that social problems did not arise. Overcrowding became a feature of life in most of the shale-oil villages. Addiewell and Oakbank were models compared with other unplanned villages and even they were overcrowded. Addiewell in 1871 had 289 families in 246 houses and at Oakbank 60 families lived in 54 houses.[1] This problem was a direct result of the great population increases which affected settlements in the 1860s.

TABLE 40

TO SHOW POPULATION INCREASES IN SELECTED VILLAGES 1861-1871

Village/Settlement	1861	1871
Armadale	2,504	2,708
Bathgate	4,827	4,991
Broxburn	660	1,457
Uphall	No Return	360
Crofthead	1,593	2,362
Benhar	No Return	417
Blackburn	758	954
Kirkliston	572	647
Whitburn	1,362	1,432
Addiewell	No Return	1,356
Oakbank	No Return	355

Source: The Census of Scotland ... 1871, pp. 144-145

There was often a striking imbalance in the population structure - far more males than females. This is most clearly apparent in the new settlements: 835 males to 521 females at Addiewell in 1871 and 214 males to 141 females at Oakbank.

1. The Census of Scotland ... 1871, pp. 144 sqq.

Apart from schools and housing there was little in the way of social or public capital to deal with this increase in population: no reformatories, no hospitals, no institutions for the blind. Police cells were the only "amenity" provided for the healthy and the Union poorhouse at Linlithgow had accommodation for 133 paupers,[1] but even this was far less than what was needed. Indeed, pauperism for some increased in this area almost as rapidly as prosperity for others.

TABLE 41

NUMBER OF PAUPERS IN COUNTY OF LINLITHGOW (1854-1865)

Parish	1854	1857	1860	1863	1865
Abercorn	40	85	74	63	56
Bathgate	155	191	213	361	454
Bo'ness	221	201	180	250	159
Carriden	67	103	95	88	85
Kirkliston	67	111	92	86	100
Linlithgow	186	267	261	297	316
Minavonside	36	68	74	82	96
Whitburn	75	102	113	114	167
Total	847	1128	1102	1341	1433

Source: House of Commons Return Relating to Poor Houses (Scotland) 27 April 1866, paper no. 217.

Gradually, community organisations arose. Cooperative trading and reading rooms spread from the established community of Bathgate. The number of public houses also increased greatly. Armadale village had grown greatly from about a dozen houses in the 1840s - and its first public buildings were two churches, built in 1862.[2] In Broxburn, similar growth had

1. Ibid., pp. 144 sq.
2. The Scotsman, 28 June and 15 December 1862

occurred; there a savings bank had been opened in 1861 and

> "... has met with the greatest success; the deposits having already amounted to several hundred pounds, almost entirely from the savings of the labouring community ..." [1]

Cramond possessed an active Parish Mutual Improvement Society [2] in 1864 which held educational meetings. The West Calder Public Subscription Library, founded about 1811 but defunct "for a number of years" was being revived in February, 1872 - the financial help of Young's Company was successfully sought [3] to assist the resuscitation. Bathgate fared best: in 1862 the Bathgate Bowling Club was founded and by 1868 there was even a Bathgate Cricket Club with twenty enthusiastic members. In addition, the Working Men's Institute was well established as was the town band and the gymnastic games.[4]

One outstanding solvent in these communities was extensive Irish immigration and settlement. The growth of racial violence and religious tension is plainly evident from 1862.[5] Social occasions were often marred by battles of one sort or the other. Catholic churches proliferated as the immigrants became settled; over the same period Orange Lodges and "Masonry" became more militant and extreme.

1. The Scotsman, 23 June 1862
2. The Scotsman, 30 April 1864
3. Letter Copybook, 1872, pp. 234-235
4. The Scotsman, 12 May 1862; Valuation Roll for the County of Linlithgow, 1868-69
5. The Scotsman, 11 and 15 July 1862

JAMES YOUNG AND ADULT EDUCATION

"My idea is this, that ... they should teach chemistry as a branch of general education, which every man ought to know ...
... I am very anxious that scientific instruction should be advanced or disseminated as widely as possible ..."

James Young before the Royal Commission on Scientific Instruction and the Advancement of Science. 8th March, 1872

1. Introduction : a period of educational ferment

James Young, for the last twenty-five years of his life, was directly concerned with the administration of Anderson's University in Glasgow.[1] They were exciting years, years full of local and national controversy - the whole future of British Education, for almost a century, was decided then. In 1858 a state pattern of elementary education was still an exhilarating dream for Radical politicians; the reform of ancient schools and universities was a developing desideratum; the creation of entirely new institutions was becoming an urgent necessity. British society was faced with the problem of evaluating its competitive position in an industrialising world - this presented educational issues which Young and all those concerned with education had to solve.

In most parts of eighteenth century Europe educational institutions were geared to the limited needs of an agrarian society. Scientific and technical education was not likely

1. Young was elected a Trustee of Anderson's University on 22nd September, 1858. (M.S. Minute Book of the Managers and Trustees of Anderson's University, 22nd December, 1830 - 22nd December, 1864, no pagination.) When he died in 1883 he was a Manager of Anderson's College.

to be taken so seriously. Like the rest of education it was a possible cause for anxiety, since there was a widespread fear that it would produce cumulative change. Self-liquidation is, understandably, not the conscious aim of most elites. Nor had Britain's initial drive to industrialisation been the result of close ties between entrepreneurs and higher education. Many entrepreneurs had learned to read and write; a few had not even done that. There were, however, educational pioneers who recognised that society had to come to terms with science and technology, that the institutions for higher education were defective or inadequate and that chages must be made.

For the European Enlightenment produced a disconnected and disunited group of philosophers, scientists, savants and politicians anxious to reform society by means of new educational institutions. This group, despite the widespread recognition of the inadequacy of society's provision for education, was strongest in France and Britain, where it came to the fore in the last two decades of the century. In France the group of thinkers, later pejoratively dismissed as the Idéologues, spawned ideas and institutions which, fortunately, far outlived their progenitors - the most successful and most widely known is the École Polytechnique.[1] According to the most recent authoritative work,[2] scientific and technical education was

1. F. Picavet, Les Idéologues, Paris 1891, pp. 32 sqq. and p. 327; F.M.H. Markham, Henri, Comte de Saint Simon, (1760-1825), Selected Writings, Oxford 1952, pp. xxix-xxx
2. J. Fayet, La Révolution Française et la Science, 1789-1795, Paris 1960, passim, but especially pp. 272-284

given an enormous stimulus by the French Revolution, and the Napoleonic system of education seems to have grown from the controversies created by the Idéologues.[1] Two of the most important of them, Fourcroy and Condorcet, favoured the establishment of a free system of higher education so that French universities and high schools would cease to be generating centres of privilege.[2] From the Idéologues St. Simon developed his view of education as an agent of social change. He believed that a new industrial society would inevitably supersede agrarian society and he thought that education in science and technology would expedite this change, since the masses would need the control and guidance of a educated elite which could only be recruited from the scientists and industrialists. This concept was very influential - as were the St. Simonians - in the development of scientific and technical education in France in the nineteenth century.[3]

In Britain there was a parallel movement which achieved a more popular base in the many provincial philosophical and literary societies - and in working class scientific societies.[4] The most outstanding representative of this social intercourse was the famous Lunar Society of Birmingham, although there were similar societies in many parts of Britain by 1800. In

1. W.A. Smeaton, Fourcroy, Chemist and Revolutionary, Cambridge, 1962, pp. 80 sqq.
2. Ibid., pp. 59 sq.
3. F.M.H. Markham, op. cit., p. xxviii
4. T. Kelly, A History of Adult Education in Great Britain from the Middle Ages to the Twentieth Century, Liverpool 1962, pp. 98-111

Glasgow Professor John Anderson tried to make science available to artisans and in 1796 left his property to found an institution for that purpose.[1] This was the earliest really significant event in what became the nineteenth century attempt to make higher education relevant to the social, economic, and technological needs of British society. Anderson believed, like St. Simon, that the task for the future was to rebuild an organic society on the basis of new ideas and new forces. Their representatives, the scientists and captains of industry, would replace priests and agrarians; the certainties of science would replace superstitions and dogma. This positivist vision of a new society could only be realised, if more civic universities arose from the enterprise of groups and individuals.

There were many such other attempts. The industrialist, John Marshall, a pioneer of flax-spinning machinery, favoured a new university in Leeds as early as 1826;[2] in 1831 T.M. Greenhow advocated a local university in Newcastle-upon-Tyne;[3] by 1843 Queen's College, Birmingham, was established and the new technologies represented in its teaching - only to fail for financial reasons.[4] There were many schemes in Manchester long before John Owens bequeathed his fortune in 1845 to found a new college.[5] The universities of London and Durham were then well established.

1. J. Muir, John Anderson and the College he founded, Glasgow 1950
2. A.E. Wheeler, A short account of the University of Leeds, 1924, p. 7.
3. W.H.G. Armytage, Civic Universities, London 1955, p. 170
4. Ibid.
5. For example, William Whatton addressed two open letters to Manchester Royal Institution in 1829 urging it to apply for university status (E. Fiddes, Chapters in the History of Owen's College and of Manchester University, Manchester, 1937, p. 206)

Gradually practical results multiplied as the new men in society accumulated wealth and power. Thirty years after the Institution of Civil Engineers was incorporated, the Mechanical Engineers in 1847 were given corporate status.[1] The Royal College of Chemistry was founded in 1845;[2] in 1848, J.S. Muspratt, the son of the founder of the alkali industry in Lancashire, founded a private college of chemistry in Liverpool.[3] Perhaps, James Young learned more than industrial management from his few years with the Muspratts in Lancashire.[4]

However, it was not until after the Great Exhibition of 1851 that the demand for a new type of university really developed. Its supporters came generally from the middle class and the skilled manual workers, although the leaders of the "promotion campaigns" often included members of the nobility. Prince Albert formally opened the Museum of Practical Geology in South Kensington which he hoped would become the nucleus of an "Industrial University". But after the appointment of Sir Roderick Murchison in 1855 this wider vision was lost,[5] despite the excellence of the teaching staff. To the Prince Consort and several of the Commissioners of the Great Exhibition, the need for a new type of institution required little demonstration:

1. W.H.G. Armytage, op. cit., p. 181
2. T.L. Humberstone, London and the Advancement of Science, 1931, pp. 171-173
3. W.H.G. Armytage, op. cit., p. 192
4. James Young was employed by James Muspratt, father of Sheridan
5. W.H.G. Armytage, op. cit., pp. 196 sq.

> "... a rapid transition is taking place in Industry; raw material, formerly our capital advantage over other nations, is gradually being equalised in price, and made available to all by improvements in locomotion, and Industry must in future be supported, not by a competition of local advantages, but by a competition of intellect ..." [1]

According to Lyon Playfair, James Young's friend and mentor, the establishment of Industrial colleges for scientific research and teaching was the best solution that Britain could provide to such a competition.[2]

On the continent the competition had already begun. By 1831 Germany has six Technische-Hochschulen: Karlsruhe founded in 1825, Darmstadt in 1826, Munich in 1827, Dresden in 1828, Stuttgart in 1829 and Hanover in 1831.[3] One British pioneer of the Industrial University, J.A. Lloyd, F.R.S., looked enviously at the French system of technical and scientific education and in 1851 proposed that models of the École Polytechnique should be established throughout Britain,[4] although, a generation earlier, Baron Dupin had urged the French government to note and copy the Andersonian University as one of "... the institutions which conduce to the progress of industry and of the knowledge that directs it ..."[5] James Hole, Secretary of the Yorkshire Union of Mechanics' Institutes, favoured state

1. Lyon Playfair, "The Chemical Principles involved in the Manufactures of the Exhibition as indicating the Necessity of Industrial Instruction" in Lectures on the Results of the Great Exhibition of 1851, London 1852, vol. i., p. 193
2. Ibid.
3. W.H.G. Armytage, op. cit., p. 234
4. J.A. Lloyd, Proposals for Establishing Colleges of Arts and Manufactures, (privately printed), 1851
5. Baron C. Dupin, The Commercial Power of Great Britain, exhibiting A complete view of the Public Works of the country, London 1825, vol. ii., pp. 235 sqq.

grants for the better type of Mechanics' Institutes, which, he thought, could become constituent colleges of the proposed Industrial University.[1] This was well in advance of continental thinking.

But apart from Anderson's University, Owen's College, the University of London and the South Kensington colleges, little was being done to advance the teaching of applied science, although modern theoretical science had penetrated the curricula of most of the existing universities.[2] A few technical colleges were founded by local enterprise, for example, in Wigan, in 1858. The idea generally faded in the fifties and revived after the Second Reform Bill. By that time James Young had taken sides in the debate.

Why did the idea of technical universities and colleges recede? Lack of state support was probably the most important reason, but state apathy was merely a reflection of the lack of interest in British society. Commercial and industrial prosperity did not establish a climate in which radical reexamination of scientific and technical training would occur. Training on the job was thought to be all that was necessary or, as T.H. Huxley put it in his address, delivered at the opening of Sir Josiah Mason's Science College, Birmingham:

1. James Hole, History and Management of Literary, Scientific and Mechanics' Institutes, London 1853
2. D.S.L. Cardwell, The Organisation of Science in England, London 1957, p. 71

> "... The practical men believed that the idol whom they worship - rule of thumb - has been the source of the past prosperity and will suffice for the future welfare of the arts and manufactures ..." [1]

But the practical men could, perhaps, be excused. Few had graduated to industrial management via formal education. Without a scientifically trained and qualified management, British industry was unlikely to encourage technical education.[2] If industrialists did not regard technical and scientific education as important, they were unlikely to urge their workers to attend classes or to reward by promotion those who did so. There was a widespread fear that trade secrets would become common property. Even the more progressive believed that an elementary education system was a crying necessity; scientific and technical education was a luxury for aspiring foremen.[3]

If British industrialists were generally unenthusiastic about scientific and technical training for their workers, the trade unions were equally remiss. But then, they were infant institutions with more obvious industrial objectives. Workmen of left-wing persuasions might ask themselves whether it was worthwhile acquiring a technical and scientific education, if, according to the nature of society, the main profits of their endeavours would go to their employers. Individual artisans, indeed, were not likely to be interested in science and

1. T.H. Huxley, Science and Education: Essays, London 1893, p. 137
2. S.F. Cotgrove, Technical Education and Social Change, London 1958, pp. 27 sq.
3. Ibid., pp. 41 sq.

technology alone; they were also, if they believed in education at all, likely to be concerned about the political and economic theory of their own society. Courses in politics and economics did not occur in the teaching of the few technical and scientific institutions that did exist, despite their advocacy in Scotland by Thomas Chalmers.[1]

James Young and the other pioneers of adult education in Britain had to convince the rest of society of the importance of their beliefs and activities. They had to convince industrialists, trade unionists and politicians; they had to reform old institutions and create new; they had to undermine the current social, economic and political dogma of laisser-faire, for there were many Liberals - even Thomas Chalmers - who worshipped the idea of self-help and feared that government grants for scientific and technological education would deprave the individual and act as subsidies to otherwise inefficient industries, preparing the path for greater state intervention in the future.[2] From educational controversy practical men had to produce practical results.[3]

1. Thomas Chalmers, On The Christian and Economic Polity of a Nation, Glasgow 1839, vol. iii., pp. 104 sqq.
2. J. Wilson Harper, The Social Ideal and Dr. Chalmers' Contribution to Christian Economics, Edinburgh 1910, pp. 363 sqq.
3. D.S.L. Cardwell, op. cit., p. 98

2. James Young, the Educationist

James Young was exceptional in that he possessed most of the qualities necessary to the ideal educationist. He had the capacity to theorise, the ambition to achieve power to implement his theories, the wealth and the philanthropic sentiments to give his theories material chances of success. Unlike most of the successful entrepreneurs of nineteenth century Britain he had been an academic; he had invented a science-based industry. His spectacular success in business was apparent to all - it was likely to give his views a wider hearing than Glasgow alone.

As an industrialist in a new section of a new industry, it may well be imagined that Young had sound material reasons for forming theories on working class education, for the heavy chemical industry, like many other industries of the nineteenth century, was becoming increasingly dependent upon a regular supply of personnel trained in basic scientific method and specialising in industrial chemistry or other sciences. This requirement was not for research personnel alone - indeed these were very few - but rather for the supervisory grades in industry. Existing academic courses were generally unsuitable; indeed, their irrelevance was the subject of fringe complaints by scientists, industrialists and politicians. In Glasgow and the West of Scotland Young was one of the leaders of prevailing discontent, just as in England his great friend and fellow-scientist, Lyon Playfair, urged radical revision

and reform of education.[1] Young's views were made clear in May, 1871, when he subscribed to a joint prospectus issued by the Glasgow Committee for the Promotion of Technical Education:

> "... None of our universities or Institutions have hitherto provided the kind of instruction required - in a great measure in consequence of the difficulty of finding teachers who passess a practical knowledge of the art to which the application of science is to be taught ..." [2]

Accommodation had to be provided and teachers to be found for a new type of adult education.

Young by 1858 had travelled widely on the continent of Europe; in 1860 he was to visit America and Canada; throughout the 1860s and 1870s he was to continue his travels. He had seen educational and training institutions in many different countries. He had been to Karlsruhe, the oldest of the German Technische Hochschulen, where, from the earliest days, there had been departments of applied science and where, by 1860, there was an active school of Chemical Technology[3] of the type that Young was to endow in Anderson's University. In

1. The best account of Lyon Playfair's part in urging educational reform in England is to be found in D.S.L. Cardwell, The Organisation of Science in England, pp. 61 passim. See also T. Wemyss Reid, (ed.) Memoirs and Correspondence of Lyon Playfair, (London 1899) pp. 145, passim
2. W. Montgomerie Neilson, Technical College, (Glasgow 1880, privately printed) p. 5
3. Karlsruhe, founded in 1825, was modelled on the École Polytechnique. E. Terres, (ed.) Die Technische Hochschule Fredericiana Karlesruhe: Festschrift, (Karlesruhe Technische Hochschule, 1950) pp. 6 sq. For educational developments on the continent and in America during Young's lifetime see L.F. Haber, The Chemical Industry during the Nineteenth Century, (Oxford 1958) pp. 63-79. This is the most recent and authoritative treatment of the subject.

Switzerland he had visited Zurich, the home of the Eidgenössiche Technische Hochschule, founded in 1855. There by 1870, two departments of Chemistry existed, both with a world-wide reputation and one of which was headed by Georg Lung, an outstanding expert on the heavy chemical industry and Young's fellow-judge at the Paris Exhibition of 1867.[1] The Select Committee, appointed by the House of Commons that year, reported that:

> "... the facilities for acquiring a knowledge of theoretical and applied science are incomparably greater on the Continent than in this country ..." [2]

With this judgement Young would have agreed. Young's interest in remodelling adult education in Scotland was not merely the product of his indigenous discontent but, more likely, the result of his ability to compare current educational practice in the United Kingdom, particularly in Glasgow and the West of Scotland, with his contemporary experience elsewhere.

Young was on good terms with many avant-garde thinkers - and not merely scientists. Apart from Playfair, who was far more than a scientist, there was August Wilhem von Hofmann, probably the greatest teacher of Applied Chemistry in Britain or Germany during the nineteenth century.[3] Dr. Angus

1. L.F. Haber, op. cit., p. 73
2. Report of Select Committee on Scientific Instruction, 1867-1868, p. viii.
3. For the career of A.W. von Hofmann, (1818-1888), see J. Volhard and E. Fischer, August Wilhelm von Hofmann, Berichte der deutschen chemischen Gesellschaft, special issue vol. 35, pp. 12 sqq.; and L.F. Haber, op. cit., pp. 68-69

Smith[1] and Dr. John Stenhouse, two more of Young's contemporaries at Anderson's University, were keenly interested in scientific and technical education. Stenhouse and Young corresponded on many subjects, but particularly on the question of education. From him Young received a memorandum which Stenhouse had circulated internationally; this contained "Proposals for the establishment of a Society for the discovery and cultivation of a superior ability, chiefly among the lower ranks of the community ..."[2] This society, according to Stenhouse, would collect £3,000 to £4,000, and then subsidize the university education in science and technology of poor, gifted boys. The scholars would be recruited from any country, but their college would have to be attached to a British university in Glasgow or Edinburgh or London.[3] Young supported the international principle but felt that the problem was most urgent at home in Glasgow and the West of Scotland.[4] However, one significant feature about Young's character was his general willingness to discuss the problems of workingmen's education - even in the cafe of the Louvre.[5] The out-

1. Dr. R. Angus Smith, F.R.S., (1817-1884), was one of Young's close friends and a regular correspondent. He made his reputation as a pioneer of public health and was appointed the first Chief Alkali Inspector under the Act of 1863, (26 & 27 Vict. c. 124.), against Alkali Pollution; the Alkali Act of 1874, (37 & 38 Vict. c. 43.), was the result of his pressure. (See L.F. Haber, op. cit., pp. 206-207)
2. Thom Collection of James Young's Private Papers: Undated MSS. (8 fo.), probably early 1860s: I suspect late February or early March 1861
3. Ibid., fo. 2.
4. Thom Collection: Letter Book of James Young, 1860-1863, fo. 35-36, 4th March 1861
5. Thom Collection: Pocket Diary of James Young, 1867, 20th April: "Long talk about education of working men in the Caffe (sic) of the Louvre".

standing influence on Young was Lyon Playfair, who, in England, became the leader of the movement for a Technical University.[1] It was Playfair who suggested to the Select Committee on Scientific Instruction in Theoretical and Practical Science to the Industrial Classes, (1868), that facilities and courses at the new university colleges should be developed for the better education of foremen and managers in industry.[2]

It was not merely that Young felt that technical instruction was an economic necessity for industries such as his own nor was he a simple-minded sentimental philanthropist dabbling starry-eyed in adult education. After all, when he took his greatest part in developing educational facilities in Glasgow he had retired from active business; and he never spent money rashly. His educational theories were the product of a coherent rationalist and radical philosophy - he was a Philosophical Radical with the Philosophical Radical's general belief in the value of a good education to the individual and the community. Yet this philosophy was ingrained by his own experience as a successful industrialist - and he never abandoned it. The achievement of the greatest happiness of the greatest number for him was based on empiricism. His own training in Anderson's University evening science classes - and afterwards as Graham's assistant - had helped Young to make his fortune and to found the oil-shale industry in Scotland, a source of employment and betterment for thousands.

1. D.S.L. Cardwell, op. cit., pp. 61-62 and pp. 84 sq.
2. House of Commons Select Committee on Scientific Instruction ... Report, 1867-1868, pp. 58 sqq.

Young had been associated with many able men, his contemporaries at the Andersonian, whose training there had been the prelude to great industrial and social service - undoubtedly the one to make the greatest popular impression was David Livingstone.[1] Clydeside, Lancashire, Great Britain and the world would have lost many men of talent, had it not been for the extra-mural training provided by Anderson's University. Young felt that he might make a definite step towards the Liberal Millenium by augmenting and reorientating the facilities provided by Anderson's University, for education provided one means to an artificial identity of interest between the individual and the community - his actions would be justified if another Livingstone was discovered and put on the road to fame, if another industry was founded in Scotland or if existing industries received a ready supply of young men of ability, equipped with the knowledge and the technical training to maintain Britain's industrial hegemony.

James Young had much to offer to the service of adult education. His enthusiasm for scientific and technical education was an outstanding asset, not always shared by other Victorian self-made men.[2] His wide experience was coupled with remarkable intelligence and vast wealth. As an academic, who maintained an active interest in science until his death in 1883, he was likely to know and appreciate the problems of

1. The 1830s was a remarkable period in the history of Anderson's University. Many brilliant men attended classes then before making their names in public life. Young knew most of them.
2. In this respect, Young was like George Stephenson, the self-taught railway engineer, whom he admired considerably, and also James Watt.

the teacher in the laboratory and class-room; as a successful industrialist he could well recognise the value of the views on educational training of his fellow-manufacturers. He never became the narrow scientific specialist, intent only on advancing the claims of one subject at the expense of others; he could command the respect, so necessary to the mediator between academic disciplines. Above all, Young was not likely to suffer from complacency about British scientific and technical education, for he had attended every great international exhibition from 1851 onwards, often in an official capacity as a judge. Thus, he had every opportunity to feel conscious of British education's shortcomings and, for example, to share the general enlightened concern about the relatively poor showing of British goods at the Paris Exhibition of 1867. Unlike many, who could only complain and campaign at the political level for Select Committees or Royal Commissions on scientific and technical education, Young could canalise his discontent into active remedies for his own native area.

3. Young's Association with Anderson's University

a. Anderson's University

In 1858 he was elected a trustee of Anderson's University under the terms of John Anderson's will.[1] The 81 trustees divided into 9 classes - tradesmen, agriculturists, artists, manufacturers or merchants, mediciners, divines, natural philosophers, and kinsmen or namesakes -[2] were the sovereign body of Anderson's University, but, in practice, the executive body of 9 managers tended to exercise the greatest influence upon the policies of the University. The 9 managers elected from among themselves a President, who was the chief officer of the University, and they also appointed a secretary.[3] The Trustees met for 4 statutory meetings in the year and the Managers for 12.[4] Young's election was to the eighth class of Natural Philosophers - manufacturers tended to infiltrate into additional classes, especially into the first and the eighth;[5] they also often controlled the ninth. Both the Managers and the Trustees of Anderson's University during the period of Young's association with them - from 1858 to 1883 - seem to have been in favour of experimental changes in the education provided by the institution under their control.

1. M.S. Minute Book of the Managers and Trustees of Anderson's University, (22 December 1830 - 22 December 1864), no pagination, 22nd September 1858
2. Article Third of the Will. A copy of John Anderson's will is given as an appendix to the Anderson's College, Glasgow, Act of 1877, (40 Vict. c. 12).
3. Article Sixth of the Will
4. Articles Fifth and Sixth of the Will
5. By 1867, when Young became a manager, every member of the eighth class of trustees was, or had been, a manufacturer, and most of the first and ninth classes. Counting Young, there were four chemical manufacturers or plant managers in the eighth class.

Not that Young was in any position to influence policy in his first years as a trustee. That was under the control of Walter Crum, F.R.S., elected President of Anderson's University in 1848, the man who was to hold this office until 1865, the longest Presidency in the history of the Andersonian.[1] Crum set an example of great initiative to Young: in 1856/7, with Young, he tried unsuccessfully to bring the great Justus von Liebig to Scotland;[2] he raised money for the endowment of lecture courses;[3] he went out to collect funds for rebuilding[4] - but when he retired from the Presidency, the Andersonian was still dependent upon sums raised on the value of its buildings and rents paid by the professors. But the buildings in George Street included a large new lecture theatre, which impressed a raw, young Professor of Natural Philosophy, G. Carey-Foster, who recalled it thirty years later.[5]

The equipment was not so impressive:

> "... Physical apparatus at the Andersonian on my arrival was most of it conspicuous by its absence, and a good part of what did exist consisted of contrivances for producing curious or surprising effects, veritable tricks, rather than apparatus for instruction ..."[6]

1. A.H. Sexton, The First Technical College, (Glasgow, 1894) pp. 58-59. For greater details of Crum's life c.f. Anon., Memoirs and Portraits of One Hundred Glasgow Men, Glasgow, 1886, vol. i., pp. 93-96
2. Wemyss Reid, op. cit., pp. 169 sq.
3. Ibid.,p.59. In 1861 the Freeland Trust of £7,500 was created for popular lectures in Chemistry, Mechanical and Experimental Physics, and Anatomy and Physiology, mainly through Crum's enterprise.
4. In 1861 Crum reported that £3,000 had been collected for new buildings. (Minute Book, 1830-1864, 9th September 1861).
5. G. Carey-Foster, F.R.S., to A.H. Sexton, 9th September 1893. (M.S. Letter in Andersonian Library MSS.)
6. Ibid.

Young, knew of the state of the apparatus, because he had[1] inspected it, on behalf of the Trustees in 1860. In Carey-Foster's second session, (1863-1864), Young tried to remedy this defect by paying the wages of a skilled mechanic to assist the Professor of Natural Philosophy.[2]

> "... Mr. Young not only found the money but with the advice of his friend, Mr. James Napier, the well-known chemist and electro metallurgist, he found the man, William Grant, who from Anderson's University went to University College, London, where he has been for more than five and twenty years ..." [3]

This was an early example of Young's generosity; he paid an assistant for the Professor of Natural Philosophy anonymously for many years.[4]

Walter Crum's presidency was followed by that of William Euing, a wealthy insurance broker, who endowed the Euing Lectureship in Music and bought adjacent property to the University in George Street.[5] Thus, Young's apprenticeship in educational administration - from 1858 to 1868 - was served under two excellent examples, since Crum and Euing were overwhelmingly generous in their support of Anderson's University. Yet the financial position of the University was chaotic; there were debts, mortgages and no general funds; student numbers were

1. Minute Book, 1830-1864, 24th July 1860
2. Carey-Foster to Sexton, 1893
3. Ibid.
4. When the Chair of Natural Philosophy was advertised in 1872, the advertisement and particulars of the appointment contained a reference to the provision of a paid assistant by the generosity of an unnamed trustee. (M.S. Minute Book of the Manager and Trustees of Anderson's University, (1865-1881), advertisement attached to p. 240).
5. A.H. Sexton, op. cit., pp. 59-60. C.f. also short note on Euing in Anon., Memoirs and Portraits of One Hundred Glasgow men, vol. i., pp. 123-126.

growing and so were the number of subjects taught in the University; the problem of accommodation was becoming urgent; professors received no salaries except if they were Freeland lecturers; they paid rents and depended for their livelihood on industrial consultancy and students' fees; the apparatus available to them had to be bought out of their own incomes; professors seemed to have little sense of a university spirit nor could this be expected if they were encouraged to regard Anderson's University as a place where they boarded and met students who provided their livelihood. Apart from John Anderson's will of 7th May, 1795, there was no legal raison d'être for the University at all[1]; the Trustees were not incorporated and their funds were not safeguarded by the law; John Anderson's conceptual vision may have been all very well for the last years of the eighteenth century, but it was exceedingly doubtful whether it was relevant to the changed circumstances of Young's Victorian years. Without university status or degree-granting powers, unlike Owen's College which was affiliated to the University of London from its beginning, Anderson's University was unlikely to become more than a staff training ground for other institutions.

1. Anderson's University was not established by royal charter but under a charter granted by the magistrates of the city of Glasgow, in virtue of powers delegated to them by the Crown. In other words, its constitutional position was anomalous. See R. Renwick (ed.), Extracts from the Records of the Burgh of Glasgow, vol. ix., pp. 27-31

b. Young's Elevation to the Presidency

On 2nd September, 1865, James Young was co-opted to the Managers' Committee of Anderson's University to assist in the supervision of a course of evening lectures on Natural Philosophy which candidates for the vacant Chair in that subject were to be invited to give [1] .. This unusual but eminently practical procedure was taken to fill the Chair from which Professor Carey-Foster had resigned on his appointment to "... the Professorship of Experimental Natural Philosophy in University College, London [2] ..." Nine years after his election to the Trustees, on 22nd June, 1867, Young, in his absence, was elected to the Managers' Committee [3]. He noted in his pocket diary for Saturday, 21st September, 1867 "... was at meeting of Managers of Andersonian for first time. At meeting of Trustees got Wm. Symington put on. Promised £1,000 to get rid of debt." [4] This at least makes clear that Young's money was promised after his election to the Managers rather than before. As a manager, Young's duties were often unspectacular and pedestrian: considering the applicants for the vacant janitor's post in September, 1867 [5], or helping to decide who should be in the first

1. Minute Book, 1865-1881, pp. 9-10
2. Ibid., p. 7.
3. Ibid., p. 37
4. Thom Collection: Pocket Diary of James Young, 1867, 21st September. The William Symington, whose election Young managed on this occasion, was Reverend William Symington, who was elected into the seventh class of trustees. (Minute Book, 1865-1881, p. 46)
5. Ibid., p. 39

Whitworth Exhibitioner at Anderson's University in September, 1868.[1] But increasingly, as a result of his abilities and reasoned generosity, he felt the desire to play a greater part in formulating the policies and shaping the future of Anderson's University. This opportunity was presented to Young by the retirement from the Presidency of William Euing. On 11 June, 1868, Euing stated that he wished to resign to make way for a younger, fitter and more energetic man;[2] he was convinced that more energetic management was necessary "... in consequence of the greater attention now being paid by the Country to the Education of the People ..."[3] Euing continued in office until 3rd September, 1868, when, unanimously by secret ballot, James Young was elected President of Anderson's University.[4]

The President by position and custom had great authority. The system of Anderson designed to eliminate professorial control and bickering in practice passed power to a kind of Directory - to government by lay committee. And like the Directory, Anderson's committee of managers in practice was susceptible to the blandishments of individual power. Young was supreme during his presidency. From the beginning he was

1. Ibid., p. 69 and p. 71
2. Ibid., p. 66
3. Ibid.
4. Ibid., p. 70. On 22nd June, 1868, Young was present at a Managers' meeting called to elect Euing's successor, but there was no quorum. (Ibid., p. 68). On 24th July, 1868, Euing agreed to continue as President pro tem. (Ibid.). In fact, Euing continued to chair meetings in Young's absences, which were particularly frequent during the period of the dispute with Professor Penny about the establishment of the Chair of Technical Chemistry.

strong because of the unanimity of his election. His wealth, in an age of self-help and no government aid, made him indispensable! Despite the many radicals among the Trustees, it was only when he became very adventurous that there were attempts to control his use of power - and these developed from timidity not from resentment. Young was President of the Andersonian until 1877, but until his death in 1883, he remained an important influence on policy. Indeed his views were often decisive.

Nowhere did he leave a memorial of his ambitions for the Andersonian and, therefore, it is impossible to say exactly what plans he had for scientific and technical education in the Glasgow area. When he addressed meetings, his remarks were rarely reported fully; indeed, he did not enjoy speech-making sufficiently to preserve many of his notes. He was far more at home in the informal committee or bringing shrewd pressure to bear behind the scenes. But when he took the chair at the Trustees' meeting for the first time on 22nd September, 1868, the Secretary of Anderson's University reported that Young made "... some excellent remarks on the importance of Scientific Education ..."[1] and thanked the assembly for the honour they had done him in appointing him President. He spoke feelingly of the "... great benefit he and the public generally had derived from the instruction given in this University ..."[2]

1. Ibid., p 72
2. Ibid.

and he stated that he hoped that "... in the future as in the past the University would prove a powerful auxiliary in Scientific and useful education ..."[1] Young hoped to play his part in the future of the Andersonian, by ridding it of debt, endowing it with funds, securing its legal status, extending its curricula, widening its student catchment area, appointing men of brilliance to its Chairs and providing it with buildings and educational facilities which would ensure its direct relevance to Clydeside's urban industry.

c. Finance

Finance was the key to the whole future: without endowments and gifts it would be impossible to abolish the debts, to provide for more students, to attract the professors or to regularise the constitution of the University. The assets of Anderson's University rose remarkably during Young's Presidency, because either Young found the money personally or he sought money from those who had it, not always with the success that he would have liked. When Young succeeded Euing, the buildings of the University and other assets were worth about £9,000, and this included the recent gift of the Model School Buildings by Euing.[2] There was no general capital fund, and the University owed £4,000 to four banks, the Bank of Scotland, The Commercial Bank, The British Linen Bank and The Union Bank being the creditors.[3] Current expenditure was met by student

1. Ibid.
2. Ibid., p. 167
3. Ibid., p. 73

TABLE 42

GROWTH OF ASSETS OF ANDERSON'S UNIVERSITY (1868-1883)

NATURE OF ASSETS	Before 22 Sept. 1868	22 Sept. 1868	22 Sept. 1870	22 June 1871	13 Sept. 1872	8 Sept. 1873	13 March 1876	30 June 1880	30 June 1883
College Property and Apparatus	College debts of £4,000	College freed from debt by Euing and Young	£9,925		£23,698. 8. -.	£26,324.14.9.		£16,820. 5. 7.	£16,820. 5. 7.
Other Property and Funds			c. £7,500		£6,395. 6. 10.		£22,007.4.10.	£21,463.18. 8½	£31,566. 5. 8.
Young Chair: Property and Apparatus	-		£10,500	£10,500	£10,500			c. £10,000	£11,000
Young Chair: Other Assets	-			£422. 12. -.				c. £10,000	£8,500
TOTALS	c. £5,000	c. £9,000	£27,925		£40,593.14.10.			£59,284.4.3½.	£67,886.11. 3.

fees, subscriptions from Trustees and Managers, normally in the range of one to three guineas each, and very largely by extracting room-rents from its professors[1] and teachers, who were also generally responsible for paying local rates and taxes.

Because the Trustees were not incorporated, there was no absolute security of the University's funds, and this certainly encouraged donors to make gifts by deeds of trust, especially if the gift was large. Young, himself, followed the examples of John Freeland and William Euing when, in July 1870, he finally endowed the Young Chair of Technical Chemistry with £10,500 by separate deed of Trust.[2] Euing and Young together had cleared the debt of £4,000 in September, 1868, each contributing £2,000.[3] By 13th September, 1872, the buildings and assets of Anderson's University, excluding the Young Chair of Technical Chemistry, were valued at £23,698. 8. 0d., and cash funds stood at £6,395. 6. 10d.[4] The session following, 1872-1873, saw the same trend continued: the University property and fixed assets were valued at £26,324. 14. 9d., and cash funds rose a further £4,421. 13 7d.[5] By that stage, the University Managers were advancing considerable sums of money

1. On 22nd June, 1868, the Professors' rents were valued at £467. 5. 7d. per annum, Professor Penny paying the largest at £58. 13. 5d. (Ibid., p. 55)
2. Ibid., p. 159
3. Ibid., p. 73
4. Ibid., p. 241
5. Ibid., p. 278

TABLE 43

FINANCIAL POSITION OF ANDERSON'S UNIVERSITY DURING YOUNG'S PRESIDENCY (1868-1877)

	1870	1872	1873	1878	1880	1882
College Assets	£17,503	£23,698	£26,324.14.9.		£39,284.4.3½	
College Receipts p.a.	£610. 8. -.	£3,977. 5. 4.	£5,082.3.10.		£708.12. 6.	
College Expenditure p.a.	£442.15.9½.	£381.18. 6.	£660.10. 3.		£934. 7.11.	
Surplus/ Deficit p.a.	+ £167.12.2½.	+ £3,595.6.10.	+ £4,421.13.7.	+ £142	- £225.15.5.	c. - £200

TABLE 44

DAY-TO-DAY EXPENDITURE (1870-1876)

Average Annual Cost of Repairs and Decoration	Average Annual General Charges	Average Gross Annual Expenditure
£228. 6. 9.	£308. 15. 3.	£537. 2. -.

Note:

During Young's Presidency, (1868-1877) the average annual surplus of day-to-day income over expenditure was about £130.

on the security of property, providing the University with a steady income by investment.[1] By 1876 there was a cash fund of £22,007. 4. 10d., of which £12,457. 4. 10d. was available for general purposes.[2] On the day to day working account there was also a transformation: on 22nd March, 1878, three months after Young's resignation from the Presidency, the Secretary reported that there had been an average annual surplus on current account of £129. 14. 0d. over the past eight and a half sessions.[3] The surplus for the 1876-1877 session, Young's last complete academic year as President, was £271. 4. 10½d.[4], more than twice the average over the period of his tenure of office. James K. Dempster, the University architect, set a demolition value on the University site of about £16,000 for the area of 1850 square yards in June, 1878[5] - and this did not include Young's personal property, costing about £10,000, upon which the Young Laboratories were built. When Young died in 1883, the total Andersonian assets, including the Young Chair and its buildings, were worth £67,886. 11. 3d.[6] Thus, Young's Presidency was a period of considerable financial growth, although by the time of his death current expenditure had begun to exceed income, the Medical Faculty in particular becoming more and more expensive to administer.

1. Ibid.
2. Ibid., p. 385
3. Ibid., p. 484
4. Ibid
5. Ibid., p. 502
6. Reports of Committee of Governing Bodies giving Technical and Science Teaching in Glasgow, 30th June, 1883. The total funds, etc. in Glasgow at that date available for such teaching was £127,298. 17. 11d.

TABLE 45

YOUNG'S FINANCIAL CONTRIBUTION TO ANDERSON'S UNIVERSITY

YEAR/PERIOD	AMOUNT	PURPOSE OF GIFT
1858-1883	c. £125	Annual Subscriptions
1862-1872	c. £500	Salary for mechanic in Department of Natural Philosophy
1872-1880	£800	Salary of Professor, Natural Philosophy
1868	£2,000	To clear Anderson's University debts
1868	£200	Reconstruction of Professor Penny's Laboratory
1870	£10,500	Endowment of Young Chair of Technical Chemistry
1876	c. £10,000	Cost of Young Laboratory
1870-1883	£600	Bursaries in Technical Chemistry
1876	£2,126. 9. 6.	Endowment of Chair of Applied Mechanics
1877-1883	c. £50	Class Prizes in Applied Mechanics
1877	£613. 11. 5.	Anderson's College, Glasgow Act.
1882-1883	£60	Lectureship in Geology and Natural History
Total	£ 27,575. -. 11.	

Notes:

1. This total of £27,575. -. 11. does not include the value of the Young Collection of books on the history of Chemistry
2. Every amount given corresponds to the value accredited to Young's gifts by the Secretary and Accountant of Anderson's University.

How was it that Young managed to increase the assets and income of Anderson's University so remarkably during his Presidency? His own generosity, of course, was the most important single factor. The Young Chair and its buildings cost Young over £20,000 - and that was by no means his only gift. His example inspired the generosity of others, although men like William Euing were already established in their philanthropy.[1] But Young's energetic management of the University convinced those likely to give that their money would be put to the best purposes. Thus, John Freeland, who had already given £7,500 by deed of trust in 1861,[2] was prepared to promise £2,000 for the "Chair of Practical Natural Philosophy", and this sum was received in May, 1873;[3] when he died in 1878, by his will

1. William Euing's first cash gift to Anderson's University was £1,000, which he made in session 1858-1859. (Minute Book, 1830-1864, 1st June, 1859). By deed of trust dated 31st May, 1866, he gave £3,000 for annual popular lectures in the History and Theory of Music and for lectures in Acoustics and the Science of Music. (Euing's Deed of Trust, 31st May, 1866, is given as an appendix to Act 40 Vict. c. 12). With Young, Euing contributed £2,000 in 1868 to wipe out the University's debts. (Minute Book, 1865-1881, p. 73). In February, 1873, he gave £500 to Young and the other managers to secure an annual endowment of £50 for ten years for the Chair of Opthalmic Medicine and Surgery. (Ibid., p. 252). When Euing died in 1874, it was found that he had left £6,000 to the University General Fund, his invaluable music library and collection of instruments, £200 for making a catalogue of these, £1,000 for making a fire-proof room to house them and to pay a librarian, and £150 for music prizes for students. (Ibid., p. 297). Euing's collection of music quartos (3,000 of them) and instruments was later insured by the Managers for£5,000 on 8th February, 1875. (Ibid., p. 333).
2. Vide p.373 n. 2
3. Minute Book, 1865-1881, p. 258.

dated 8th June, 1868, he left a further £5,000 to the Univer-
sity.[1] The gifts of Euing and Freeland would most likely have come to Anderson's University, no matter who was President, provided he appeared competent.

But Young's initiative and energy in fund-raising can be easily illustrated by considering the endowment of the Chair of Applied Mechanics. The concept of such a Chair was probably derived from Joseph Whitworth's scholarship scheme. In June, 1868, it was reported at a Managers' meeting that one of Whitworth's exhibitions, valued at £25, had been allocated to Anderson's University;[2] a copy of Whitworth's scheme to create "... a faculty of Industry analogous to the existing faculties of Divinity, Law and Medicine ..." was entered in the minutes, and there it was recorded that Whitworth believed it vital that departments of Applied Mechanics should be established throughout the United Kingdom.[3] With Whitworth's sentiments the Managers agreed, and in September, 1869, they planned to appoint a teacher of Mechanical Drawing, as a beginning.[4] In 1872, at Young's instigation, a course of evening lectures on Marine Engineering was given by Mr. Laurence Hill;[5] this proved a great success. Hill reported:

1. Ibid., p. 191 and pp. 479-480
2. Ibid., p. 55
3. Ibid., p. 59. Whitworth's scheme for a Faculty of Industry may well be the origin of Young's Chair of Applied Chemistry, and not Lyon Playfair's evidence to the Select Committee in 1868, as L.F. Haber suggests, op. cit., p. 75
4. Minute Book, 1865-1881, p. 97
5. Ibid., p. 245

> "... The little Hall was nearly full ... My second lecture went off very well and I was told afterwards was very well liked ... I hope these lectures will prove the success the directors wish ..." [1]

Thus, the association between the Andersonian and the applied science of engineering began; education was linked with heavy industry on Clydeside. Meanwhile Young collected money for the Chair.[2] John Tennant of St. Rollox contributed £1,000; James White and his brother, both also manufacturing chemists, put up £500 each;[3] Robert Freeland £500.[4] John Freeland gave £2,000;[5] Young, himself offered £1,000 and David Laidlaw £100;[6] offers of bursaries, amounting to £300 were also received.[7] By September, 1875, £1,126. 9. 6d. was still required, and Young agreed to give this amount,[8] in addition to the £1,000 which he had already promised.[9] On 29th May, 1876, the Managers reported to the Trustees "... This Chair ... suggested by your President about four years ago ..." was to be instituted.[10] Young's vision had been realised.

Young's successful fund-raising - of this £7,00 and other sums - was the product of good public relations. His friends far and wide rallied to his appeals, and so often he personally reported additions to the funds to the Managers. His leadership of Anderson's University inspired confidence in the other

1. Ibid., p. 248
2. Ibid., p. 236, 23rd September 1872
3. Ibid., p. 247, 6th December 1872
4. Ibid., p. 249, 23rd December 1872
5. Ibid., p. 258, 2nd May 1873
6. Ibid., p. 283, 10th November 1873
7. Ibid., p. 354, 9th August 1875
8. Ibid., p. 222 and p. 289
9. Ibid., pp. 356 sq., 13 September 1875
10. Ibid., p. 395

managers, who gave according to their ability. His friend, Dr. John Stenhouse, campaigned for money extensively and secured many bursaries.[1] When Young was cruising in the Mediterranean in the spring of 1875, he called to see John Freeland in Nice.[2] On 24th March, 1876, he took breakfast with James Duncan on Duncan's yacht, Pinico; over the meal they agreed to give £15 each to provide a student with a bursary for one year.[3] Young was prepared to use any opportunity to present the Andersonian as a worthy cause for philanthropy - and generally he was successful.

Economic circumstances did not favour Young's activities in the late 70s. He tried, in 1879, to raise £4,000 locally in Glasgow for the endowment of lectureships in Natural History and Geology, having already offered £1,000 himself.[4] The Managers gave him their support but not their money: they hoped that "... the amount required for these lectureships will be speedily raised ..."[5] J.L.K. Jamieson, President at the time, the Secretary, and Young went canvassing for the money, but without any appreciable success; on 11th August, 1879, it was agreed to defer further canvassing until replies

1. I have been able to trace £1,800 which came to the Andersonian as a result of Stenhouse's efforts.
2. Thom Collection: Pocket Diary of James Young, 1875, 27th April
3. Thom Collection: Pocket Diary of James Young, 1876, 24th March
4. Minute Book, 1865-1881, p. 551, 9th June 1879
5. Ibid., p. 553, 23rd June 1879

had been received "... from some of the parties called on ..."[1] By October, 1879, it was considered inadvisable to press the matter further and it was agreed that "... when business revives further efforts should be made to raise the required sum of £4,000."[2] In fact, this money was never raised.

d. Status

Another basic problem of Anderson's University was the anomaly of its status. Without a charter, its funds were only protected, if they were trustee endowments - lack of adequate safeguards for funds was unlikely to attract more general subscriptions.[3] One of the past secretaries had died owing the University money, and there was nothing to be done. An enterprising President and committee of Managers could be accused of acting ultra vires, if they infringed the terms of Anderson's will, for example, by creating Chairs in subjects which Anderson had not catered for. Professor Penny almost prevented the development of the Young Chair in Technical Chemistry by exploiting these tactics.[4] Incorporation of the Trustees was the answer - and, if with it went a royal charter conferring university status, money-raising would be made so much easier.

There were ground for hope since in other parts of Britain new university colleges were in the process of creation.

1. Ibid., p. 564
2. Ibid., p. 570, 13th October 1879
3. This point was elicited from James McClelland, Trustee for 37 years, by the Royal Commissioners, 8th March, 1872. Royal Commission of Scientific Instruction and the Advancement of Science, Minutes 9,994-9,996
4. Vide infra., pp. 407-421

Matthew Arnold had a visionary's insight in 1868: "We must plant faculties in the eight or ten principal seats of population, and let the students follow lectures there from their own homes ..."[1] John Scott Russell favoured a great federal technical university with one hundred chairs at the central college and twenty five chairs in fifteen local colleges in the main industrial cities.[2] But the provincial colleges grew from much smaller beginnings. The Newcastle College of Physical Science, backed by steel, shipbuilding, mining, and heavy engineering interests, had opened its doors in 1871;[3] by 1874 textile and mining interests had founded the Yorkshire College of Science;[4] Josiah Mason rallied the hardware trade into opening a new university college in Birmingham by 1880;[5] a College of Science for the West of England was established at Bristol in 1876;[6] a university college of Liverpool in 1882;[7] in Nottingham and Sheffield, university extension movements fathered new colleges.[8] In Wales a university college was opened at Aberystwyth in 1872.[9] Why should there not be similar changes in Scotland?

Young and the Managers of Anderson's University decided to rely on the Royal Commission on Scientific Instruction. With the Liberals in power, educational reform in the air and

1. Matthew Arnold, Schools and Universities on the Continent, London 1868, p. 276
2. J.S. Russell, Systematic Technical Education for the English People, London 1869
3. W.H.G. Armytage, op. cit., p. 222
4. Ibid., p. 221
5. Ibid., p. 223
6. Ibid
7. Ibid., p. 224
8. Ibid., pp. 226 sq.
9. Ibid., p. 214

a tradition of self-help in Adult Education going back to 1796, it seemed inevitable that changes for the better would occur. The Devonshire Commission was Gladstone's answer to the steady pressure being exerted on his government by radical pressure groups inside and outside of parliament.[1] In December, 1868, Edward Baines, editor of the Leeds Mercury, was advocating that the colleges at South Kensington should be made into a technical university,[2] and in January, 1868, a conference of interested parties was called;[3] in March, 1868, Joseph Whitworth launched his philanthropic scheme of national scholarships in applied science which he hoped would provide the incentive for the development of faculties of Industry in the existing universities.[4] By 1871 there was an active committee campaigning for a National University for Industrial and Technical Training.[5] Inside Parliament, E.T. Gourley and J.M. Carter urged Gladstone to support this National University.[6]

Finance deterred many Liberals from supporting these radical M.P.s, until J.R. Taylor turned public attention to the wealthy guilds and companies of London, whose endowments had been intended for craft and technical training.[7] In such an atmosphere James Young, James McClelland and Alexander Harvey gave evidence to the Royal Commission on 8th March,

1. Ibid., p. 227
2. D.S.L. Cardwell, op. cit., p. 85
3. Ibid., pp. 85 sq.
4. Ibid., p. 87
5. W.H.G. Armytage, op. cit., p. 227
6. Ibid.
7. J.R. Taylor, Reform Your City Guilds, London 1872

1872.[1] McClelland, an accountant, gave evidence first. He dealt with many questions on finance, student numbers and staff and then openly stated that "... we were as much entitled to a charter from the Government as any school for the teaching of science in Great Britain ..." When asked if he proposed that there should be an additional body in Scotland established to grant degrees, McClelland was clearly non-plussed. He imagined a federal university examing board[2] "... from whom might emanate degrees for the whole nation ..." He also thought - and this was more likely to appeal to the Commissioners - that Anderson's University should become the nucleus for the training of science teachers in Scotland for "... you are powerless to conduct scientific education until you educate teachers in science[3] ..." This was certainly one self-perpetuating weakness in the state system of elementary education.

When Young was examined, he agreed with everything that McClelland had said and went further. He declared that he favoured teaching general science to all classes and that it was vital to the economy and to the community to develop advanced classes in Applied Sciences.[4] He thought government grants should be made to colleges throughout Britain for "... I cannot see a better application of money than by teaching science ..."[5] Lack of suitable endowments had, in his view, been the great drawback to the work of Anderson's University "... We have been

1. The total evidence given on behalf of Anderson's University is to be found in Report of Royal Commission of 1872, vol. ii., pp. 51-58 inclusive
2. Royal Commission on Scientific Instruction and the Advancement of Science, 1872, Minutes 9,991-9,993
3. Ibid., Minute 10,015
4. Ibid., Minute 10,030
5. Ibid., Minute 10,053

a training school for professors. London and the University of Glasgow have taken some of our best ..."[1] He expected to recruit professors who could do fundamental research as well as teach. The best teacher was also an original researcher. "... If he is not, I think it would be a great misfortune ..."[2] Young evidently thought that a charter and adequate remuneration, partly backed by government grants, would enable Anderson's University to attract and retain this type. Science and research would flourish and so would student scholarship.

Anderson's University could make no immediate use of the evidence given by its representatives until the report of the Royal Commission was laid before Parliament, because of its confidential nature, but McClelland, while recognising this, favoured applying to the Government for a charter incorporating the University.[3] However, the Managers decided to wait until the report was available.[4] Meanwhile, they decided to strengthen their case by acquiring more land and accommodation, which was necessary because of increased student numbers. In October, 1873, the Secretary made the first of a series of

1. Ibid., Minute 10,047. Young's view was supported by at least one Professor at the University of Glasgow. On 26th October 1869, Dr. G.H.B. Macleod had sent a letter resigning the Chair of Surgery at Anderson's University "... I am sincerely convinced that my removal to the University of Glasgow has in no small measure been secured by my connection with the Andersonian ..." (Minute Book, 1865-1881, p. 106). Sexton, op. cit., p. 157, states that 17 professors left Chairs in Anderson's Medical School for Chairs in the University of Glasgow between 1796 and 1894. Professors in the Faculty of Arts normally went to England, although a few left university life for industry.
2. Royal Commission on Scientific Instruction and the Advancement of Science, 1872, Minute 10,050
3. Minute Book, 1865-1881, p. 219
4. Ibid.

attempts to purchase the High School which was behind Anderson's University,[1] but by February, 1874, it became clear that this idea would fail.[2] However, by September, 1874, a new laboratory had been built for Professor Forbes[3] who was given power to spend £500 on apparatus, if he so desired,[4] and great improvements were made in the dissecting rooms of the Medical School.[5] The Managers were than thinking of the planning of the complete rebuilding of Anderson's University and Young was to head the sub-committee which was appointed to direct development.[6]

There was also pressure from below. In 1875 the Medical Professors were anxious about the state of Anderson's Medical School, "... which ... was a little behind the requirements of the day ..."[7] New classrooms and laboratory space were urgently needed.[8] A deputation met the Managers and urged them to consider selling the present university buildings, and erecting a new Medical Faculty building in the neighbourhood of the new Royal Infirmary which, they thought, should

1. Ibid., p. 281. Young was one of the prime movers in this scheme and was one of the sub-committee appointed in November 1873. (Ibid., p. 282.)
2. Ibid., p. 290
3. Ibid., p. 302. On 15th August 1873, Young reported that Sir William Thomson, (later Lord Kelvin), had contributed £100 to the funds for Forbes's laboratory. (Ibid., p. 270). Kelvin had at least two connections with Anderson's University: he married Margaret Crum in 1852; she was the daughter of Walter Crum, the President of Anderson's University at that time. (G.F. Fitzgerald, Lord Kelvin, (Glasgow 1899), p. 2). Sexton, op. cit., p. 76, mentions that Kelvin and his brother James, attended evening lectures at the Mechanics' Institute. Kelvin was also one of the first professors of the University of Glasgow to sit on the Technical College Board of Governors in 1887. (Sexton, op. cit., p. 92).
4. Minute Book, 1865-1881, p. 294
5. Ibid., p. 302
6. Ibid., p. 318
7. Ibid., p. 357
8. Ibid.

be absorbed by Anderson's University.[1] The last suggestion of the Medical Faculty was significant: Anderson's University should seek a Royal Charter and adopt a new name, such as Anderson's College of Science.[2] There was considerable discussion, and the Managers promised to reconsider these suggestions later.[3] But the most pressing grievances of the Medical Faculty about the refusal of Glasgow University to accept Anderson's Medical School certificates as valid were referred to the Royal Commission on Scottish Universities in 1876.[4] In 1876, Young's Trustees were negotiating for adjacent property, the Jewish Synagogue, which was to be turned into laboratories.[5] The Managers in Young's absence on the continent decided to limit the cost of any new building to £2,000 at their meeting on 13th March, 1876.[6] They were loth to risk their general fund of £12,457. 4. 10d.:[7] they calculated from their experience of the last six years that to meet an expenditure of about £550 per annum, their total general fund had to be invested at 4%[8]

At Mc.Clelland's suggestion it was decided to reprint privately the evidence given before the Royal Commission in 1872, since the report had now been laid before Parliament.[9]

1. Ibid.
2. Ibid.
3. Ibid.
4. Ibid., p. 400
5. Ibid., pp. 390 sq.
6. Ibid., p. 385
7. Ibid.
8. Ibid., p. 386
9. Ibid., p. 392

As a booklet it was to be circulated to all members attending the British Association meeting, which in 1876 was held in Glasgow.[1] The Booklet was printed; it was being circulated early in July, 1876.[2] The Andersonian buildings and Museum were painted and decorated specially for the occasion,[3] and were thrown open to members of the British Association, and their friends. But Anderson's University's campaign for a Royal Charter was not immediately successful. The Royal Commission's report did not recommend this course.[4]

e. <u>The Private Bill of Incorporation</u>

Young, therefore, decided to apply for a Private Bill of Incorporation and instructed the Secretary accordingly.[5] The Managers then discussed the matter and unanimously decided to support Young's policy.[6] Grahame and Wardlaw, the Parliamentary Solicitors, prepared the draft Bill;[7] by December, 1876, the Bill was in the Private Bill Office, and by 8th January,[8] 1877, the City members and Sir Edward Colebrooke, M.P., had been lobbied.[9] On 12th January, 1877, the Managers were discussing Lord Redesdale's comments on the Bill: he suggested that the number of Trustees should be reduced and that there should be retained some residence qualification for Managers.

1. Ibid.
2. Ibid., p. 408. A copy exists in the Andersonian Library Archives.
3. Ibid., p. 407
4. Royal Commission on Scientific Instruction, Seventh Report, 1875, p. 22
5. Minute Book, 1865-1881, pp. 409-410
6. Ibid.
7. Ibid., p. 411
8. Ibid., p. 429
9. Ibid., p. 432

The Managers opposed both these suggestions, since any reduction in the number of Trustees would diminish both the funds obtainable from subscriptions and the wide area of enlightened interest which Anderson's 81 had ensured; they also thought that attendance by Managers was a better test of interest than residence.[1]

Opposition, in Young's absence, came from the Senatus Academicus of the University of Glasgow. On 5th February, 1877, a conference took place between a deputation from the Senatus and the Managers.[2] The Very Reverend Principal Caird prefaced the discussion by stating that:

> "... there might exist the most cordial relations between the University and Anderson's Institution. They both existed for the promotion of learning and Science, and they could have no interest save in forwarding and acting in friendly relations ..."[3]

Yet, the Senatus felt that they must oppose the Bill. They objected to the name, "Anderson's University", and, therefore, wanted a title containing neither the words "University" nor 'College'. John Anderson still inspired some positive but hostile reactions: he was "... not in very friendly favor towards the University ... he obviously intended to set up what might prove ultimately a rival university ..."[4] This,

1. Ibid., p. 433
2. Ibid., p. 435
3. Ibid., pp. 435-436
4. Ibid., p. 436. This was certainly true, if under-stated by Principal Caird. Later, it transpired that the Senatus Academicus wanted Anderson's University renaming "Academy of Science" or 'Institute of Science'. (Ibid., p. 438).

they intended to prevent. The Private Bill should renounce their right to establish Anderson's University as "... a mimic university ..."; they should disclaim any right to grant degrees.[1]

The Managers of the Andersonian made comments and speeches which varied from the ambivalent to the most candid. Mr. Mc.Kinlay said that he could not imagine that the Andersonian would ever wish to be a rival institution to the University of Glasgow.[2] Yet, McKinlay must have known that he and his fellow-managers, under Young's leadership, had been pursuing a university-promotion campaign; perhaps, he believed that the Andersonian's concentration upon pure and applied science would not infringe the intellectual boundaries of the University of Glasgow. It was futile to McKinlay to deny that Anderson's Managers had intended to secure university status, since the evidence, given by McClelland, Young and Harvey before the Royal Commission in 1872, was in print, and those members of the Senatus who had attended the British Association meetings in 1876 must have received it. The ambitions of Anderson's University were certainly known to a small section of the Senatus, those Medical Professors who had been recruited by the University of Glasgow from Anderson's University. Whatever the source of information, from Parliamentary Papers, hearsay, or informed individuals, it seems most likely that the main grounds of the opposition to the Bill were based on

1. Ibid., p. 437
2. Ibid.

the belief that Anderson's University wished to grant degrees and exercise the other functions of a university.

Mr. Cunliffe followed McKinlay and openly stated that:

> "... one of the principal objects in applying for the bill was to obtain the effect of a Charter, and to place them in a proper relation with the University and they were always seeing that objection was taken to the tickets of the Medical School being accepted by the University on account of its assuming the title of a University ..." [1]

That was why the Managers were prepared to drop the name "University", in favour of 'Anderson's College, Glasgow.'[2] They clearly did not regard degree-granting power as very important in itself; they had made no mention of granting degrees in their Bill, but they were most anxious to ensure that their medical students' qualifications were recognised under the terms of the Act of 1861.[3] There were several reasons why Anderson's College, Glasgow, Bill made no reference to degree-granting powers. Apart from medical students and students intending to take up industrial appointments, they had very few students likely to want to take degrees in science. Medical students were provided for under the terms of the Act of 1861; potential industrial managers were generally not

1. Ibid.
2. The Title, "Anderson's College, Glasgow," was modelled upon Owen's College, Manchester. Anderson had expressly forbidden that the name 'Glasgow' should be associated with his university, and by his will, officials connected with the city's government were ineligible for membership of its governing board or its teaching staff - as were members of the University of Glasgow.
3. 21/22 Vict. c. 83 allowed medical professors of Anderson's University to be regarded as private teachers of medicine; the certificates, which they issued to students successful in their examinations, were as valid as a university degree

degree-conscious. If a student demand did develop, and the government or industry decided that scientific and technological education was to be encouraged, degree-granting powers were not essential. The Managers expected that all degree-granting powers would "... be taken from all Educational Schools and given to an independent body ..."[1] This statement must be seen in terms of the City and Guilds Industrial University movement, which was being officially canvassed; to the examining body in London, provincial colleges were to be linked in a system of examinations of technological subjects.[2] Throughout 1877 and 1878 - and even later - there was considerable public interest and controversy about this scheme, but no "Industrial University", in fact, developed in Great Britain.[3] Mistakenly, as it turned out, the Managers were gambling on the assumption that an Industrial University would be founded, to which Anderson's University would be affiliated.

However, a deliberate insertion in the Private Bill disclaiming degree-granting powers, apparently could do no harm and it might, by improving relations with the University of Glasgow, do some good. The Managers were neatly and logically manoeuvred into this action, once they admitted that they, themselves, did not intend to apply for degree-granting powers.[4]

1. Minute Book, 1865-1881, p. 437
2. D.S.L. Cardwell, op. cit., p. 99. Playfair was recommending such an idea as early as 1851. See his letter to Sir Henry de la Beche, 20th August, 1851 in Wemyss Reid, op. cit., pp. 134-135.
3. D.S.L. Cardwell, op. cit., pp. 98-103
4. Minute Book, 1865-1881, p. 438

The deputation from the Senatus Academicus were, then able to suggest that a disclaimer would suit both parties, for they thought Anderson's will far, far too definite in its requirements of his Trustees: as Professor Allen Thomson put it, "The Will of Anderson directed the Trustees to found a literal copy of the University ..."[1]

Four days after this meeting, on 9th February, 1877, the University representatives sent in, as requested by the Managers, their list of suggested modifications to the Bill.[2] On 19th February, the Secretary of Anderson's University replied, after consulting the Parliamentary Solicitors and legal opinion in Glasgow.[3] The Managers were not prepared to drop the title, "Anderson's College, Glasgow"; nor were they prepared to call their professors 'lecturers', as the Senatus wished, but they were prepared to disclaim degree-granting powers, which they had never enjoyed.[4] No reply was received to the Secretary's letter, but the ten days' delay in sending it may have convinced the Senatus that Anderson's University was using obstructionist tactics to prevent the University of Glasgow protesting against the Private Bill. In fact, on 23rd February, 1877, a petition against the Bill, containing seven points of objection, was presented to the House of Lords by the University of Glasgow, signed by Principal Caird in the name of the Senatus Academicus.[5] Hastily, the Secretary and

1. Ibid.
2. Ibid., pp. 440-441
3. Ibid., p. 441
4. Ibid.
5. Ibid., pp. 442 sq.

and Managers mobilised their defences against this petition by lobbying M.P.s and influential friends of Anderson's University, by preparing to send witnesses from the Faculty of Medicine and from the Trustees.[1] The Bill was due to be heard before a Committee of the House of Lords on Monday, 6th March, 1877.[2] On the previous Saturday, 4th March, 1877, the Secretary received a letter from Professor Blackburn, who was leading the University of Glasgow's objections to the Bill, asking for another meeting between the Managers and a deputation from the Senatus Academicus.[3] Although there was no time for this meeting to be held before the first hearing of the Bill, and Blackburn, indeed, had left Glasgow for London to support the University's petition before his own letter had been delivered, it seems likely that the Senatus were seeking a compromise.[4] On Sunday, 5th March, 1877, the University's counsel approached the solicitors acting for Anderson's Trustees privately, and a settlement was reached: in exchange for a slight rewording of one clause, the University would allow the Bill to pass unopposed.[5] Thus, the Bill on the following day, 6th March, 1877, was sent to Lord Redesdale, Chairman of the Committee of Unopposed Bills.[6] It quickly passed its three readings in the House of Lords and by 22nd March, 1877, had been read for the first time in the House of Commons.[7] It received royal assent on 17th May, 1877.[8]

1. Ibid., pp. 443 sqq.
2. Ibid., p. 445
3. Ibid., p. 446
4. Ibid.
5. Ibid.
6. Ibid.
7. Ibid.
8. 40 Vict. c. 12

The Anderson's College, Glasgow, Act of 1877 incorporated the Trustees, changed the name of the institution and remodelled the powers and duties of both the Trustees and the Managers. Funds were safeguarded by giving the Trustees the right to sue and be sued;[1] gifts could be elicited much more readily when they were protected by law; investments could be modernised from time to time according to varying economic circumstances.[2] Thus, financial regularisation was achieved. The Chair of Technical Chemistry, created by Young in 1870, was permanently associated with Anderson's College, thereby strengthening the teaching of applied sciences in Glasgow and the West of Scotland for ever.[3] Trustees and Managers were no longer disqualified by membership of, or association with, Glasgow University or the government of the city of Glasgow.[4] This clause paved the way for closer and closer co-operation between the higher educational institutions and also the city authorities.[5] However, the sub-clause disclaiming degree-granting powers has in practice placed the University of Glasgow in the dominant position in any negotiations about degree courses which have occurred since the Act. Although at this stage Young was not in the best of health, he had had enough experience of legal disclaimers in business to recognise the weaknesses of such a sub-clause - perhaps, his absence was

1. Ibid., Clause 4; Clause 16 provides for the service of writs on the Trustees
2. Ibid., Clauses 5, 6 and 8
3. Ibid., Clause 7
4. Ibid., Clause 9
5. Ibid., Clause 4

critical. On the other hand, Young could not be expected to anticipate the failure of the technical university movement in Great Britain in the 70s and 80s, nor had he our gift of hindsight. The expenses, moreover, of the Private Bill procedure are well-known; this Act cost £613. 11. 5d.[1], and had it not been unopposed, it would have cost more. It seems that Young's fellow Managers, in his absence, were likely to consider the costs of retaining a principle which the College was unlikely to need - after all, their own immediate needs for medical students were already provided for. In any case, the Technische Hochschulen, which they fervently admired, did not grant degrees either; they were operating in that field of higher education which the Managers intended for their own College. The control of the Trustees and Managers over academic appointments and policy was made clear and complete by this Act. The Trustees were to appoint new professors "... without any recommendations from the Senate ..."[2] They were to have powers to alter lecture courses, to abolish existing professorships or to institute new ones, if they so desired; Anderson's will was no longer their sole authority.[3] Also, they were to have a new common seal.[4]

1. Minute Book, 1865-1881, p. 467. Sexton mistakenly gives the figure of £450 as the cost of the Act, (Sexton, op. cit., p. 63), but this figure is never mentioned in the official minutes.
2. Act. 40 Vict. c. 12., Clause 12
3. Ibid., Clause 13
4. Ibid., Clause 15. The old seal of the Trustees went astray in the 1850s and has never been traced

f. The Young Chair of Technical Chemistry in Young's Life-time

i. The Quarrel with Professor Penny and the initial set-back

James Young's outstanding contribution to education was his creation of the Chair of Technical Chemistry. At the Manager's meeting on 4th June, 1869, Young indicated that he was prepared "... to give a sum of Ten Thousand Guineas for the encouragement of Practical Chemistry ..."[1] A week later Young "explained more particularly the object he had in view and requested the advice and assistance of the gentlemen as to the best mode of carrying it into effect ..."[2] No definite scheme was agreed. Instead, a sub-committee of Messrs. Euing, Harvey, Cunliffe, and McGrigor, together with Young himself, were "... to get the matter put in a more formal shape ..."[3] This sub-committee apparently decided in favour of establishing an additional Chair of Chemistry, little suspecting the consequences to follow. On 25th August, 1869, Young's lawyer and accountant, Alex. Moore, sent a draft deed of trust to the Managers which he had drawn up with Young's approval.[4] On behalf of the Trustees named in this deed, James Napier had written to W.H. Perkin, the inventor of the first coal-tar dyes, offering him the Chair for a period of not less than five years at a salary of £300 per annum.[5] Perkin accepted.

1. Minute Book, 1865-1881, p. 86
2. Ibid., p. 87
3. Ibid
4. Ibid., p. 94
5. The holograph copy signed by James Napier, on Young's behalf, is in the Perkin collection of I.C.I. Library, (Dyestuffs Division), Manchester

At the request of their sub-committee, the Managers met on 27th August, 1869, specially to discuss the draft deed of trust and the provision of accommodation for the Young Chair of Technical Chemistry[1] within the buildings of the University. There was only one slight modification of the deed: the Young Trust would pay the rents of their professor.[2] With this made clear, the Managers recommended the acceptance of Young's offer to the Trustees at their meeting on 1st September, 1869.[3] Young was absent;[4] Harvey and McClelland, two senior managers, successfully proposed this recommendation[5] - only Dr. James Adams protested but, ominously, he had taken the trouble to make his protest in writing, pleading that there was "... no authority under the last Will and Codicil of the Late Dr. Anderson for the appointment of two Professors[6] of Chemistry ..." Adams said later that "... I protested ... because the Trustees had not been furnished with any information which would prepare them for safe legislation ..."[7] But on the morning of that meeting the Glasgow Herald had announced the appointment of W.H. Perkin,[8] and Adams's close friend, Professor Frederick Penny, the incumbent of the existing Chair of Chemistry in Anderson's University, had been thoroughly affronted.[9]

1. Minute Book, 1865-1881, p. 94
2. Ibid.
3. Ibid.
4. Ibid., p. 95
5. Ibid., p. 96
6. Ibid
7. J. Adams, Reasons of Protest against the Appointment of an Additional Professor of Chemistry in Anderson's University, (Glasgow, 1869), p. 1.
8. Glasgow Herald, 1st September 1869
9. F. Penny, Remonstrance and Appeal against the Nomination and Appointment of an Additional Professor of Chemistry in Anderson's University, (Glasgow 1869), p. 1.

On 8th September, 1869, Professor Penny wrote to W.H. Perkin, pointing out that:

> "I regard this appointment not only as antagonistic but as very injurious to my interest .... I strongly object to your intrusion upon my province as the Professor of Chemistry ..."

He felt that Perkin's appointment "... with equal status in the same Institution ..." gave Perkin:

> "the opportunity and ... the necessity of endeavouring to supersede me .... and of seeking emoluments which have hitherto been my peculiar and indeed my principal recompense and privilege ..." [1]

This letter was written "on terms of friendship", according to Penny,[2] but it was clearly designed to put Perkin off.

There is some evidence that Penny was only partially successful. Writing from Harrow to a Glasgow friend, R. Hogg, Perkin refers to his enclosure of "... a pleasant letter from a friend ...",[3] but this satirical reference to Penny's letter did not hide his uneasiness. He suggests that "... now the school is being written about in the papers[4] I suppose war is commencing ..." He intended to avoid any entanglement, by telling Penny that there was no difference between them but only between Penny and the Trustees.[5] Hogg, a dyestuffs merchant, was keeping Perkin in touch with events in Glasgow;

1. Andersonian Library MSS. Penny to Perkin
2. Ibid.
3. Andersonian Library MSS. Perkin to Hogg
4. The Glasgow Herald carried reports, not always accurate, of the progress of events on the 2nd September, 1869, 7th September, 1869 and 13th September, 1869
5. Andersonian Library MSS. Perkin to Hogg

Perkin thanks him for "... the paper with a letter from a Trustee telling James Young how to spend his money ..."[1] Dr. Stenhouse had written to Perkin, telling him that Mr. R. Henderson was prepared to endow a scholarship in the new school - £50 per annum, for three years - and had promised "... to write to Mr. J. McEwan asking him to do the same ..."[2]

Professor Penny aimed to prevent the fruition of such schemes. In a letter to the Secretary, dated 10th December, 1869, Penny hinted that he might sue at law.[3] He was the source of Adams's legalism, for it was Penny who had transcribed Anderson's will and given a copy to Adams.[4] Both Adams and Penny then prepared a pamphlet war. On the 11th September, Adams had printed his "Reasons of Protest ..."[5]; on the 15th, Penny issued his "Remonstrance and Appeal ..."[6]; Both of these had reached the Managers and the Trustees by 20th September, 1869.[7]

The Managers met on 20th September, 1869, and, in Young's presence, discussed at some length the Young Trust, without considering these pamphlets, which were taken as read.[8]

1. Ibid.
2. Ibid.
3. Minute Book, 1865-1881, p. 97
4. Andersonian Library MSS. Andrew Freeland Fergus to H.F. Stockdale, 25th January 1927. Fergus had this copy, which "was made by Dr. J. Penny (sic), at one time Professor of Chemistry in Anderson's University ... I know of no reason why Dr. Penny transcribed the will ..." Fergus would not know of this episode because it was ignored by the official historian of Anderson's University, A.H. Sexton.
5. This date is given in Adams' pamphlet
6. This date is given in Penny's pamphlet
7. Minute Book, 1865-1881, p. 98
8. Ibid.

This meeting broke up without any decision being taken - no unified course of action could be agreed. Two days later, the Managers met before the Trustees' meeting;[1] since Young was absent, discussion was probably more free than on the previous occasion. The pamphlets of Adams and Penny were thoroughly discussed. The substance of Adams's Reasons of Protest[2] was essentially legalistic. He believed that:

> "... contrary to, and inconsistent with, the object of the Institution and the intentions of the Founder ...",

this new Chair was being created. New rules and regulations had been created and existing rules and regulations had been modified:

> "... without notice or intimation having been made and entered in the Record six weeks at least before the time of the discussion or enactment, all in terms of Article Eleventh of the Deed of Constitution ..."

Valid appointments could only be made after considering the "... conjoint opinion and recommendation of the Professors then holding office .." The Professor of Technical Chemistry "... owes Anderson's Trustees nothing, and is not in any way subject to their control ..."[3] Adams concluded by stating that he believed that the interests of the Medical School might well be endangered and that there might result direct harm to Penny "... who has been laborious and active in the discharge of his duty ..."[4]

1. Ibid., p. 99
2. Adams, op. cit., p. 12
3. Ibid., p. 4
4. Ibid., p. 12

Although very occasionally Adams stooped to sensational comment - "Money has been rattled in a padlocked box, and the Trustees have been regaled with the sound" [1] - Penny was far more vituperative. He claimed that the first that he had heard of Young's Chair of Chemistry was from the morning papers on 1st September, 1869. [2] For him it was a story of swift and ruthless action coupled with shifty connivance, a shabby intrigue. According to Penny, "... the entire business had been pushed through at a sitting of a very few minutes duration ...", but, despite this, "... several of the astonished Trustees had yet found time to gather their thoughts, and had asked for information and delay ..." [3] One gentleman, with whom Penny had had no previous contact on this matter - so he said - had protested against the hastily concluded proceedings. [4] This was, of course, Adams, Penny's close friend for over twenty years. Connivance between these two seems most likely, especially since we know that Penny transcribed Anderson's will, and Adams used it as the basis of his legal objections. What seems most likely to have been the real cause of Penny's aggrievement was Perkin's appointment and the terms of Young's draft deed, which one Trustee, probably Adams, allowed him to see. [5] Why should Penny wait a week before he wrote to Perkin? Perhaps, he had not realised that he was totally excluded from

1. Ibid., p. 5
2. Penny, op. cit., p. 1. Adams repeats this is his Biographical Sketch of the late Frederick Penny, Ph.D., F.R.S.E., Professor of Chemistry, Anderson's University, Glasgow, (Privately printed 1870), p. 23
3. Penny, op. cit., p. 1.
4. Ibid., p. 2.
5. Ibid.

Young's largesse. Not only did he object because he had:

> "... neither directly nor indirectly been consulted as to the arrangements under Mr. Young's Trust ..."

but also because he thought that it was intended :

> "... and provided that I shall be practically superseded in my office, and cruelly, however unwittingly, injured in my feelings and legitimate pecuniary interests ..." 1

He felt that he had an absolute right to be consulted:

> "... in virtue of my position as the thirty years occupant of a Chair to which I was appointed to teach, and in which I have taught; Chemistry in all its branches ..." 2

Penny suggested that Young's new Chair had little hope of acquiring prestige unless it were attached to the Andersonian, neither would its occupants. His view was that the Andersonian would gain very little from the association:

> Young's Trust was to be financed quite separately from the Andersonian; the Trustees of the Andersonian were to have no power to appoint, supervise or dismiss the occupant of the Young Chair; the sole "questionable advantage" was that Young's six Trustees, "... as vacancies occur among their number, are enjoined to select from among Anderson's eighty-one Trustees ..." [3] To Penny the arrangement "... seems a strange one-sided connection ... sanctioned by no analogy - no precedent - no experience ..." [4]

1. Ibid.
2. Ibid.
3. Ibid., p. 3
4. Ibid.

Penny pointed out that the connection between the Young Chair and the Andersonian was not merely tenuous but also possibly temporary. Young's Trustees would rent part of the Andersonian building for their professor, but under the Young Trust deed they need not continue the occupancy. Clumsily, he imputed mercenary motives:

> "... the probability of having a monied lodger may be a very important element in the minds of some of Anderson's Trustees in determining this question ..." 1

However, he admitted that he was not free from mercenary and selfish considerations himself. He thought:

> "... this intrusion of an additional Professor of Chemistry ... as most prejudicial to my vested rights and to my future success and usefulness ..." 2

But Penny was:

> "... fully and indeed painfully aware that whether my words be few or many I lay myself open to the blame of having said either too little or too much ..." 3

He felt that his long service justified his right to comment. He had transformed a department of 58 students into a school of over 800.[4] As far as he was concerned, Technical Chemistry had its Chair already, for his students were not only medical students but:

> "... either sons of chemical manufacturers or young men following earnestly the study of Chemistry with a view of becoming connected with chemical works ..." 5

1. Ibid., p. 4
2. Ibid
3. Ibid., p. 5
4. Ibid., pp. 5-6
5. Ibid., pp. 6-7

There was no need for an additional Chair; his own laboratory was "... unmistakably a Technical Laboratory ...", in which, the previous session, 1868-1869, "... the number of students working ... has exceeded that of any laboratory in Great Britain, excepting one, and that exception is one so peculiar, and so really exceptional, as to deserve exclusion in the estimate ..."[1][2] According to Adams, Penny meant the Royal College of Chemistry, from which, of course, Perkin would have come.

Perhaps, one main root of Penny's anger was his failure to gain anything from Young's scheme. He had already benefited from Young's philanthropy in 1868, when Young had provided £200 to pay for alterations, so that more laboratory space could be provided for Penny's students.[3] Penny spoke then of "... the timely assistance of Mr. Young in defraying the expenses ...", which he said "... had been a great boon to the Institution ..."[4] He had quarrelled with the Managers about paying an additional rent for his improved laboratory, a sum of £14, according to Adams.[5] Young could certainly have not been impressed by such a man, easily the wealthiest professor and yet the ring-leader when disputes about rents arose.[6]

Penny regarded the Young chair as a personal insult, part of a vendetta being pursued by Young. He felt that the title,

1. Ibid., p. 6
2. Adams, Biographical Sketch, p. 20
3. Minute Book, 1865-1881, p. 75
4. Ibid., p. 78
5. Adams, op. cit., p. 22
6. As, for example, in 1866, (Minute Book, 1865-1881, p. 30)

Technical Chemistry, had been chosen deliberately, so that its very novelty might deceive the more gullible Trustees. He was anxious to avoid material loss: "Technical Chemistry has been ... the principal source of my earnings and income ..." [1] It is quite certain that business consultancy was the main source of what Penny described to Adams as "... the truly splendid income realised from my present position ..." [2] For years Penny had concentrated on consultancy to the exclusion of academic research: he had been an expert scientific witness in patent cases, in public enquiries and in "... criminal cases on behalf of the Crown ..." [3] Adams's view was that Penny had the largest industrial consultancy practice in Great Britain "... for some years before his death his professional income exceeded £6,000 a year and it was progressing ..." [4]

Naturally, it could be expected that Penny would not welcome a consultancy competitor of the calibre of Perkin, whose scientific and industrial reputation was prodigious. Penny's sense of his own dignity and status was offended by the prospect of a very young man being imported as his equal: Perkin was:

> "... to be made at once co-equal with myself - to share my students - to share my consulting rooms ... to participate in all the benefits and advantageous results which have cost me so many years of labour and thought to build up ..." [5]

1. Penny, op. cit., p. 8.
2. Adams, op. cit., p. 20
3. Penny, op. cit., p. 9
4. Andersonian Library MSS: Letter from Adams to A.H. Sexton, 1893
5. Penny, op. cit., pp. 9-10

His pride and his pocket had been hurt!

Yet Penny had already thought of retirement so that he could undertake more leisurely research months before the Young Chair was mooted. Writing to Adams, Penny indicated this "It is hard, very hard to give up ... I may never again have an opportunity of doing it so gracefully or so graciously ..." [1] This was almost prophetic. Once the quarrel became public property, Penny felt that he could not retire, without the public thinking that he had been superseded by Perkin. [2] Penny was sceptical of Young's ability to be impartial in his dual position as President of Anderson's University and chief trustee of his own Chair. [3] Once Perkin was appointed and in the Andersonian, Penny's bargaining position was bound to become weaker. He suspected greater duplicity when he discovered from William Euing that the Managers had been led to believe that Young had obtained Penny's "... complete concurrence ..."; Euing said that otherwise the Young Trust deed would not have been approved. [4]

This certainly seems to be untrue. Having discussed both pamphlets, the Managers minuted that they still favoured the acceptance of Young's offer individually. [5] Neither was it

1. Adams, Biographical Sketch, p. 20
2. Ibid., p. 24
3. Penny, op. cit., p. 11
4. Adams, op. cit., pp. 27 sq
5. Minute Book, 1865-1881, p. 99

true that Young had ..attempted to railroad his scheme to reality; there had been considerable consultation from 4th June onwards. There was nothing in the draft Trust deed which had not been subject to negotiation. Its terms were clearly based on the Freeland and Euing Trusts and Penny had not objected to the first of these, perhaps, because he received an annual stipend of £100 from it. Young had already been a munificent benefactor of the Andersonian; in science and business he had relentlessly lived and prospered by backing his hunches and being impatient of restrictions upon his authority. How could he have been successful otherwise? He was likely to be a laughing-stock, if he gave way to Penny; after all, the man had apparently more students than he could reasonably teach and a very lucrative industrial consultancy practice. What was likely to be Penny's loss was the Andersonian's gain: Perkin was a man of undoubted genius, already a Fellow of the Royal Society, a man likely to advance the fame of the Andersonian and the Young Chair - Penny was not of the same stature.

If Young's motives for remaining obdurately in favour of establishing an additional chair are perfectly clear, the reasons for the Managers' decision to reverse their recommendation of 1st September are certainly obscure. Their central motive for action on 22nd September was still the same as it had been earlier:

> "... the furtherance of that scientific education to which the Establishment of Anderson's University in this City has so largely contributed ..." 1

They believed, (and Young was not there to influence their words),

> "... that the progress of scientific knowledge called for the subdivision into several departments of these branches of knowledge and enquiry ..." 2

How could they rely upon the guidance laid down in John Anderson's will? How could Anderson - or anyone, for that matter - prophesy the future progress of scientific knowledge? Anderson had done his best for the knowledge of his day. Why should not they attempt to do their best for the knowledge of their day? Other universities created new Chairs by subdividing the old "... as seemed conducive to the public interest ..." 3

Besides, even in Anderson's University there had been changes. The "... original programme of the founder ..." had been modified by the creation of new Chairs.[4] Were they alone of all University Trustees to "... stereotype the requirements of 1796 as answering to those of 1869 or of following years ..."[5]? Were they alone to:

> "... refuse to extend the teaching of their schools - whether of Medicine or of Arts - in accordance with the usages of other institutions and the requirements of the time ..."? 6

1. Ibid
2. Ibid
3. Ibid
4. Ibid. Anderson's full scheme of professors was never implemented.
5. Ibid
6. Ibid

Penny and Adams were wide of the mark, for no injustice or injury to individual interest was intended.[1] In fact, the Managers had expected Penny to benefit. All those who took courses in the principles of Chemistry, and, therefore, the Technical class:

> "... might prove a feeder to the existing Chair of Chemistry and the interests of the occupant of the latter be indirectly advanced ..."[2]

They had thought Penny so over-loaded with his duties that:

> "... it seemed clearly impossible to super add to these the peculiar obligations as to technical teaching which it was proposed to lay upon the new Professor ..."[3]

They regarded Penny in much the same way as the University of Glasgow had regarded Professor John Anderson. He was an awkward customer.

Despite all these arguments in favour of accepting Young's offer, the Managers felt that the legal difficulties, raised by Adams and Penny, were too great. They, therefore, recommended the Trustees on[4] 22nd September to turn down Young's offer ..." with much regret ..." However, several Trustees still favoured accepting Young's offer.[5] An amendment was proposed, asking that a committee be appointed to find out whether a Chair of Technical Chemistry could be added without contravening Dr. John Anderson's will, "... keeping in view the

1. Ibid., pp. 99 sq
2. Ibid., p. 100
3. Ibid.
4. Ibid.
5. Ibid., p. 102

existing rights and interest of the present Professors ..."[1]

This was defeated, and the Secretary was to communicate the Manager's minute of regretful refusal[2] to both Young and Penny.

Young was deeply offended and proceeded to make plans for the establishment of an independent school of Technical Chemistry in Glasgow.[3] He refused to be party to a bargain to buy Penny off, which Penny suggested in a letter to the Managers:

> "... I am quite willing to vacate my chair, and leave the trustees unfettered by my occupancy, on condition of my receiving a reasonable compensation for my apparatus in the Institution and for the loss I should thereby incur ..."[4]

This offer to resign was disregarded by the Managers, and it is quite clear that Young had no wish merely to replace Penny by Perkin. Penny's health was far from good at this stage:

> "... I have been constrained to remain close in town, and to give my mind to the defence of my reputation and of my material interests; and the consequent confinement, mental worry, and pained state of feeling have together so affected me as to exaggerate my old complaint ..."[5]

1. Ibid. Five Medical Professors had supported Penny
2. Ibid
3. Glasgow Herald, 22nd September 1869. Before the meeting, this paper had been informed that at the meeting Young was likely to ask leave to withdraw his offer. Young, in fact, did not attend the meeting. At the Chemical Section of the Glasgow Philosophical Society, it was reported that Young intended to establish an independent school of Chemistry in Glasgow. (Reported in Chemical News, vol. xx., p. 247, 19th November 1869)
4. Adams, op. cit., pp. 28 sq
5. Minute Book, 1865-1881, pp. 113-114. Penny certainly felt a deep sense of personal injury. He wrote to Adams at this time: "The Andersonian cruelty pursues me everywhere and is no respecter of my bed or sleep - I write you after a bad, bad night ..." (Adams, op. cit., p. 31)

He, therefore, gave up his evening classes until 12th November, when he collapsed, dying ten days later.[1] Penny's death was reported to the Managers at their meeting on 3rd December, 1869.[2]

They minuted their sympathy with his dependents and:

> "... their sense of the loss which the University has sustained by the death of Dr. Penny who has so ably filled the Chair of Chemistry for upwards of 30 years ..."[3]

Significantly, however, there was no immediate attempt to appoint a successor or to advertise the vacancy; Penny's assistant, Dr. John Clark, was to carry on his classes.[4]

ii. <u>The Young Chair established</u>

Young was probably informed of Penny's death by Alex. Moore, to whom he wrote on Christmas Eve from Rome "... What about the Andersonian?"[5] At the next meeting of the Managers on 7th January, 1870, Young's friend and confidant, James Napier, was asked to prepare a paper "... as to the advantage to be gained from the creation of a Chair of Technical Chemistry in Glasgow ..."[6] It seemed that, with Penny dead, Young might still get his own way. Napier's paper was read to the Managers on 19th January, 1870.[7] This could be depended upon to summarise the views of all those connected with the revoked

1. Ibid., pp. 31 sqq. It seems definite that this controversy contributed to Penny's death.
2. Minute Book, 1865-1881, p. 117
3. Ibid
4. Ibid
5. Thom Collection: Letter Book of James Young, 1867-1873, p. 53
6. Minute Book, 1865-1881, p. 122
7. Ibid., pp. 123 sq.

Young Trust, for Napier had been its secretary and the writer to Perkin. Young's views, in his absence, could not have had a better exponent.

Napier pointed out that since the last election of a Professor of Chemistry, that subject had changed greatly. More was known about the scientific principles of chemistry; industrial applications of the subject had constantly multiplied; there was room in teaching the subject for additional specialists. Apart from the revolution in chemical knowledge in all fields, "... there had also been a much greater demand for Chemical instruction..." [1] Without considering medical students who took chemistry as subsidiary part of their course:

> "... there are now twenty to one who studied chemistry 30 years ago. But that is short of the demand for chemists ..." [2]

Napier was confident that if a good course in Technical Chemistry was arranged, there would be no shortage of students. He was equally critical of existing courses:

> "... As Chemical education stands at present, manufacturers know that, if they engage a young man as a Chemist, although he may have certificates of proficiency for years of study in the Laboratory, when he enters the Factory he has to begin an apprenticeship, and for a year or two is of little use to his employers ..." [3]

A more practical course of Technical Chemistry would enable the student to be of more immediate use:

> "... after a few months the student might be able to enter a manufactory, alive to everything going on, and even with less prejudice than when taught in the Works ..." [4]

1. Ibid., p. 124
2. Ibid
3. Ibid
4. Ibid.

A school of Technical Chemistry would bring academic distinction as well as students. So, according to Napier, it was eminently desirable that Young should be prevailed upon to repeat his offer to endow such a school for it would not only free the Trustees from economic anxiety and responsibility but also inaugurate a vital system of education.[1]

Napier's paper was then debated, and the Managers agreed unanimously to submit his scheme to the Trustees:

> "... with a recommendation that the President should be requested to renew his offer to endow a Chair of Technical Chemistry ... and that in the event of his doing so, the Managers should be authorised to accept the offer ..."[2]

The Trustees met on 28th January, 1870, and without any controversy agreed that Young should be approached once more, his sensibilities placated by:

> "... the high appreciation entertained by the Trustees of the motives by which he was induced to make a proposal to endow a Chair of Technical Chemistry ..."[3]

But Young was away on a Mediterranean tour and could not easily be reached. Neither was he well-disposed if one can judge from the actions of the Managers. Unable by normal means to find a quorum on 29th January, 1870, a few of them adjourned and re-assembled at the house of William Euing in West George Street, thereby adding the necessary one for the quorum.[4] There was "... long and anxious deliberation as to the best method of giving effect..." to the Trustees' resolution.

1. Ibid
2. Ibid., p. 125
3. Ibid., p. 126
4. Ibid., p. 127

It was finally agreed that the Secretary should write "... to request Mr. Young to let him know when he could favour the Managers with an interview ..."[1] The Secretary reported on 1st February, 1870, that "... Mr. Young's present address is Jerusalem ..."; inevitably weeks would pass before any answer could be expected.[2]

Young's first meeting on his return was on 3rd June, 1870. On that occasion he told the Managers that the draft Trust deed was so worded that the Chair would always be "... under the control and superintendence of persons practically acquainted with the subject ..."[3] There were still obstacles. Daniel Forbes, a Trustee specially co-opted for this meeting, put the view that the whole idea of a Trust ought to be reconsidered and that the Young Chair ought to be under the direct control of the Managers.[4] When the Young Trust met on 14th June, 1870, they agreed with Young, who did not wish to alter the terms or nature of the original deed. They felt that if the Andersonian Trustees wanted alterations, they should put forward their suggestions.[5] The Trustees met on 16th June, 1870, and appointed a committee of seven of their number and all eight Managers, (naturally, excluding Young), to consider Young's Trust deed and to make suggestions about modifications of it.[6]

1. Ibid
2. Ibid., p. 128
3. Ibid., p. 138
4. Ibid
5. Ibid., p. 141
6. Ibid., pp. 147-148

On 29th June, 1870, Daniel Forbes produced his suggested modifications of the Young Trust deed: first, that the idea of an independent Trust should be abandoned and secondly, if this suggestion was not accepted, that there should be consultation and report between the Young Trust and Anderson's Trustees.[1] Young sent a tart reply to this joint committee of Managers and Trustees on 8th July, 1870. He still stood by the idea of an independent Trust but he was prepared to have his Trustees confer with, and report to, the Andersonian Trustees, and he added:

> "..... I never doubted the entire practicability of the harmonious working of the two chairs, although the Technical Chair should be under an Independent Trust, and I quite understaod that my Trustees, all of whom are Trustees, and some of whom are managers of the University, would have seen to that harmonious working, without special directions from me on the subject ..."[2]

Nonetheless, Young had the draft Trust deed extended by Alex. Moore, and a copy was sent to the Trustees of Anderson's Univæsity for their formal acceptance.[3]

The Copy Deed of Trust was unexceptionable - save in very minor matters of language. The Trustees were to be Young himself, his son, James, his friends and fellow-chemists, Alexander Harvey, Hugh Bartholomew, and James Napier; the sixth was the venerable William Euing.[4] The total endowment

1. Ibid., pp. 150 sq.
2. Ibid., pp. 154 sq.
3. Ibid., p. 155
4. Ibid., p. 156

of ten thousand guineas was divided into three parts; the income from the first £5,000 was to pay for accommodation and apparatus; income from the next £5,000 was to pay the Professor's salary; the last £500 could be used at the Trustees' discretion to supplement the Professors' salary or for some similar capital purpose, but never more than £100 per annum.[1] The Trustees had absolute control over investment of the funds but they were not to be held responsible for losses incurred through investment failures. Yet they were to seek reasonable security when making investment, and there was to be strict accounting; the Trustees were on no account to allow their investment funds:

> "... to be mixed up with the funds of the said Anderson's University or lent to the Managers thereof ..." [2]

This provision was copied from the Euing Trust deed and was included because at this time the Trustees of Anderson's University were not incorporated. Yet, James Young's Trustees were to be selected from John Anderson's Trustees, and as soon as any one of them became ineligible to act as a Trustee of the University, he ceased to be eligible for membership of the Young Trust. Young, during his lifetime, controlled appointments to the Chair; the Trustees could only nominate. After Young's death power of appointment was vested exclusively in the Trust.[3]

1. Ibid.
2. Ibid., p. 157
3. Ibid.

This draft deed revealed Young's amazing mixture of liberality and egocentricity. He liked command and absolute control - he was used to it. In practice, he had increased the assets of Anderson's University tremendously, from £17,503 to £28,003.[1] Was he not being merely human when he expected to play with his own gift? Was he not wise to maintain some legal control in a separate Trust rather than commit itsfuture irrevocably to that of an institution with a long history of enforced parsimony?

On 11th July, 1870, the Trustees accepted the inevitable with good grace. They formally accepted Young's offer and expressed "... their high sense of his liberality ..."[2] The laboratories, which would have been prepared for forty students, the previous January, had Penny not caused their postponement, were to be made ready.[3]

iii. The Young Chair under Professor Bischof

Ten months later, at the Manager's meeting of 5th May, 1871, Young stated, on behalf of his Trustees, that Gustav Bischof, son of the eminent Professor of Chemistry in Bonn, had been appointed to the Young Chair of Technical Chemistry.[4]

1. In the balance sheet of 22nd September, 1870, University assets were put at £17,503, receipts at £610. 8. 0d., and expenditure at £442. 15. 9½d. The balance was £167. 12. 2½d. (Ibid., pp. 165-167)
2. Ibid
3. Ibid. It was announced in the Chemical News, 17th September, 1869, that Young's laboratory would open in January, 1870, "... and will accommodate about forty students." (Chemical News, col. xx., p. 142.)
4. Minute Book, 1865-1881, p. 186.

Despite the many legends that Perkin took up his appointment in Glasgow, there can be no doubt that Bischof was the second man to be appointed to the Young Chair but the first to occupy it.[1] In 1870 Perkin was fully occupied at Greenford Green devoting his time to the more profitable manufacture of alizarine: he would not have been able to spare the time to take up the appointment as Professor of Technical Chemistry.[2] There was no prospect of Young's organising a separate lecture course in 1869, and there were several lamenting souls in Glasgow who regretted that Perkin was not with them.[3] In any case, there was no Chair, since the draft deed of Trust was never ratified. The story of Perkin's tenancy, in fact, begins with E.J. Mills who was appointed after Bischof[4] - and who never knew the true facts.

1. Bischof arrived in Glasgow in May 1871, and was introduced to the rest of the Managers by Young at their meeting on 10th May. (Ibid., p. 187). In a short note on the life of Young, written by J. Stephen Jeans in 1872, Bischof is called "the first occupant of the chair." J.S. Jeans, Western Worthies, Glasgow 1872, p. 68.
2. For this particular information I am grateful to my colleague, Mr. C.G. Wood, Librarian of the Andersonian Library, who has taken up the Perkin mystery very thoroughly.
3. The Chemical News on 19th November 1869, reported Dr. Wallace of the Glasgow Philosophical Society's Chemical Section: "... they must all regret that they had not amongst them so able a man and so diligent a worker as the gentleman who had been chosen to fill the chair ..." This referred to Perkin - and in the past tense. (Chemical News, vol xx., p. 247)
4. Mills mentioned Perkin's appointment in a letter to Professor Meldola, 12th January 1900. (Andersonian Library MSS.) By that date Mills no longer held the view that Perkin had taken up his appointment, but the letter reveals that Mills had certainly asked Perkin about it. Sexton, op. cit., p. 55, is the origin of most of the recent statements about Perkin's association with Anderson's University.

TABLE 46

YOUNG TRUST : STUDENT ENROLMENTS IN TECHNICAL CHEMISTRY FROM INCEPTION TO DEATH OF JAMES YOUNG (1871-1883)

SESSION	1871/2	1872/3	1873/4	1874/5	1875/6	1876/7	1877/8	1878/9	1879/80	1880/1	1881/2	1882/3
TOTAL	14	17	11	8	25	39	40	28	28	81	112	149
Increase/ Decrease	First Session	+ 3	- 6	- 3	+ 17	+ 14	+ 1	- 12	0	+ 53	+ 31	+ 37

Note on increase after 1879:

Many courses were arranged for supervisory grades in industry and preparation was being provided for certificate examinations of City and Guilds of London Institute. These were great attractions.

The appointment of Bischof turned out to be a mistake, but the fact that Young preferred to appoint a German professor to the new chair, once he had failed to secure W.H. Perkin, is an indication of German superiority in chemical technology. Omens were good when Bischof took up his duties. Eighteen candidates presented themselves for the bursary competition in 1871/2 but students numbers gradually fell. There were many reasons for this. The course was relatively expensive, costing £20 per annum as compared with 2/6d. for the evening science courses. Thus, the expense of undertaking the course must have acted against student recruitment. Those who could afford £20 tuition fees per annum were likely to go to one of the Technische Hochschulen, for the distinction of German chemical qualifications was outstanding in Europe and America. Thus, by the fifth report of the Young Trust, in 1875, the tune had changed;

> "... the success which has attended the establishment of a Chair of Technical Chemistry .. has proved after four years experience to have been much less than might have been expected ..." [1]

Bischof, "... being disappointed with the results of his four years connection with the Chair ...", resigned.[2]

It was not that the industrial applications of Chemistry were not being taught well: in December, 1873, Young's friend, Dr. Angus Smith, F.R.S., had examined the students and stated in his report that they:

1. See Mc.Clelland's evidence, and that of Young, before the Royal Commission in 1872
2. Minute Book, 1865-1881, p. 348

> "... appear to me to have attained a great amount of accurate knowledge of a very practical kind, and if the Institution send out men with such information and so capable of expressing it, the duty laid upon it is most effectively performed ..." [1]

There was a clear relation between Bischof's lectures and the industry of Clydeside. In session 1871/1872 he concentrated on the means of production and the uses of a large number of salts and acids which were commonly used in the textile, soap and chemical industries;[2] in 1872/1873 his course included instruction in the various raw materials of the textile industries, in dyeing and printing, in paper-making, brewing and distilling, in the preserving sections of the food industries, in the match industry and in the tanning and glue-boiling industries.[3] Special reference was made to the analytical examination of materials employed in these widely varying industries, and, therefore, a good general background to the applications of Chemistry to industry was given. In 1873/1874 Bischof indulged his own special interest: Metallurgy:

> "... embracing explanations of those principles and apparatus which are applied to the extraction of Copper, Iron and Steel, Lead, Zinc, Tin and Silver ..." [4]

There can be no doubt that since the Andersonian Chemistry classes were nationally advertised,[5] industry in the West of Scotland and further afield, had a recruiting ground for skilled personnel, if it really wanted them.

1. Ibid., p. 305
2. Ibid., p. 229
3. Ibid., p. 263
4. Ibid., p. 305
5. The Chemical News carried full advertisements for these courses, and this was likely to have a wide circulation throughout Britain

Bischof suggested to the Young Trust that industry did not want such trained individuals; his report in 1874 indicated that manufacturers did not rush to employ those with three years academic experience in Technical Chemistry.

> "... It would be of much importance if suitable situations could be found for at least some of the bursars and students ... as nothing would tend more to demonstrate the value of Technical education, than the practicalaknowledgement by manufacturers that they give preference to those who have been educated by this chair ..." 1

Bischof did not regard it as part of his own duties to educate manufacturers to the idea of science-based industry. It is doubtful whether he did consultancy work for industry or whether his classes and he made visits to firms. Perhaps, he lacked initiative for such a pioneering venture; perhaps, the fact that he was a foreigner militated against his success - and that of the Chair - for foreign industrial competition was just beginning to make Germans and other foreigners unpopular in Glasgow in the 1870s. Certainly, the success of the Young Chair depended upon its professors' convincing industry of the value of subsidizing their own students. This was bound to be an immense problem that no single individual would be likely to solve.

Bischof was a subject of ridicule among his students because his English was very bad. He tended to leave laboratory instruction to his assistants, Otto Hehner and William Ramsay, who, although brilliant by most standards, had at this time

1. Ibid., pp. 305-306

in their careers very little experience. Both were dissatisfied; according to Hehner:

> "neither of us could obtain advice or stimulus from our professor ... Chemically, our life at the Andersonian was unsatisfactory." [1]

Students and staff, however, later made their names. Ramsay learned gas manipulation techniques in the Young laboratory which he later used inthe isolation of rare gases, and he became Glasgow's outstanding chemist in recent times. Hehner became a famous analyst and consultant in London. R.W. McIvor went to Australia and became a leading agricultural chemist.[2] Significantly, all three made their reputations outside Scotland.

Bischof did not try courses of lectures in the evenings, and this was certainly one reason why he failed; for example, he made not attempt to provide evening courses for skilled workmen and supervisory grades, exactly the sort of employee likely to benefit most and yet unlikely to have the capital or the financial backing to be able to afford a full-time course. Had it been Perkin, perhaps, spectacular industrial success in the dyestuffs industry would have attracted more direct support from manufacturers. But self-help was a stumbling block, not easily overcome. The quality of Scottish students did not impress Bischof, and this directly reflected the

1. Sir William A. Tilden, Sir William Ramsay: Memorials of his Life and Work, London 1918, p. 42
2. M.W. Travers, A Life of Sir William Ramsay, London 1956, p. 27.

necessity for a sound elementary and secondary education system before the triumph of technical education could be ensured. The Young Trustees expected that this obstacle to the Chair's success:

> "... will diminish with the greater importance now being given to the training of the young in the ordinary braches (sic)of education ..." [1]

But the shortage of teachers trained in science prevented this. Most of the Young Trustees supported James Napier's hope of 1873:

> "... I look forward to the time when the elements of science will be taught in common schools. And technical teaching will be a necessity in every high class school and college ..." [2]

Until that time, men would learn their science in the workshop: Napier had realised that bursars were lost because

> "... they were being taught the trade of Chemistry but not its science ..." [3]

iv. The Young Chair's developing success under Professor Mills

The fortunes of the Young Chair began to revive with the appointment of Dr. Edmund J. Mills, F.R.S., who succeeded Bischof in 1875.[4] Mills had considerable experience in several universities;[5] he was and remained a prolific researcher,

1. Minute Book, 1865-1881, p. 348
2. Proceedings of the Philosophical Sciety of Glasgow, vol. viii., p. 439
3. Ibid., p. 438
4. Minute Book, 1865-1881, p. 363
5. Mills studied under Hofmann at the Royal School of Mines; in 1861 he became assistant to Dr. John Stenhouse; he came to Glasgow University in 1863 as a tutor; later he was for a time at University College, London; He had considerable examining experience both in Glasgow and in London. When he was appointed to the Young Chair he was about 35 years old. Ibid., p. 403 and Sexton, op. cit., pp. 106-107

employing team methods of investigation;[1] he was ready to pioneer and organise new departures in technical education. He lectured very early in the morning and, because of this, his lectures:

> "... attracted the attention of young men in business either from connection with their ordinary pursuits or from a desire for the study of Technical Chemistry ..."[2]

Mills instituted works visits for his students, collected a small technical library, ordered new apparatus and prepared the ground for close industrial contacts.[3] Thus, the Young Trustees were able to report of session 1876/1877 that it had been "... the most encouraging yet experienced by the Young Chair ..."[4] Student numbers were rising, and industrial interest was slowly awakening. Mills recognised the importance of making industrial contact:

> "... I have made every possible effort to attract the attention of manufacturers to the advantages of the Chair as a means of education for their sons; and by special Lectures on manufacturing subjects, I have endeavoured to assist manufacturers themselves ..."[5]

Business consultancy was likely to assist the Young Chair in gaining a local and national reputation.

1. For example, in 1879, Mills had three papers in the Proceedings of the Royal Society, the results of collaboration. (Proceedings of Royal Society of London, 1879, vol. xxviii., pp. 268-279)
2. Minute Book, 1865-1881, p. 403
3. Ibid
4. Ibid., p. 453
5. Ibid., p. 454

Mills certainly expected greater support from Scottish industry than in fact he received, although he thought that interest in the technical applications of chemistry to industry would increase as trade became more and more competitive:

> "... If we could only convince manufacturers that money earned must depend upon skill expended, the number of students would be much increased. There are some signs that the natural progress of commerce is teaching that lesson ..." [1]

Before Young resigned from the Presidency on 10th December, 1877, he had begun negotiations for a new site for the Young Chair, which up to that time had been housed in adapted premises, adjoining the main Andersonian building.[2] By October, 1876, the building on the corner of George Street and John Street, formerly a synagogue, had become Young's personal property.[3] The Managers of the Andersonian approved plans for new laboratories and class-rooms on this site in March, 1878;[4] in April a petition was presented to the Dean of Guild Court for authority to proceed.[5] This was given, and the Young Building was quickly erected at Young's personal expense and occupied in July, 1879.[6] Young's new building was a clear move away from slapdash laboratory accommodation, in cellars, so common in Britain in the nineteenth century: it was known as "... the handsome and commodious new building ...", and[7]

1. Ibid
2. Ibid., p. 391 and p. 407
3. Ibid., p. 417
4. Ibid., p. 482
5. Ibid., p. 487
6. Ibid., p. 519
7. Ibid., p. 588

included a suite of photographic rooms, numerous small laboratories for manufacturers and bursars to use in privacy, a museum, a lecture theatre, several teaching laboratories of varying sizes and a library.[1] This building remained Young's personal property, which he leased to the Young Trust for a nominal rent,[2] until in April, 1883, it passed into the possession of the Young Trust by deed of settlement.[3]

Research developed fairly rapidly, because the field was unexplored. In session 1877/1878, nine students were engaged on original investigations,[4] as well as the Professor and his assistants. One project, concerned with the explanation of the chemical action which occurs in the manufacture of glass, was reported to the Chemical Society, since it was the first time that this process had been elucidated.[5] Another team effort was associated with researches on chemical equivalence;

> "... the working equivalence of potassic and sodic salts and to the law whereby a dye vat is exhausted of its colouring matter ..."[6]

Mills was receiving £100 for apparatus and materials, on the recommendations of the Committee of the Royal Society, for his work in establishing Standard Industrial curves.[7] Papers to the learned societies multiplied from this time onwards.

1. Sexton, op. cit., pp. 105 sq.
2. Minute Book, 1865-1881, p. 554
3. Minute Book, 1881-1887, pp. 83 sq.
4. Minute Book, 1865-1881, p. 506
5. Ibid
6. Ibid
7. Ibid. See also Proceedings of Royal Society of London, 1879, vol. xxviii., p. 79

Perhaps the most original and brilliant research worker in the Young laboratory was a bursar, James Bannantyne Hannay.[1] He was the first man in the world to make artificial diamonds but could not repeat his success. He was scoffed at and his diamonds forgotten, until the last twenty years when X-ray crystallography has vindicated his reputation.[2]

There were difficulties for the support of manufacturers was spasmodic, because the depression of profits in the late 1870's militated against sustained expensive research programmes. Mills concluded his report for 1877/1878:

> "... I would draw the attention of Manufacturers to the fact that the Technical Laboratory of Anderson's College is the only one in this Country where Technical Chemistry is exclusively studied and as a Science; while its bursary system regarded as an investment cannot fail to yield an invaluable return both to them and to the community at large ..." [3]

Student numbers actually fell again in the following session, 1878/1879; the "... decrease is believed to be attributable to the general depression which has borne so peculiarly in (sic) our city ..."[4] One foreign country at least recognised the importance of the Young Chair:

> "... a young Japanese sent to this Country to pursue his studies and especially to devote a year to the instruction given by the Professor of the Young Chair..."

was among Mills' students in 1879/1880.[5]

1. M.W. Travers, op. cit., p. 37
2. Ibid
3. Minute Book, 1865-1881, pp. 506-507
4. Ibid., pp. 553-554
5. Ibid., p. 589

Industrial contacts grew up as the lecture courses in Technical Chemistry were widened in scope. In the period 1875-1880 Mills alone lectured regularly, although occasionally he might be replaced by an assistant or visiting lecturer. Lecture courses were given on the development of destructive distillation techniques and apparatus, on the vitriol, soda, bleaching-powder and soap industries,[1] on the technical problems of sanitation and public health,[2] on the production of "Potable waters" and alcohol,[3] on fuels, the gas industry,[4] lubricants and their uses,[5] on oils, paints and varnishes. From 1880 onwards there were increasing numbers of special courses and greater numbers of lecturers. Evening courses on the metallurgy of the Iron and Steel industries attracted many students, mostly artisans interested in passing the examination of the City and Guilds of London Institute.[6] Other evening courses were gradually developed concerned with textile bleaching, dyeing and printing, on the application of chemistry to agriculture, and on the development of explosives.[7] Gradually, students left to take up positions in industry and then, by their success, won converts to the idea of academic

1. Ibid., p. 403
2. Ibid., p. 453
3. Ibid.
4. Ibid., pp. 554 and 589. The course on Fuels received a good notice in the Colliery Guardian. Reports of all 12 lectures were given in some detail. (Colliery Guardian vol. xxxvii., (January - June 1879), pp. 255, 295, 336, and 374). Apparently, there were several works visits to chemical firms and gas-works. (Ibid., p. 375)
5. Minute Book, 1865-1881, p. 631
6. Ibid.
7. Minute Book, 1881-1887, p. 66

education for technologists. The small private laboratories were used by brewers to improve techniques of fermentation,[1] by a chemical manufacturer and a bursar, who worked together on a preliminary design project before a factory was built;[2] and by research teams who had applied for three patents for new explosive substances.[3] But the process was slow; the Scottish economy did not seem to be able to tear itself away from its "one-off" capital goods base; the change to science-based industry could not be achieved overnight.

g. James Young and the Technical College Direction

i. Curricula

There were many additions to the curricula of the Andersonian during Young's presidency, although some did not long survive. Apart from Technical Chemistry, Applied Mechanics, Engineering Drawing, Marine Engineering, and Pharmaceutical Chemistry, which all have the flavour of directed practical training for industry, classes in languages flourished, although Spanish, introduced in 1875, did not have the success enjoyed by French and German.[4] Classical education in Latin, Greek and Hebrew was well entrenched, and during Young's presidency reached its highwater mark. Young sponsored the principle of a general scientific education for all classes:[5] he supported the teaching of Astronomy, Geology and Natural

1. Ibid., p. 112
2. Minute Book, 1865-1881, p. 631
3. Minute Book, 1881-1887, p. 66
4. See Table of subjects taught [APPENDIX V]
5. Young in November 1872, undertook to subsidise any loss incurred by Professor Forbes in giving 6 Saturday evening lectures on Astronomy for working men: the entrance fee was 1d. per lecture. (Minute Book, 1865-1881, p. 245)

History, and all the basic scientific subjects to working men. The general teaching of science was fundamental to the economy: it explained why Glasgow had developed a "... high position in mechanical engineering and manufacturing chemistry ..."[1] But it was also sound educationally: Young believed that there:

> "... should be no attempt in a school of applied science to teach actual manufacturing work, but to give a thorough acquaintance with the branches of science which are applicable to the work ..."[2]

Science was to be taught for the benefit of mankind. Thus, Young supported the project of a Sick Dispensary, attached to the Andersonian Faculty of Medicine, which provided students with diagnostic practice and the poor with cheap medical treatment.[3] Opthalmic Medicine and Surgery, Public Health and Dentistry were other pioneering studies first associated with Anderson's University which Young supported. He remained until his death in 1883 a formative influence in Andersonian politics in favour of educational experiment, by which he hoped science would be diffused through all grades of society. When he died, the Andersonian Faculty of Medicine consisted of eight professorships and five lectureships, an imposing array unequalled by any other Faculty of Medicine in Scotland. The Faculty of Arts was not so prosperous. As the ex-Principal of the Imperial College of Japan, Henry Dyer, explains:

1. Report of Royal Commission on Scientific Instruction and the Advancement of Science, 1872, Evidence of James Young, Minute 10,022
2. Ibid. Minute 10,027
3. Minute Book, 1865-1881, pp. 522 sq.

> "... The Arts Faculty of Anderson's College has never been very successful, not because the Professors were inefficient, but because their teaching was not recognised by Universities, Faculties, or Presbyteries, as forming part of any course, and all that is wanted to ensure success is some such recognition ..." 1

James Young tried his best and failed to overcome this difficulty, although his failure was due to the national decision not to establish a City and Guilds Industrial University. Long before this was mooted - or, indeed, the idea of a Technical College for Glasgow and the West of Scotland - Young had tried to bring to Glasgow men of academic reputation and practical ability, men like Perkin, around whom the idea of a Technical University might have developed to reality. According to James Napier, all that was necessary was to rally the finances of benevolent industry behind the Andersonian. Young had endowed the Chair of Technical Chemistry but he found it exceedingly difficult to raise the funds for the Chair of Applied Mechanics. Napier asked the right question:

> "... would it not therefore be wise, as practical men, to set this agoing, and by these means to find out what is really required?" 2

1. Proceedings of Philosophical Society of Glasgow, vol. xv., p. 34. Dyer gave a paper, Technical Education with special reference to the requirements of Glasgow and the West of Scotland, on 21st November 1883, just after his return from Japan.
2. Ibid., vol., viii., p. 438. Napier was one of those who took part in a discussion on 9th April 1873, on a paper given by David Sandeman on Technical Education.

ii. Young and the appointment of new professors

It would be wrong to assume from the case of Penny and the foundation of the Young Chair in Technical Chemistry, that Young had many problems in managing the Professors. He was often the moving spirit behind their election, for even though, in theory, the Trustees elected new professors by secret ballot, in fact, they generally had to rely upon the judgement of the Managers, who surveyed the applications and recommended a short leet or, in some instances, one man. This practice made it possible for Young to exercise paternalistic control over appointments in which he was interested. He rarely seems to have intervened in the election of professors to Chairs in the Faculty of Medicine, but in the Faculty of Arts, most elections were the result of his backstage management.

The Chair of Scientific Chemistry, created after Penny's death, was not filled until after arrangements for the Chair of Technical Chemistry has been completed, so that the new Professor would be unable to object in the manner which Penny had adopted.[1] There were six candidates for this Chair, including Dr. John Clark, formerly assistant to Penny, who thought it worth his while to assure Young of his loyalty to the principle of a separate Chair of Technical Chemistry.[2]

1. Minute Book, 1865-1881, p. 145. "... it having been thought better to delay the appointment of a successor till the issue of the negotiation with the President regarding the creation of the proposed Chair of Technical Chemistry ..." Annual Report, 1869-70, made on 22nd June 1870
2. Ibid., p. 131. 3rd March 1870

Clark was well supported in the ballot, but it was significant that two of Young's closest associates, James Napier and Alexander Harvey, took the initiative in proposing Dr. T.E. Thorpe, of Owen's College, Manchester.[1] Thorpe was elected.[2] Young could hardly have proposed Thorpe himself and maintained the appearance of impartiality, but his friendship with H.E. Roscoe, Professor of Chemistry in Owen's College, and the nature of the election suggest his influence. During Thorpe's tenure of the Chair, it was Young who took the greatest interest in his activities and welfare.[3]

In 1874 Thorpe resigned to become the first Professor of Chemistry in the new Yorkshire College of Leeds, and Dr. John Clark, once more, sought to ease his way into the vacant Chair by writing to Young pledging himself:

> "... to conform to the wishes of the Managers and do nothing but what Dr. Thorpe and his predecessors were in the habit of doing ..."[4]

But just as Clark's blandishments had failed to secure his succession to Penny, so they failed to enable him to replace Thorpe. Before Thorpe had been appointed in August, 1870, Young had been approached by William Dittmar, in May;[5] Dittmar sent Young his latest off-print "... with the Author's respects ..." and enquired about the possibility of succeeding Penny.[6] Although he was unsuccessful on that occasion, Dittmar

1. Ibid., p. 164
2. Ibid.
3. For example, Young, in November 1870, argued for Thorpe to be given sabbatical leave to join the Royal Society's Astronomical Party for the eclipse of that year. (Ibid., p. 174)
4. Ibid., p. 321
5. W. Dittmar, The Vapour-Tension of Formate of Ethyl and of Acetate of Methyl, Off-print from Journal of Chemical Society, November 1868.
6. Thom Collection: Letter Book, 1867-1873, fo. 62-63, 4th May 1870

in 1874 succeeded Thorpe, and Clark was once more bypassed.[1]

More definite evidence is available about Young's intervention in appointments. In 1871 the Chair of Natural Philosophy fell vacant, when Professor Herschel resigned to take the first Chair in Natural Philosophy at Newcastle. Seven candidates applied, none of whom were deemed suitable.[2] Apart from the Freeland stipend of £100 per annum, there was no salary attached to this post, and Young rightly felt that this was the greatest obstacle to obtaining worthwhile applicants.[3] William Euing and he, therefore, attempted to get additional endowments for this Chair, but without success.[4] Later, in November, 1871, Young reported to the Managers that he had met Dr. Joule of Manchester, who was prepared to accept the Chair:

> "... provided he was appointed without an application on his part an (sic) secured an Income of £300 or thereby and that from £500 to £1,000 be expended as required on Philosophical Instruments ..." [5]

Although the prospect of having Joule as well as Kelvin in Glasgow must have been remarkably attractive to the Managers, his financial conditions proved to be beyond the range of the Andersonian Managers: Young offered £100 per annum:

> "... and expressed his conviction that no man better qualified than Mr. Joule could be found ..." [6]

1. Minute Book, 1865-1881, p. 325
2. Ibid., p. 202
3. Ibid
4. Ibid., p. 207
5. Ibid., p. 207. J.P. Joule, 1818/1889; F.R.S. in 1850; educated in chemistry by John Dalton in Manchester; established mechanical equivalent of heat; 1844 onwards had a laboratory at Whalley Range and was Librarian (1844), Secretary (1846), Vice-President (1851) and President (1860) of Manchester Literary and Philosophical Society.
6. Ibid.

Three other Managers offered £50 each per annum, and all piously agreed to try to raise the funds for Mr. Joule's apparatus.[1] But there were no classes in Natural Philosophy that session.

In the long vacation of 1872 Young was in touch with a young man of much promise, down from Cambridge. His name was George Forbes, and he could not expect to make such prohibitive conditions as Mr. Joule. Forbes was the son of Principal J.D. Forbes[2] of St. Andrews, an enthusiastic member of the Royal Society of Edinburgh and an old friend of James Young. While Young was away at Durris, his estate in Kincardineshire, in the first week of September, 1872, George Forbes called at Kelly to see Young. Young gathered from information sent by Forbes that he intended to be a candidate for the Chair of Natural Philosophy in Anderson's University, and on 2nd September, Young wrote to Forbes asking him to come and stay at Durris so that they "... could talk the matter over ..."[3] Forbes did not manage to keep this appointment and therefore Young arranged another by letter sent on 5th September "... and if you will stay with us for the night so much the better ..."[4] On 6th September, 1872, Young was elected to a committee, consisting of R.S. Cunliffe, Alexander Harvey and James Napier,

1. Ibid., p. 227
2. James David Forbes, (1809-1868), was elected F.R.S.E. in 1829, Professor of Natural Philosophy in Edinburgh University in 1833 and Principal of St. Andrews in 1860. Although his main fields were astronomical physics and glaciology, he produced a vast volume of scientific papers and research. The only life is J.C. Shairp, P.G. Tait and A. Adams-Reilly, Life and Letters of James David Forbes, F.R.S., (London 1873).
3. Thom Collection: Letter Book, 1867-1873, fo. 116 v.
4. Ibid., fo. 123 v.

whose task it was to recommend a new Professor of Natural Philosophy.[1] On the same date, Young copied into his letter-book the full list of applicants for this Chair - and for the Chair of Medical Jurisprudence.[2] Although several of the applicants for the Chair appeared to have better experience than Forbes, apparently Young persuaded the committee that "... Mr. George Forbes was the most eligible of the candidates ...", for this was their recommendation to the Managers.[3] Forbes was then recommended to the Trustees and elected,[4] and he accepted the Chair on 4th October, 1872.

iii. The Trade School Pressure Group

It is true that Young anticipated the general direction that higher education for working men would take. But that is not to say that he accepted the arguments of those who believed that all that was necessary was craft training. He had no intention of turning the Andersonian into an enormous dyeworks or factory workshop.[5] Pressure groups existed for a technical college of this sort. Partly it was caused by fear of the Germans. It was recognised in Glasgow and elsewhere that the Germans had won their wars through superior technology, that they had won off the battlefields and in the school-rooms. This explains the analysis of German education undertaken by

1. Minute Book, 1865-1881, p. 235
2. Thom Collection: Letter Book, 1867-1873, fo. 122 v.
3. Minute Book, 1865-1881, p. 236
4. Ibid., p. 238
5. Young's evidence to the Royal Commission of 1872 is all to this effect.

Scots.[1] There was considerable fear of a commercial battle of Sedan, yet to be fought:

> "... We are falling into the rear of our German neighbours, let us therefore begin a friendly rivalry to regain the front rank ..." [2]

Those with wide continental experience were prepared to extend their incipient zenophobia:

> "... investigation recently prosecuted by competent inquirers throughout the industrial communities of Europe have led to the general conviction that this country is not keeping pace with her continental neighbours in many of those departments of trade in which hitherto she has been unrivalled ..." [3]

It was complained that the success of the foreigner was occasionally due to sharp practice: at the International Exhibition of 1862:

> "... no exhibits, by the rules of the Exhibition were allowed to be copied by any one, but the ready hand sketching of the French and Germans could not be suppressed. English made tools, which on the Continent up to this time commanded a high premium over tools made anywhere else, began to lose their long-sustained reputation ..." [4]

But education was the root cause of Britain's economic difficulties:

> "... the nations which are successfully emulating Great Britain in the various branches of mechanical engineering, and of chemical and textile manufactures, and which surpass her in the arts of mining and metallurgy, are precisely those in which adequate provision has been made for Technical Education ..." [5]

1. For example, by Dr. James Bryce, Notes of a Tour in Germany with special inquiry regarding the Provisions for Scientific and Technical Education, a paper read before the Glasgow Philosophical Society on 27th January, 1875. (Proceedings of Philosophical Society of Glasgow, vol. ix., pp. 267-271)
2. Ibid., vol. viii., p. 439. Conclusion of James Napier's remarks on Sandeman's paper. (Vide. infra., p. 442 note 2)
3. W. Montgomerie Neilson, Technical College, (Glasgow 1880), p. 10. Preamble to Proposals to found a Technical College, drawn up in June 1871
4. Ibid., p. 24 n.
5. Ibid., p. 10

There had been changes in the Scottish Universities - and there were to be many more. In 1840, a Chair of Civil Engineering and Mechanics was established in the University of Glasgow, which grew in importance after the appointment of Professor W.J.M. Rankine.[1] The appointment of William Thomson to the Chair of Natural Philosophy in 1846[2] tied the natural sciences more firmly to technology for Thomson became the best known and possibly the most brilliant electrical engineer of his generation. In 1883, the Chair of Naval Architecture completed the educational base for a heavy engineering superstructure.[3] In the University of Edinburgh technology had mixed fortunes. The Chair of Chemical Technology was founded in 1855, only to be abolished in 1859.[4] In 1868 the department of Engineering was established, but generally the Heriot-Watt College performed the function of providing higher scientific and technical education for the East of Scotland, until the foundation of Queen's College, Dundee, in 1881.[5]

The gap between England and Scotland in the seventies was essentially in the Scottish failure to found entirely new institutions. The new provincial university colleges in England, from the very beginning, taught only the sciences

1. J. Coutts, A History of the University of Glasgow from its foundation in 1451 to 1909, Glasgow 1909, p. 390
2. J.D. Mackie, The University of Glasgow, Glasgow 1954, p. 276
3. Glasgow University Calendar, 1961/2
4. Edinburgh University Calendar, 1961/2
5. St. Andrews University Calendar, 1961/2

and technology; indeed Arts faculties were generally grafted onto institutions designed deliberately for the education of industrialists, managers and supervisors.

In Glasgow the idea of a technical college for the West of Scotland started well. Many private individuals and organisations backed it, including the Managers of Anderson's University and James Young. Young was authorised to speak on behalf of the University at the meeting called by the Lord Provost on 2nd June, 1871.[1] At this meeting a large committee was elected[2] and issued a prospectus which explained their motives - their chairman was "J. Young, Esq. of Kelly".[3] Enthusiasm was not enough. £50,000[4] was needed, and it was generally accepted that the State would not, and ought not, to help on the same scale as was normal on the continent.[5] In fact, £12,030[6] was raised by the initial subscription scheme, and the only practical result of this campaign was the foundation of the Weaving Branch in 1877.[7]

Partly as a result of the recruitment of men prepared to consider the application of science to industry, partly as a result of recruiting students directly engaged, or about to be engaged, in commerce and industry, Anderson's University

1. Minute Book, 1865-1881, p. 188
2. Neilson, op. cit., p. 5.
3. Ibid., p. 13
4. Ibid., p. 11
5. Ibid. Local industrial interest on Clydeside would have to back the venture, the committee thought
6. Ibid., p. 18
7. Ibid., pp. 20 sq.

in the 1870s naturally maintained its close contacts with technical instruction. Already in the 1860s there had been pressure for commercial education, which was met by instituting courses in Commercial Law, Book-keeping and Writing; in the 1880s classes in shorthand were also very crowded. William Dittmar started evening courses in Pharmaceutical Chemistry which were intended for "... Druggists' Assistants and others..."[1] George Forbes made his name as an electrical engineer in the early days of electric lighting and the transmission of electric power. He did varied work in theoretical and applied Physics; he later became an inventor and consultant on the Niagara hydroelectric scheme.[2] Of the fifty papsrs which he produced during his stay in the Andersonian, several had direct industrial applications,[3] for whichhe took out patents. W.T. Rowden, Professor of Applied Mechanics, was a man of considerable drive and efficiency, undoubtedly a very successful teacher judged by the standards of payment by results.[4] He had wide experience of shipbuilding and allied engineering trades, and Clydeside gained when the Andersonian Managers lured him from Newcastle. The first two

1. Minute Book, 1865-1881, p. 328
2. The best short account of Forbes's career is in Royal Society, Obituary Notices, vol. ii., 1936, pp. 283-286
3. Forbes did work on the telephone, fire-damp, gas in mines and on the measurement of alternating current during his stay in Glasgow; he also was a great astronomer, predicting the discovery of an ultra-Neptunian planet in 1880; Pluto was not discovered until 1930. (Ibid).
4. In addition to his salary of £200, by 1881 Rowden was receiving over £540 p.a. from the Science and Art Department as a result of his pupils' successes in examinations. (Minute Book, 1865-1881, p. 638)

bursars working under his supervision were ex-engine fitters from the North British Railway Company's works at Cowlairs.[1] The effect of the Andersonian on industrial society in Glasgow was clearly recognised by those unconnected with the Managers. Dr. James Bryce, Rector of Glasgow High School and father of the historian of the Roman Empire, was the first to connect the technical college concept with the Andersonian and the Mechanics' Institution in April, 1873, and in passing he stated:

> "... we all know that the Andersonian has been the beginning of scientific light and thought to great numbers of the working classes in Glasgow ..." [2]

There were problems associated with creating a technical college out of the Andersonian. Local pressure groups favoured trade schools rather than general scientific education; the future of the Anderson School of Medicine was placed in jeopardy; the problem of management had to be solved so that diverging interests could be reconciled. It was not enough to say as W. Montgomerie Neilson said: "... the time has come when we must do something for Technical Education ..."[3] It was necessary to sink all differences and organise a central institution for the West of Scotland. Young made this possible by advising the Andersonian Managers to allow the Anderson School of Medicine to move as a separate unit to the area of the University while the remaining departments re-

1. Ibid., p. 456. Both were men in their early twenties
2. Proceedings of Philosophical Society of Glasgow, vol. viii., p. 441
3. Ibid., p. 437. Neilson, the son of J.B. Neilson, the inventor of the hot-blast, was inclined to subordinate education to trade training, and this Young and Napier would not tolerate.

mained on the John Street site. This advice was offered after Young had retired from the Presidency, but the fact that the decision was made by Young at the Managers' request is a definite sign of his standing among them.[1] His advice was acted upon, four years after he died.[2] Young had also realised the need for co-operation between all interested parties: in 1871 he had subscribed to the idea of representatives from different bodies upon the governing body of the new college;[3] he had reached harmonious agreement with the Mechanics' Institution about the types of classes to be taught in the Andersonian.[4] But he would never accept the view that mechanical learning of a technical process was the sole purpose of technical education.

His endowment of the Chair of Technical Chemistry was his prize achievement for education and industry. It betokened the future. His friend, James Napier, indicated this when he said that:

> "..... before any movement was made about a technical college, Mr. James Young had established and endowed a chair of Technical Chemistry ...." [5]

Young's vision was recognised most clearly by E.M. Dixon, Principal of Allen Glen's School, in 1883, just after Young's death:

1. Minute Book, 1865-1881, pp. 496 sqq.
2. Sexton, op. cit., pp. 157 sqq.
3. Neilson, op. cit., p. 12
4. Minute Book, 1865-1881, p. 458
5. Proceedings of Philosophical Society of Glasgow, vol. viii., p. 438

"... I think it would be a serious mistake to set up, on the one hand, any institution for the higher learning to act as a rival to the University; but on the other hand I think it would be an equally short-sighted policy on the part of the University to withhold its recognition from any institution that possessed the necessary appliances for doing well what is really University work, and which had come into existence through the very fact that such work was not being carried on by the University. I think we have a clear case in point in the Chair and Laboratory for Technical Chemistry, founded by the late Dr. Young of Kelly. This Chair unquestionably supplies one thing that is wanting to give even a moderate degree of completeness to the means of chemical teaching in the University of Glasgow ..." 1

1. Ibid., vol. xv., p. 51

4. Conclusion : an assessment

There were many men of widely differing abilities who sponsored the development of education in the nineteenth century. Some were motivated by ill-considered idealism, others by rigorous economic principles. James Young was a combination in himself. He enjoyed power, and his philanthropy gave him an opportunity to mould Anderson's University to suit his own views. Yet he was sufficiently idealistic to recognise the value of a good scientific education to the whole community. When asked by the Royal Commissioners in 1872 whether his idea of training technologists in the principles of science "... tends to the good of the community ...", he replied that he was convinced that it did for he knew:

> "... nothing that tends more to the good of the community than improvement in manufacture ..." [1]

The purpose of such an educational system was, for Young, the reduction of costs and the wider availability of commodities in a developing, dynamic economy.

Many public figures recognised that foreign competition was becoming more dangerous after the Paris Exhibition of 1867. Some thought that all that was required was to organise Cooks Tours for skilled workmen to see the foreign exhibits;[2] others favoured the abolition of the skilled trades unions

1. Report of Royal Commission on Scientific Instruction and the Advancement of Science, 1872, Evidence of James Young, Minute 10,041
2. A.H. Layard, M.P., was the public figure most associated with this view point. C.f., The Times, 9 May 1867

which, they thought, bedevilled industrial relations.[1] The scientific rationalists generally favoured the improvement of education. But many of these would have been content with trade training alone:

> "... The middle classes cannot afford to spend their adolescence in an education which only opens the gate of knowledge; their instruction must be practical from the first ..."[2]

But the cost of good laboratories and training workshops convinced some politicians that it was impossible to establish "... on a large scale technical sections for the appliance of science to art and manufacture ..."[3] Many Liberals, therefore, contented themselves with the aim of establishing a literate working population.[4]

Young was not content with this. He felt that Britain's future depended upon the development of a new type of Adult Education, practical and yet Liberal. His vision and his generosity in endowing and equipping the Chair in Technical Chemistry - and his support for the intellectual activities of Anderson's University - were portents of that future. He, like Joseph Whitworth, recognised that the development of a scientific technology was an indispensible prerequisite for the British economy. But technical instruction was not enough

1. This point of view was considerably strengthened by the public outcry in 1867 resulting from the "Sheffield Outrages".
2. Charles W. Merrifield, Principal of a School of Naval Architecture, in a letter to The Times, 11 June 1867.
3. Lord Granville at the opening of the Coventry Exhibition, reported in The Times, 20 June 1867
4. C.f. The Speech of W.E. Forster on the abortive Education of the Poor Bill, 1867, reported in The Times, 11 July 1867

for Young. His own wide interests in science and his early academic experience led him to support the principle of a Liberal scientific education for all. This principle is still engaging the attention of our society.

JAMES YOUNG AND DAVID LIVINGSTONE

> "If I die at home I would lie beside you. My left arm goes to Professor Owen, mind. That is the will of David Livingstone ..."
>
> David Livingstone to James Young.

Biographers of David Livingstone have tended, naturally enough, to stress the significance of his religious and geographical achievements without examining the fundamentals of his social, economic and political ideas; because of his natural goodness and self-dedication they have minimised the force of his early environment and the formative nature of his education. In fact, Livingstone's own belief in the importance of education was a vital contribution to his later career; he was probably the best educated of all the African explorers for the career he undertook despite his own deference to James Bruce.

Natural ability and industry enabled him, through his literacy, to escape from the life of piecing and spinning in the mill of Monteith and Company of Blantyre. His formal higher education consisted of two sessions at Anderson's "University" in Glasgow, and this provided his entrée into medicine which was to be his key to a missionary career.

Anderson's "University" when Livingstone enrolled in the academic session 1836-37 was a remarkable place to receive a scientific training. In the Medical Faculty was Dr. Andrew Buchanan, later for many years an eminent Professor of Medicine in the University of Glasgow. The Professor of Chemistry was Thomas Graham, F.R.S., one of the most original and influential younger men in British Science. Graham's assistant and

instrument maker was James Young, two years older than Livingstone and already the inventor of a galvanic cell in competition with Michael Faraday's.[1]

Young's association with Livingstone was personal and intellectual. Both were examples of socially mobile Scottish working men. Young was just as interested in travel and in the philosophy of religion as in atomic chemistry. Young admired Livingstone's purpose and sense of vocation; had he been less concerned with the material rewards offered by industry to the scientist, he might have pursued a similar career. Both were radicals in politics but not revolutionaries. Livingstone, Young and Lyon Playfair became great friends and Graham's favourites. They met frequently in Young's room or workshop which contained a bench, turning lathe and a variety of tools and apparatus, including Young's cell. There Livingstone learned to use a variety of tools under Young's instruction, and this practical knowledge and amplification of manipulative skills was to prove invaluable experience to him in Africa. Like Playfair and Young, Livingstone combined within his personality a scientific practicality with a certain political, social and religious idealism.

Livingstone was able to maintain for a short time his association with Young, Playfair, and Graham, because, when they went to University College, London, he went up to join

1. W.G. Blaikie, The Personal Life of David Livingstone, London 1880, pp. 20 sqq.

the London Missionary Society in 1838. Young left Graham to join Muspratt as manager in 1839; in the summer of 1840 Livingstone qualified as a Licentiate of the Faculty of Physicians and Surgeons of Glasgow. On 20 November, 1840 he was ordained and, eighteen days later, sailed for Africa.[1]

It seems that Young had no contact with Livingstone until the first furlough of 1857-58. By then Livingstone's views on the needs of Central Africa had matured. His idealism had deepened almost into mysticism; he was close to God. This mystical sense assured him that he was God's chosen instrument for great work in Africa; his liberal scientific training enabled him to rationalise his methods and objectives. Nor can we forget the influence of his personal psychology, his habit of self-abstraction from his surroundings, his exclusiveness, his natural tendency to becoming a solitary. He became a constant frontiersman because of his inclinations, because he was frustrated by his early years spent in mission stations. He thought, with the radical's sense of urgency, that a more dynamic approach to the problems of conversion had to be found, instead of the stagnant mission station concept. First, Africa had to be explored and mapped; its population had to be roughly estimated and precisely located, before the size of the task of conversion could be assessed. Thus, exploration was the scientific answer to the problem of heathenism in Africa. The mission station was no answer:

1. Ibid., p. 23. R.J. Campbell, Livingstone, London 1929, pp. 58-60

> "... The conversion of a few, however valuable their souls may be, cannot be put into the scale against the knowledge of the truth spread over the whole country ..."

Livingstone explained these radical views on missionary policy in unequivocal language.[1] He thought that, once a church had been built in an area, a native missionary should be trained to act as pastor to the congregation. European missionaries should be forever on the move. This view may have been ideally adjusted to Livingstone's own psychology, but it was also entirely logical. For European missionaries were expensive to train; it was wasteful, when they were scarce, to employ them in areas that could be better served by trained and convinced Africans.

Tribal heathenism was so great an obstacle that Christianity was not sufficient a solvent in itself. Already by 1851 Livingstone had recognised the important sociological truth that the bestialities of heathenism were so stubbornly ingrained in the primitive social structure of tribal Africa that civilisation had to occur before Christianity would be successful. Economic contacts between two distinct civilisations, two thousand years apart, had to be made. Once trade with industrial Europe had raised the standard of life of Africans, the basis for cultural advance would be established; once cultural progress occurred, Christianity would be accepted:

1. British Quarterly Review, vol. xiv., August 1851, pp. 106-113 passim

> "... Commerce has the effect of speedily letting the tribes see their mutual dependance. It breaks up the sullen isolation of heathenism ... But Christianity alone reaches the very centre of the wants of Africa and of the world ... You will see I appreciate the effects of commerce much, but those of Christianity much more ..." [1]

Apart from heathenism, another major obstacle was slavery, exactly the wrong kind of commercial contact. Violence, injustice and oppression would be incessant as long as a primitive social structure was exploited by the sale of human beings. There would be no future for peaceful commerce, no opportunity for cultural progress, no occasion for the acceptance of Christianity:

> ".... By the witchery of the slave trade, the attention of Europeans and others were entirely withdrawn from any other source of wealth ..."

Opportunities for trade in cotton, coffee, oil, wheat, iron, coal, and, even, gold were forgotten; a permanent war society was the result.[2]

After the discovery of Lake Ngami, in 1849, which first brought Livingstone into the foreground, his great transcontinental journey, (1852-56), seized the popular imagination in Britain. His prayer made on 14 January, 1856 when he reached the confluence of the Loangwa and the Zambesi reveals his life work as he saw it:

> "O Jesus grant me resignation to Thy will and reliance on Thy powerful hand. But wilt Thou permit me to plead for Africa? My family is Thine. They are in Thy hands ..."

1. I Schapera, Livingstone's Missionary Correspondence, 1841-1856, London 1961, pp. 301 sq.
2. Ibid., p. 309. C.f. also a detailed treatment of this point, J. Butt , "David Livingstone and the Idea of African Evolution" in History Today, June 1963, pp. 376-382

In May, 1856 he reached the mouth of the Zambesi and prepared to go home to Britain. When he arrived in December, he was feted as the greatest individualist of his age. He was given little opportunity to enjoy the reunion with his wife and children, whom he had last seen in April, 1851. The publicity was not a particularly enjoyable experience for Livingstone, but there can be no doubt that it greatly assisted in making his first book a financial success. This volume, "Missionary Travels and Researches in South Africa", was published in 1857 and was an immediate success. The first edition of 12,000 at a guinea a copy was not sufficient to meet the advance orders, and seven more editions followed in rapid succession.[1]

One of the rare opportunities for privacy was presented to Livingstone by his old friend, James Young, who invited him to stay at Sardinia Terrace in Glasgow.[2] During this stay Livingstone and Young talked over their old College days and discussed Livingstone's views on the needs of Africa. They met again at the 1857 meeting of the British Association in Dublin, which Livingstone addressed, and began a regular and at first largely inconsequential correspondence. They never lost touch again. In November, 1857, for example, Livingstone was recommending the life of Hedley Vicars to Young as edifying reading: "... If you have not read it, the sooner you dip into it the better. You will thank me for it ..."[3]

1. G. Seaver, David Livingstone: His Life and Letters, London 1957, p. 284
2. Scottish Guardian, 29 December 1857
3. W.G. Blaikie, op. cit., p. 218 n.

At the end of 1857 the Government announced that £5,000 was to be spent on a government expediture to explore the Zambesi valley.[1] Overtures had been made earlier to Livingstone, who, apparently, had been thinking as early as 1853 of severing his connection with the London Missionary Society.[2] He resigned in 1857 and returned to Africa in 1858 as consul for "The Eastern Coast of Africa". Arrangements had to be made for Livingstone's children, since Mary Livingstone did not intend to live in such neglected circumstances as had been the case before her husband's furlough. David Livingstone had money enough which he had received from public bodies and corporations[3] as well as from John Murray, the publisher of his "Missionary Travels". He decided to establish a trust composed of James Young, Andrew Buchanan and James Hannan; this trust spent much time on the care and education of Livingstone's children, upon lobbying M.P.s to support Livingstone, whenever this was necessary, upon administering his estate and looking to his needs. James Young was the most active member in all these activities and Livingstone's most regular correspondent.

Livingstone semi-humourously reported his progress from the "Pearl" on 10 May, 1858:

1. Sir R. Coupland, Livingstone's Last Journey, London 1945, p. 12
2. The researches of I. Schapera have made this clear
3. For example, Livingstone received £2,000 from the City of Glasgow

> "... Here we are off Cape Corrientes (Whaur's that I wonner?) and hope to be off the Luabo four days hence. We have been most remarkably favoured in the weather, and it is well, for had our ship been in a gale with all this weight on her deck, it would have been perilous ... I met a Dr. King in Simon's Bay, of the 'Cambrian' frigate, one of our class-mates in the Andersonian ..." [1]

The decks were crowded with the parts of a steamer which Livingstone intended to use on the Zambesi, the Ma'Robert,[2] named after Mary Livingstone. This vessel was built by Lairds of Birkenhead of thin steel plate made according to Bessemer's new process; it was never an adequate vessel for the task, being too thin-bottomed to survive the shallows of the Zambesi and Shiré.[3] Eventually, Livingstone bestowed upon it opprobrious names such as the 'Old Tin-Can' or "H.M.S. Asthmatic". He, therefore, requested the government to supply a more suitable vessel and asked James Young to take private action if the government refused.[4]

Young's letters to Livingstone from 1858 to 1860 went missing until early December, 1860. Livingstone, of course, could not understand the delay in replies:

> "... This is July 1860, and no letter from you except one written a few months after we sailed in the year of grace 1858. What you are doing I cannot divine. I am ready to believe any mortal thing except that Louis Napoleon has taken you away to make paraffin oil for the Tuileries. I don't

1. W.G. Blaikie, op. cit., pp. 247-248
2. A representation of this steamer is given in The Illustrated London News, 27 February 1858
3. C. and D. Livingstone, Narrative of an Expedition to the Zambesi and Its Tributaries, London 1865, p. 84; c.f. also W.G. Blaikie, op. cit., p. 252; and David Livingstone to J.S. and E. Moffat, 14 January, 1861 in J.P.R. Wallis, Matabele Mission of J.S. and E. Moffat, London 1945, p. 129
4. H.H. Johnston, Livingstone and the Exploration of Central Africa, London 1891, p. 246

> believe that he is supreme ruler, or that he can go an inch beyond his tether. Well, as I cannot conceive what you are about I must tell you what we are doing, and we are just trudging up the Zambesi as if there were no steam : and no locomotive but shank's nag yet discovered ..." [1]

On 4 December, 1860, he reported that all Young's letters had turned up in a heap, including one written during Young's stay in America.[2]

What Livingstone had written to Young is more certain. There was a reference in his Journal for 4 August, 1859 of his desire to begin a colony, in the Shiré Highlands, "of the honest poor", to which he was prepared to contribute £2,000 or more; he intended to write to Young about it "... and authorise him to draw if the project seems feasible ..." Livingstone certainly wrote to Young and asked him to canvass the idea among his influential friends. If 20 or 30 families were prepared to settle in this part of Africa, Livingstone was prepared anonymously to help support them in the initial stages of settlement:

> "... Now my friend do your best, and God's blessing be with you. Much is done for the blackguard poor. Let us remember our own class, and do good while we have opportunity ..." [3]

Livingstone's idea of establishing a Scottish colony in the Shiré Highlands was part of his general plan to destroy heathenism, to end the slave-trade and to establish Christianity firmly in Central Africa. Permanent enclaves of Britons

1. W.G. Blaikie, op. cit., p. 272
2. David Livingstone to James Young, 4 December 1860, printed in part in The Glasgow Herald, 20 April 1861
3. W.G. Blaikie, op. cit., pp. 261 sq.

were to underpin a native economy and to provide the security necessary to raising the standards of living and culture. As he wrote later on his voyage from Quilamane to Bombay in 1864:

> "... The idea of a colony in Africa, as the term colony is usually understood, cannot be entertained. Englishmen cannot compete in manual labour of any kind with the natives, but they can take a leading part in managing the land, improving the quality, increasing the quantity and extending the varieties of the production of the soil; and by taking a lead too in trade and in all public matters, the Englishman would be an unmixed advantage to every-one below and around him for he would fill a place which is now practically vacant ..." [1]

Livingstone was one of the first men to realise that colonies, or rather protectorates, were essential to African development. His vision was of a society nurtured and managed by Europeans for Africans; his colony was to begin a managerial revolution in African life, not for exploitation but for progress.[2]

Concluding a speech in the Senate House at Cambridge in December, 1857, Livingstone had appealed for support from all the best young men:

> "... Gentlemen ... I beg to direct your attention to Africa ... I go back to Africa to make an open path for commerce and Christianity. Do you carry on the work which I have begun. I leave it with you ..." [3]

By 1860 the Oxford and Cambridge Mission had taken up the idea of a colony in Central Africa. Livingstone agreed to help in every way possible, and, therefore, he let his own scheme lie on the table. Young also favoured this course; it seems likely that he doubted Livingstone's ability to finance a colony. In addition, he thought it wisest for Living-

1. G. Seaver, op. cit., p. 444, quoting Livingstone's Log of his Journey from Quilimane to Bombay, 1864
2. J. Butt, History Today, June 1963, pp. 381-382
3. William Monk (ed.) Livingstone's Cambridge Lectures, London 1860, quoted by W.G. Blaikie, op. cit., p. 226

stone to use the experience of the Oxford and Cambridge Mission to advantage. Livingstone agreed with this, especially since he hoped to find a better route to Lake Nyasa than the Shiré. He was also hoping for government support: "... I think the Government will not hold back if we have a feasible plan to offer ..." But secrecy was essential; the Portuguese were to have no facts to use as the basis for complaints to the British government.[1]

Livingstone's letter of 22 July, 1860 makes it clear that he had not abandoned his idea of a government-backed colony. Discovery was useless, if settlement did not result from it:

> "... I am tired of discovery when no fruit follows ... All that is needed is religious and mercantile establishments to begin a better system and promote peaceful intercourse ..."[2]

Under his brother's influence, Charles Livingstone was writing much the same sort of thing. He made much of the commercial opportunities of the Shiré Highland. The people were friendly and willing to trade; what was needed was European ingenuity:

> "... I wish we had a few hundred good industrious Scotch families on these fertile highlands. Instead of, as at home, toiling for a bare sustinence, here they could cultivate largely sugar and cotton etc., benefit the natives by their example, and furnish material for our manufactures at home ..."

1. W.G. Blaikie, op. cit., p. 279
   M.S. Letter (in Miss Thom's Collection) Livingstone to Young, 17 November, 1862 talks of five young Scots collected by a London missionary making their way to join Livingstone to form a colony
2. Livingstone to Young, 22 July 1860, printed in part in The Glasgow Herald, 20 April 1861

To Thomas Clegg of Manchester, Charles Livingstone emphasized that: "This vast cotton region is easily accessible ... a fine country for benevolent enterprise ..."[1]

But David Livingstone realised that to end slavery in the area, physical violence might be necessary as well as colonial settlement. Although he was normally a gentle religious man, his radical conscience was so affronted by the horrors of slavery that he looked for some swift if violent solution:

> "... A small armed steamer on Lake Nyassa could easily, by exercising a control, and furnishing goods in exchange for ivory and other products, break the neck of this infamous traffic in that quarter; for nearly all must cross the Lake or the Upper Shiré ..."

Livingstone knew that this vessel would have to be specially prefabricated, brought to Africa and reassembled on Lake Nyassa. George Rae, a friend of the Young family and Livingstone's engineer, was sent home to supervise the boat's building.

After an eventful journey home, Rae reached London on 18 October, 1860 "...with the clothes he stood in and a few borrowed shillings ..."[2] He and James Young went to see Captain John Washington, the Admiralty's hydrographer and reputedly a keen supporter of Livingstone.[3] But Washington blew cold, saying that the Government would not incur any additional expense. Young listened to Washington's objections and in his characteristically direct manner asked, "... if we get the

1. Charles Livingstone to William Logan, 1 December 1859; and Charles Livingstone to Thomas Clegg, 4 November 1859
2. Letter Copybook, 1861-63, Young to Livingstone, 5 November 1860. British Museum Additional MSS., 50184, David to Agnes Livingstone, 1 September 1862, makes it clear that Rae was shipwrecked.
3. G. Seaver, op. cit., p. 302.

boat will you or the Government throw a wet blankit on our boat and us ..." At this Washington became less obstructive but even then Rae was quite disconsolate after this meeting, until Young told him that he intended to order the boat, in accordance with Livingstone's instructions, notwithstanding government objections.[1]

After preliminary discussions in London, the boat was ordered from Tod and McGregor of Finnieston Quay, Glasgow, and Rae went to stay with Young and his family at Sardinia Terrace,[2] while the boat was being built. By 4 March, 1861 when Young wrote to Livingstone again, the position had changed little:

> "... I have been in London for a week but got little good done when you have to ask favours it is slow work. Washington told me distinctly that the Government won't pay for the portable steamer neither would they do anything to help to take her out ..."

After talking to J. Bevan Braithwaite, a Quaker barrister of Lincoln's Inn and a keen supporter of Livingstone, Young began to think of trying to raise the money by public subscription, and this was also the policy favoured by Robert Dalglish, one of the Glasgow M.P.s. However, when Young went to see Washington again, he advised against raising the money by public subscription clearly because he thought that the Government would be embarrassed in the process. He, therefore,

1. Letter Copybook, 1860-63, Young to Livingstone, 5 November 1860
2. Ibid., Young to Mrs. Livingstone, 8 December 1860

suggested that Livingstone's own money should be used for the moment in anticipation that the Government would pay ultimately. The Government estimates for the Zambesi expedition for 1861 were over £11,000 "... and it was needless to try to get more this year ..." This explains how Livingstone's money came to be used for avowedly Government responsibilities for the work of its own consul.

To make the attainment of Livingstone's other objectives more possible, Young began to lobby M.P.s. He tried to stimulate a parliamentary pressure group to "... urge the Government to arrange with the Portuguese to have the river free to our commerce ..." Thus, access to the Shiré Highlands was to be achieved. In attempting to secure the support of influential commercial groups in Lancashire Young had mixed fortunes. Baizley, the member for Manchester, was openly unenthusiastic but blamed others for his lack of inspiration: "... the folk in Manchester were not in right earnest about cotton supply .." [1] As the Cotton Famine was to prove, the Lancashire Cotton Supply Association was not prepared to abandon its traditional sources of supply in the southern states of America. [2] Nonetheless, in March, 1861 Young and Rae went to Manchester to try to drum up support for trade with a future colony.

1. Ibid., Young to Livingstone, 4 March 1861
2. R. Pares, The Economic Factors in the History of the Empire in E.M. Carus-Wilson (ed.), Essays in Economic History, vol. i., p. 430

By 28 November, 1861 Livingstone had received Young's letters and was expressing his joy that the "Lady Nyassa", the prefabricated boat built to Rae's design, had left Glasgow for Africa.[1] By early 1862 Livingstone was at the mouth of the Zambesi, eagerly awaiting his "Lady of the Lake" and his wife Mary, who had been left at the Cape. James Stewart, who had been sent by the Church of Scotland to examine the feasibility of establishing a settlement in the Shiré Highlands, was an eye-witness of this reunion: Livingstone

> "... still enjoyed many an hour of prolonged talk about current events at home, about his old College days in Glasgow, and about many of those who were unknown men then, but have since made their mark in life in the different paths they have taken. Among others his old friend Mr. Young of Kelly or Sir Paraffin, as he used subsequently to call him, came in for a large share of the conversation ..." [2]

Another less enthusiastic but more sceptical and garrulous eye-witness was W. Cope Devereux, paymaster on the "Gorgon", part of whose crew had been seconded to Livingstone's expedition until the Lady Nyassa was reassembled:

> "... They have with them the pieces of a steamer (120 feet long), in charge of an engineer, who has the responsibility, first of taking the brig and her cargo to Quillimane river (a place reeking with fever), crossing its dangerous bar, putting the steamer together (a work of three weeks), taking her to Congoni, steaming up the shallow and comparatively unknown river of Zambesi, unshipping her at the Murchison Falls, carrying the ladies, maid-servants, steamer, and gear, weighing 140 tons,

1. W.G. Blaikie, op. cit., p. 288
2. Mary Livingstone was so sea-sick and generally ill from Sierra Leone to the Cape that David Livingstone thought it wisest to leave her with her parents at the Cape. (British Museum Additional MSS., 50184, David to Agnes Livingstone, 7 May 1858).
   W.G. Blaikie, op. cit., p. 293. James Stewart, (1831-1905) read Divinity at New College, Edinburgh; inspired by Livingstone's Travels: sent to Africa by Church of Scotland; founded Livingstonia.

through a country full of obstacles, tribes, jungle, and brutes of the wilds, and to push his way to the Lake Nyassa, where, perhaps, he may find the mission located. If the engineer carries all safely to its destination, and floats the "Lady Nyassa", as his piecemeal steamer is called, on the lake, he will deserve a monument in the Institute of Civil Engineers; but I am afraid the obstacles will overcome his energy, and that pieces of the steamer will be left here and there - small memorials, monuments of a great but wild endeavour ..." [1]

But Livingstone had high hopes of success. In a letter to J.S. Moffat written on 23 February, 1862 he remarked that he estimated that 19,000 slaves a year passed through Zanibar "... and nearly all come from Nyassa ..." He had fond hopes of ending this traffic, visions of violent cessation:

> "... we shall stop a good deal of that soon after we get our new vessel Lady of the Lake on the Nyassa ... Lady Nyassa is nearly as large as Pioneer but of iron, and well got up in Glasgow ..." [2]

Livingstone was well satisfied with the construction standard of the Lady Nyassa and he was very impressed with the stores, provisions and furnishings: "... The Glasgow friends had fitted up the Lady Nyassa splendidly ..." [3]

Meanwhile Young was finding it difficult to get the Government to acknowledge its financial responsibility for the Lady Nyassa. He tried to get Washington's support but was unsuccessful. J.B. Braithwaite promised "... to help me to get at Jack Russell and put the matter properly before him ..." Tod and McGregor wanted their money. Young expected that their bill would be over £4,000 for the boat and about £400

1. W.Cope Devereux, A Cruise in the Gorgon, London 1869 pp. 164-165
2. J.P.R. Wallis, op. cit., p. 167
3. Ibid., p. 178

for other expenses.[1] He still optimistically assumed that the Government would honour Washington's pledge. Having failed with Washington he lobbied M.P.s:

> "... I have got Mr. Gurney, M.P. to take in hand with the matter as he is a friend of Livingstone's and a great anti-slavery man I am pretty certain that he will get the thing done some way ..."[2]

Andrew Buchanan's brother was one of the Glasgow members and Young asked Andrew to bring his influence to bear:

> "... Tod and McGregor need the cash about £6000 in all and if we cannot get it out of the Government we must take the Doctor's money ..."[3]

Both Buchanan and Young also waited upon Robert Dalglish, another of the Glasgow M.P.s, thus beginning a lobby. By December, 1862 Tod and McGregor were still after their money, and there were several agitated meetings of the Trustees in Glasgow, before any decision was reached.[4] Additional costs for freight and insurance were referred by Washington to the Trustees, much to Young's annoyance:

> "... it realy is too bad to put such burdens on the Doctor it is the old story driving the willing horse ..."[5]

But Young could do little; he received more obstruction than support from the Government spokesmen "... all matters that the government have to do with give immense trouble ..."[6]

1. Letter Copybook, 1860-63, Young to Livingstone, 3 May 1862
2. Ibid., Young to Tod and McGregor, 10 June 1862
3. Ibid., Young to Buchanan, 14 June 1862
4. Ibid., Young to Buchanan, 8 December 1862
5. Ibid., Young to Tod and McGregor, 10 December 1862
6. Ibid., Young to unknown correspondent, 8 January 1863

On the Zambesi Livingstone was faced with insurmountable difficulties. The area had been widely devastated by slave-raiders: famine and disease were widespread. In spite of the good work of George Rae, John Reid, John Pennell and Richard Wilson, the team responsible for reconstructing the Lady Nyassa, the expedition was a tragic failure. Livingstone was heart-broken by the death of his wife at Shupanga on 27 April, 1862; he became more and more introspective. His short-comings as the leader of this expedition cannot be under-estimated: his choice of personnel was bad; he lacked the decisive precision required for leading a difficult team. The Government, apart from its double-dealing at home, vacil-lated about the objects of the expedition so anxious were they not to offend the Portuguese or to spend more money. Finally, Russell recalled the expedition. Thus, the Lady of the Lake never sailed on Lake Nyassa.

Livingstone was afraid that she would fall into the hands of Portuguese slave traders and become the bulwark of the trade on Lake Nyassa instead of its scourge. To avoid this he sailed her forty-five days across the Indian Ocean to Bombay with a scratch crew. There the Lady Nyassa was put into dry dock; Livingstone knew that he faced a heavy loss if he sold her there and then. He returned to Britain, know-ing that he would be able to consult Young as to the best policy to be adopted.[1] When he returned to Bombay in 1865

1. W.G. Blaikie, op. cit., p. 328

after his second furlough he sold the Lady Nyassa for £2,300 and invested the proceeds in an Indian Bank which collapsed in 1866.[1]

Meanwhile, Young had been watching Livingstone's family interests at home. The Livingstone children were put to their respective schools: Robert was at Glasgow College, Agnes at Helensburgh, Thomas at Kendal, and Oswell at Brighton. By 1860 Mrs. Livingstone had briefly returned from the Cape. She was not happy with her position at Hamilton nor was she content with the arrangements made for the education of her children. Young was always anxious to do what he could and encouraged the Livingstone family to visit his home regularly.[2] When Mary Livingstone decided to return to the Cape prior to rejoining her husband on the ill-fated Zambesi expedition, Young tried to dissuade her. Instead, he suggested that she should take a house near either Glasgow or Edinburgh and make a home for the children. They could go to good local colleges and day schools. To support them, after paying David Living-stone's mother a pension from the trust, there was £400 a year.[3]

However, Mary Livingstone was fixed in her intention to rejoin her husband and to explain her failure to settle in the rarified atmosphere of Livingstone's family home in Hamilton. This resolution led Mary Livingstone to her death, and there can be no doubt that she would have been better advised to

1. G. Seaver, op. cit., p. 472
2. Letter Copybook, 1860-1863, Young to Mrs. Livingstone, 8 December 1860
3. Ibid., Young to Livingstone, 3 November 1862

take Young's advice. After her death David Livingstone had a period of self-recrimination which Young tried vainly to assuage:

> "... Now my dear friend do not allow yourself to think for one moment that you ever were harsh to your lamented wife if ever a man was kind to his wife it was you if you talk in this way what am I to think of my treatment of Ma James ..." 1

Young's failure to persuade Mrs. Livingstone to make a home for her children in Scotland placed a heavy burden of responsibility upon all Livingstone's Trustees but especially upon Young himself. At the end of April, 1862 they met and decided to bring Thomas and Oswell to Glasgow and put them to school there - Andrew Buchanan advised that Robert should be sent to Edinburgh to study medicine; he thought that Robert would do better there than in Glasgow. Young intended to rely upon the good offices of Lyon Playfair who had been Professor of Chemistry in Edinburgh since 1858:

> "... I am intending to get Playfair to take a fatherly care of him. Playfair has always been interested in him and he is the man to give good advice about his studies so I have hopes that all will go well with Robert ..." 2

But Robert did not settle or intend to settle in Edinburgh. Playfair and Young arranged to meet and discuss his

1. Ibid. On 20 May 1861 Livingstone had written to his daughter Agnes making it clear that he did not expect to return to Britain quickly:
"Having sent for Mama you will now be left in England alone ... you have however kind and good friends who will no doubt continue to befriend you and you have our blessed Lord Jesus ..." (British Museum Additional MSS, 50184, David to Agnes Livingstone, 20 May, 1861)
2. Ibid., Young to Livingstone, 3 May 1862

future on 15 September, 1862.[1] On the 18th Young heard of Mrs. Livingstone's death. Immediately, Young decided to write to Robert, although he expected that David Livingstone would have written to his son. He hoped that Robert would settle down:

> "... Dear Robert this is a sad serious matter I am not going to preach to you but do make a good use of this warning and resolve to carry out your fathers wishes he is very much concerned about you and I hope you will now do all you can to set his mind at ease ..."[2]

The week before this letter, in Young's absence from Limefield, Robert had turned up there to see Young:

> "... to say that he could not pass at Edinburgh and that if he was not removed from Hodge's School he would remove himself ..."

James, Young's eldest son, advised Robert to go to St. Andrews but Robert "... shewed no signs of being at all willing to take such advice ..." He stayed for a few days but lived a moody, solitary existence, out by himself all day after breakfast and one evening he did not return. The next morning he turned up and when questioned said that he had thought of running away but, becoming tired and dispirited, had decided to return. At last Mrs. Young had to take him to the station and give him the money to get to St. Andrews, since he had arrived at Limefield with nothing more than 1½d. in his pocket.[3] On 23 September Young met Hannan in Glasgow

1. Ibid., Young to Playfair, 15 September 1862
2. Ibid., Young to Robert Livingstone, 18 September 1862
3. Ibid., Young to James Hannan, 18 September 1862

and discussed Robert's future. Hannan suggested that they send him to his father. Young thought this might be the best policy.[1] Unknown to them, Livingstone was thinking the same and on 30 August, 1862 had written to his mother suggesting that Robert should be sent out to him.[2] By 25 September, 1862 Young received word that Robert had not arrived at Hodge's School in St. Andrews.[3] At the beginning of October he had been found and placed in the care of his aunt in Hamilton. The trustees were still agreed that he should be sent to his father. But Young, out of duty to David Livingstone, was inclined to give Robert a last chance in the medical classes of Anderson's "University": "... it is a sad matter to give up his father's intention of giving him a medical education ..."[4]

But when the Trustees heard of David Livingstone's letter of 30 August, 1862 their minds were made up. In 1863 Robert Livingstone sailed for Africa but failed to reach his father. Instead he fancied a life of travel and signed on as a seaman on a ship sailing for Boston. When the ship reached port, according to his own story, Robert was shanghaied and then press-ganged into the Federal Army. He changed his name to Rupert Vincent and after a number of forays was wounded near Laurel Hill in Virginia, captured by the Confederates and died of wounds in a Prisoner of War Camp at Salisbury,

1. Ibid., Young to Buchanan, 24 September 1862
2. G. Seaver, op. cit., p. 421
3. Letter Copybook, 1860-63, Young to Buchanan, 25 September 1862; Young to Thomas Nicolson, 25 September 1862.
4. Ibid., Young to Thomas Hodge, 1 October 1872; Young to Miss Kate Livingstone, 27 October 1872

North Carolina on 5 December, 1864.[1] Like his father he was a wanderer; like his father he died fighting against slavery.

Tom Livingstone, David's second son, seems also to have presented problems to his father's trustees. He was removed from his Brighton school as the result of some excapade or other, only hinted at in Young's correspondence.[2] His father reveals in a letter that James Young had freed him from undesirable acquaintances.[3] He seems to have been just as weak as Robert was wild, sullen and reckless. He enjoyed only poor health which his father suggested was due to congestion of the kidneys.[4] He also visited Young's home and occasionally in the summer sailed on Young's yacht.[5]

In 1872, as the eldest surviving son, Tom was the person to whom H.M. Stanley handed over the Journals and letters which Livingstone had entrusted to him.[6] That autumn he almost died. In October, 1872 Young reported to Horace Waller:

> "... Tom has had a very close shave for his life. The doctor is confident that he will recover but he cannot remain at home this winter, his only chance is to get to a warm climate ..."

1. G. Seaver, op. cit., pp. 452 sqq.; H.H. Johnston, op. cit., p. 74. British Museum Additional MSS., 50,184, David Livingstone to Agnes Livingstone, 8 July 1863, mentions that David had told his son Robert to work his passage from Natal: "... Robert has come to Natal, I hear from one of the missionaries. There is no more communication between this and Natal than between Glasgow and the moon ..."
2. Letter Copybook, 1860-63, Young to Charles L. Braithwaite, 19 June 1862; Young to Buchanan, 19 June 1862; Young to Hannan, 19 June 1862.
3. British Museum Additional MSS., 50,184, No. 84, David to Agnes Livingstone, 23 August 1872
4. W.G. Blaikie, op. cit., p. 341
5. Pocket Diary of James Young, 1867, August, passim.
6. H.M. Stanley, How I found Livingstone, London 1872, p. 718

It was Young who saw Tom's employees in Glasgow to see "... if they or any of their friends can give him anything to do in Cairo ..." After his experience with Robert, Young was anxious that Tom should:

> "... have something to attend to where-ever he is and it is a poor life lounging about an hotel & Satan finds some mischief etc. ..." [1]

Eventually, Tom secured a light business post in Cairo and died there in 1876.[2] After his father's death and the burial in Westminster Abbey, it was Tom whom the trustees advised in 1874 to edit the Last Journals of David Livingstone.[3] But he lacked the energy, good health and technical expertise for the task, and this led John Murray, Livingstone's publisher since 1857, to suggest the Reverend Horace Waller - after W.C. Oswell had refused - as editor of what proved to be a Victorian classic.[4]

The other children presented few problems. Oswell was a brilliant scholar at Gilbertfield Preparatory School in Hamilton,[5] and later joined one of the search expeditions forestalled by H.M. Stanley. His motives were not entirely altruistic since he was anxious to get his father home to Britain so that his own education could be paid for. Anna Mary was a mere child, having been born in 1858.[6] Agnes was David's favourite child. After her mother died she lived

1. Letter Copybook, 1867-73, Young to Horace Waller, 19 October 1872
2. W.G. Blaikie, op. cit., p. 341
3. A.Z. Fraser, Livingstone and Newstead, London 1913, pp. 230
4. Ibid., p. 233
5. Hamilton Advertiser, 8 June 1867, gives the prize list for session 1866-67 in which Oswell figures prominently
6. British Museum Additional MSS., 50,184, No. 84. David to Agnes Livingstone, 23 August 1872. Anna Mary was educated at the Quaker School in Kendal, A.Z. Fraser, op. cit., p. 177

for a time with her aunts in Hamilton but her father in 1865 sent her to a finishing school in Paris, in the care of Madame Hocédé, the niece of the Reverend P. Lemue, the French Protestant minister who had officiated at David Livingstone's marriage to Mary Moffat. Madame Hocédé kept a small Protestant school for British girls; Agnes seems to have enjoyed her time there.[1] In vacations and after a year or so there, Agnes divided her time between the houses of Livingstone's friends; Webb of Newstead Abbey, Andrew Buchanan and James Young regularly provided her with hospitality.[2] She travelled far and wide in Young's yacht, even visiting the Great Geyser in Iceland. David Livingstone even advised her to accept Young's advice about suitors, so highly did he prize Young's judgement.[3]

During his second furlough in Britain, 1864-65, David Livingstone spent more time in Scotland than had been possible in 1857-58. He was at Limefield with Young and his family at the end of July, 1864.[4] This enabled him to lay the foundation stone of Young's new refinery at Addiewell and also to plant trees in the garden of Limefield which still survive. He also met Young's engineer Alexander Kirk, the brother of John Kirk of the Zambesi. In Paisley he learned photography from John Urie, a professional friend of Young's

1. Ibid., 161
2. Ibid., p. 161 and pp. 173 sqq.
3. British Museum Additional MSS., 50,184, No. 84, David to Agnes Livingstone, 23 August 1872. Agnes had told Oswell that she would not marry until her father came home.
4. W.G. Blaikie, op. cit., p. 341

and a keen local historian.[1]

By 20th January, 1865, Livingstone was ready to return to Africa via Bombay where the Lady Nyassa still awaited him. The direction of the monsoon south westerlies blowing from Africa to India was against his taking the Lady Nyassa back to Africa. Thus, he sold her and made up his mind to go via the Seychelles to the mouth of the Rovuma river. His advice to Young was touchingly amusing "... tak yer speks and keek at the map or geugrafy ..." Although much has been made of the fact that Livingstone avowedly went back to Africa to find the sources of the Nile, the point should be made that he had not turned his back on missionary work. He did not agree to lead this Royal Geographical Society expedition as an explorer:

> "... but as a missionary, and do geography by the way because I feel I am in the way of duty when trying either to enlighten these poor people, or open their land to lawful commerce..." [2]

Having reached Bombay and taken his loss on the Lady Nyassa, Livingstone did not bewail his ill-luck with his £6,000 investment:

> "... The whole of the money given for her I dedicated to the great object for which she was built. I am satisfied at having made the effort; would of course have preferred to have succeeded, but we are not responsible for results ..." [3]

1. John Urie was the author of "Glasgow and Paisley Eighty Years Ago." C.f. J.D. Henry, History and Romance of the Petroleum Industry, London 1914, vol. i., p. 96
2. W.G. Blaikie, op. cit., p. 351; c.f. also R.J. Campbell, op. cit., p. 279
3. W.G. Blaikie, op. cit., p. 364

The history of British expansion in Africa is littered with the efforts of the men on the spot and the general passivity or obstruction of governments.

For Young there were no principles by which he became an imperialist. He believed in the goodness of Livingstone and that was sufficient motive; in financing this second expedition to the Zambesi interior Young was as generous as the Royal Geographical Society and the British Government put together.[1] They gave £500 each; he gave £1,000. Indeed, one of Livingstnne's biographers believed that without Young's support this expedition would not have been organised.[2]

Early in 1867, after Livingstone had disappeared into the Interior, a rumour reached Britain that Livingstone was dead. Nine deserters from his expedition, led by one Musa, reached Zanzibar on 6th December, 1866, and in order to escape punishment and to collect their wages, they told the story that Mazitu tribesmen had killed Livingstone. This story was so well told that many experienced travellers, Europeans, Arabs and Africans, believed it to be true. On 7th March, 1867 Livingstone's death was announced in The Times.[3] E.D. Young - with whom James Young has occasionally been confused - knew Musa to be untrustworthy and believed he and his eight companions to be liars. This James Young found glad news:

1. R. Coupland, op. cit., p. 25
2. R.J. Campbell, op. cit., p. 299
3. R. Coupland, op. cit., pp. 60-63

> "... of course we are all very glad to see such good news from Africa it is quite evident that E D Young does not believe that the Dr. is dead ..." 1

E.D. Young led a rescue expedition into the Interior and proved that Livingstone was alive. From this time Livingstone referred to James Young as "Sir Paraffine" "... I have been obliged to knight him to distinguish him from the other Young ..."

Livingstone's relations with Kirk, consul in Zanzibar, were embittered by the failure of Kirk to ensure that supplies and correspondence passed regularly to and fro. Kirk had little in the way of government backing for Livingstone's exploration but as soon as he contacted Young he was told that Livingstone's requirements had to be met:

> "... and intimate you have done so and I shall meet the bills ..." 2

Kirk's shortcomings were proven by Stanley's success in finding Livingstone. Throughout 1870 there was speculation about Livingstone's activities for mail was at best intermittent. Livingstone complained in a letter to Kirk that he had heard nothing from Young:

> "... Not a single line from Sir Paraffin Young since I left England and I have written him by every opportunity. The money I sent for was to be lifted from £1,000 in Coutt's hands - mine not his ..." 3

In fact, Stanley picked up all the accumulated mail for Livingstone and later gave an account of Livingstone's reactions:

1. Letter Copybook, 1867-73, Young to Hugh Bartholomew, 13 July 1867
2. Ibid., Young to Kirk, 21 December 1869
3. R. Coupland, op. cit., p. 112

> "... Agnes, my eldest daughter, has been enjoying herself in a yacht with 'Sir Paraffine' Young and his family ..." [1]

For Young, Livingstone was "a kind of a miracle"[2]. He had just retired from business, and this led Livingstone to extend his congratulations, beginning his letter with the tag "Opere peracto ludemus". Livingstone felt differently about his own future; he seemed imbued with a religious fatalism:

> "... I am differently situated; I shall never be able to play ... To me it seems to be said, 'If thou forbear to deliver them that are drawn unto death, and those that be ready to be slain; if thou sayest Behold we knew it not, doth not He that pondereth the heart consider and He that keepeth thy soul doth He not know, and shall He not give to everyone according to his works?' ..." [3]

On 4 October, 1870, when Young was hearing rumours that Livingstone had been murdered[4], the explorer was attempting to perpetuate Young's name along with those of his friend Webb and the statesmen, Lincoln, Palmerston and Bartle Frère,

> "... three names of men who have done more to abolish slavery and the slave-trade than any of their contemporaries ..." [5]

Both Webb and Young were to give their names to the rivers that Livingstone believed to be the true sources of the Nile. What Livingstone called "Young's Lualaba" was, in fact, the river Lomame, a tributary of the Congo. In his dispatch

1. H.M. Stanley, op. cit., p. 422; T. Hughes, David Livingstone, London 1889, p. 143
2. Letter Copybook, 1867-73, Young to unknown correspondent.
3. W.G. Blaikie, op.cit., p. 443
4. Letter Copybook, 1867-73, contains a Copy Telegram, Young to Moore, 1870. "Telegram from Paris says Livingstone murdered what is known write Port Said Leaving Constantinople now."
5. H. Waller, The Last Journal of David Livingstone, London 1874, vol. ii., p. 65

to the Foreign Office, a few weeks before his death, Livingstone made it clear that honouring Palmerston and Lincoln was his way of placing "... my poor little garland of love on their tombs ..." Bartle Frère deserved recognition for his work of abolishing slavery in the Sind, and Livingstone's tribute was almost prophetic for Frère was, within a month of Livingstone's death, to end the slave mart at Zanzibar. Young's elevation to this company in Livingstone's thoughts was a recognition of his unfaltering support and social significance:

> "... 'Paraffin' Young, one of my teachers in chemistry, raised himself to be a merchant prince by his science and art, and has shed pure white light in many lowly cottages, and in some rich palaces. Leaving him and chemistry, I went away to try and bless others. I, too, have shed light of another kind, and am fain to believe that I have performed a small part in the grand resolution which our Maker has been for ages carrying on, by multitudes of conscious, and many unconscious agents, all over the world ..." 1

At the end of 1871 anxiety about Livingstone recurred, when no word had been received from him and this led to Stanley's expedition. In Britain the committee habit was becoming entrenched: the Royal Geographical Society in January, 1872 sent out a circular inviting subscriptions from the general public towards a fund for despatching an expedition to find Livingstone. The Royal Geographical Society started the list with £500; the government's grant to Livingstone of £1,000 in 1870 - the result of pressure by Waller and Young - still

1. Ibid., pp. 65-66 and p. 170; c.f. also W.G. Blaikie, op. cit., p. 23 and H.M. Stanley, op. cit., p. 448

had a balance of £557. 7. 10d.; the public appeal raised this nucleus to £5,570. 3. 1d. The expedition sent on 7th February, 1872 actually cost £2,359. 6. 6d. leaving a surplus of over £3,000 which Young and Waller in 1872 were trying to secure for Livingstone's depleted finances, since the Government were trying to avoid paying any salary to Livingstone.[1]

Like several other members of the Royal Geographical Society, Young did not think one official expedition from Zanzibar was sufficient. He was convinced that Livingstone might find his way to the east coast of Africa blocked, and since he believed that Livingstone was exploring the Congo sources and not those of the Nile, he thought it possible that Livingstone would make his way westward. He, therefore, offered £2,000 for another expedition from the Congo delta, and, in fact, spent over £3,000 on this object.[2] The official party turned back because of Stanley's successful expedition; Young's party led by Lieutenant W.J. Grundy, R.N., finally turned back when it was clear that Livingstone was dead.

Stanley's successful expedition was marred by a sensational aftermath of unsavoury publicity in a wide variety of

1. H.H. Johnston, op. cit., p. 345 n. Glasgow Herald, 28 December 1872. Young copied into his Letter Book 1867-73 a letter from Lord Granville, September 1872, which was unenthusiastic about helping Livingstone. Letter Copybook, 1867-73, Young to Waller, 19 October 1872

2. G. Seaver, op. cit., p. 604; Glasgow Herald, 22 November 1872; Proceedings of Glasgow Philosophical Society, vol. viii, pp. 278-80 contains a paper on this expedition by Young's friend, James Napier; c.f. also Ibid., p. 486. Pocket Diary of James Young, 1874, 1 January: "Sir Bartle Frere called I told him I would bear all the expenses of Grundy's Exp."

newspapers. Some suggested that Stanley was a fraudulent scoundrel; others that the journals and letters which he brought back were not Livingstone's.[1] Young did as much as he could to comfort Agnes Livingstone and to dissipate the publicity. Stanley's personality did not help - neither did his attack upon Kirk.

However, the news of Livingstone's death settled the dust. After the funeral in Westminster Abbey, Young assisted greatly in securing an accurate record of Livingstone's Last Journey. One of Livingstone's porters, Jacob Wainwright, was brought to Britain by the London Missionary Society and acted as a pall-bearer in the Abbey; the L.M.S. paraded him around Britain in fund-raising sprees which, in the process, gave him an exalted view of his own significance.[2] Susi and Chumah, Livingstone's personal servants and the moving spirits behind the act of carrying Livingstone's body to the coast, were forgotten, until Young had them brought to Britain at his own expense.[3] At Whitsuntide 1874 Horace Waller and his wife were staying with the Webbs at Newstead Abbey when Susi and Chumah arrived on their way to stay with Young. Waller and the

1. G. Seaver, op. cit., pp. 601 sq.
   Even the Glasgow Herald did a scurrilous review of Stanley's book, Glasgow Herald, 12 November 1872.
   Letter Copybook, 1867-73, Young to James Aytoun 2 Sept., 1872 tried to make it public that the Journals and letters were genuinely Livingstone's; and c.f. also Young to R.J. Findlay, 6 September 1872 deploring "the unfortunate discussion in the newspapers."
2. A.Z. Fraser, op. cit., pp. 222 sq.
3. Ibid.
   H.H. Johnston, op. cit., p. 363;
   R.J. Campbell, op. cit., p. 333;
   Pocket Diary of James Young, 1874, Copy Telegram, Young to Waller "Received yours of Twelfth. Arrange to bring Chuma and Susi to London will pay cost."

company at Newstead found their English very much better than they expected; in consequence, Waller was able to hold regular conferenceswith them as he worked through his edition of Livingstone's Last Journals. These conversations and their skill as geographers were of great value to Waller; this he acknowledged in the introduction to the Last Journals:

> "... I cannot close these remarks without stating how much obliged I am to Mr. James Young, F.R.S., of Kelly, for having ensured the presence of the Doctor's men, Chuma and Susi. Ever ready to serve his old friend Livingstone, he took care that they should be at my elbow so long as I required them to help me amidst the pile of MSS and maps ..." [1]

Had Young not been so thoughtful a considerable amount of elucidatory information might have been lost. After this period at Newstead, Susi and Chumah went north to Scotland to stay with Young. Young questioned them carefully about Livingstone's last days and asked them about the hut in which he had died. Their answer was to copy the hut of Ilala in saplings and hay. Young had it photographed, and Waller used it as one of the illustrations for the first edition of the Last Journals.[2]

Young also helped to start the managerial revolution which Livingstone had thought necessary for Africa. The colony of Livingstonia - or Nyasaland - was started with a fund of

1. A.Z. Fraser, op. cit., pp. 210 sqq;
   H. Waller, op. cit., vol. i., p. ix., Waller named his edition: "The Last Journals of David Livingstone in Central Africa from 1865 to his Death, continued by a Narrative of his last moments and sufferings, obtained from his faithful servants, Chuma and Susi."
2. A.Z. Fraser, op. cit., pp. 217 sq.

£10,000, of which Young contributed £1,000.[1] In the summer of 1878 the Livingstonia Central Africa Company was founded in Glasgow and Edinburgh; this became later the African Lakes Corporation Limited.[2] Young sympathised with its aims and objectives.

Essentially, his regard for Livingstone was the key to his actions. As he told W.G. Blaikie, Livingstone's greatest biographer:

> "... Livingstone was the best man he ever knew, had more than any other man of true filial trust in God, more of the spirit of Christ, more of integrity, purity, and simplicity of character, and of self-denying love for his fellow-men ..." [3]

Indeed, Young knew that he had known a saint!

1. James Wells, Stewart of Lovedale, the Life of James Stewart, London 1908, pp. 126-127.
2. Ibid., p. 139 n.
3. W.G. Blaikie, op. cit., p. 22
   Young was a moving spirit in securing the Glasgow Statue to Livingstone, Letter Copybook, 1867-73, Young to Lord Provost, 18 September 1872

A FINAL JUDGMENT

> "It will not, we hope, be considered impertinent if we suggest that some public honour should be done to the memory of a man who has deserved so well of Science, of his country, and of the world ..."
> Chemical News, 25 May, 1883

There is more to any successful industrialist than the capacity to make money. Yet Young's business qualities were fundamental attributes of his character. Clearly, his tenacity accounted greatly for his business success, but this must be allied to his interest in science and his technical ability. But the nineteenth century is studded with the names of men with scientific or technical ability who either failed to make a fortune in industry or never even tried. Young set about the task of making money in an almost scientific fashion; it was a serious, all-absorbing game, a satisfying intellectual exercise.

An instinct for caution is not often linked with a capacity to imagine the horizons of profit beyond the technical limits of an invention or discovery. But Young possessed both. He approached scientific and technical problems with a careful spirit of enquiry and an over-powering capacity for hard work. His experiments with coal at Tennants, before he patented his process for the distillation of coal at low temperatures, illustrate this. Careful enough to seek professional advice, Young, nonetheless, was prepared to back his own intuition. Thus, he refused to take Edward Frankland's advice when the latter suggested that Young should not claim the making of oil containing paraffin.

Young was certainly proud. Apart from the fortune at stake in the lawsuits involving his patent, it was a matter of pride in the belief of his own priority in making paraffin oils in commercial quantities that sustained him. While his personal pride inflated his own tenacity, this, in turn, stiffened the determination and courage of his partners. Their resolve was rewarded with success at law because Young's legalism had assisted in making his patent specification foolproof. Even in the United States it was his patent specification that was universally recognised or attacked and not that of Abraham Gesner. David Livingstone made Young's reputation permanent by ascribing to him the nickname "Sir Paraffin".

Yet, without a scientific education in Anderson's University, Young might have remained a respectable joiner or cabinet maker. He, himself, recognised by his service and by his philanthropy that it was a special institution devoted to the task of producing the scientists, engineers and doctors so necessary to the new urban society. With its emphasis on technical subjects and new sciences, on the practical aspects of chemical analysis, isomerism and atomism, the Andersonian provided an education which Young had the genius to utilise. Its emphasis on practical training and modern chemical and physical theory suited his nature.

His habits of hard work and perseverance learned in his father's workshop were invaluable aids in his rise to economic power; this earlier existence was a valuable corrective to the more cloistered assistant's life with Thomas Graham.

Young's knowledge of human nature was linked to a sharp intelligence. His sense of reality and his cautious capacity to calculate did not destroy his consciousness of the human problems produced by the industrialisation process. It was not that he developed a guilt complex that he benefited from this society, and others did not. Nor did he feel that his own new industry was creating cumulative social problems which others would have to solve; there was no great affront to his conscience from the Left. Rather it was that he believed it possible to strike an identity of interest between making his own fortune and improving the lot of the community. It is surely significant that he found his political friends among the left-wing of the Liberal Party and never was a middle-of-the-road-man. But his grasp of what was practicable, reinforced by his social and economic ambitions, was unlikely to take him into the lost realms of naked idealism. Not for him the Utopian Owenite land schemes or co-operative ventures, not for him Chartist hopes of the efficacy of physical force. Far better to join a respectable, sober organisation, an intelligent lobby with limited objectives and representatives in parliament. James Young wanted to extend the benefits of capitalist society; he had no revolutionary Socialist ideals. Although he was a great individualist in many respects - and, particularly, in his money-making activities - he was an inveterate organisation man, a believer in social groupings for limited purposes.

It has generally been stated that Young's technical skill was the reason for his success. It is certainly true that Young possessed two important and related qualities: he had the practical man's capacity to pose solutions to technical problems encountered in production and also the brilliant scientist's imaginative ability to see what problems require answers. But with this inventive flair Young linked commercial acumen, a mathematical calculating capacity, an embryonic cost accountancy. This regard for financial realities began in his father's workshop and was greatly stimulated first by his experience with Muspratt and then by the profit incentive scheme for their managers operated by Tennants. It was accentuated by the recognition that what money he could make for others, he could make for himself. The very limited supply of capital available to Young led not merely to the partnership with Meldrum and Binney but also to the sophisticated analysis of the costs of production at Bathgate and the later organisation of remote control through his accountants.

The dishonest who recognise their own money-making capacities generally look for opportunities for theft or fraud; the honest, like Young, look for an opportunity to launch into their own business. The success of both seems to depend upon chance. The dishonest are either found out or able, from their ill-gotten gains, to launch themselves into more respectable ventures. The acquisition of capital by the honest, no matter how gifted they are, is just as fortuitous.

Young was fortunate in many respects: first in his association with Lyon Playfair which led him to the Derbyshire petroleum spring and to the distillation of coal; secondly, that Tennants were so big that small ventures did not attract their interest; thirdly in the chance factors revolving around his friend, Hugh Bartholomew, which led to the exploitation of Boghead cannel coal; fourthly in his association with Meldrum and Binney, each in his own way a very gifted person with assets of special significance to contribute to the partnership. To these examples of good fortune we must add others: the failure of William Gillespie's law-suit against James Russel and Son and the discovery of a suitable lamp to burn the illuminating oil.

But it should never be forgotten that it is necessary to make the best use of good fortune. Young possessed the bucaneering spirit so essential to the success of the self-made manufacturer, the creative capacity to capitalise on good fortune, the decisive but speculative precision to use profit-earning opportunities, the sense to make violent but necessary changes in policy and to depersonalise economic relationships, the hard intellectual instinct to sweep away all considerations in the consuming game of money-making. It was a crude battle of intelligence with opportunity, a catch-as-catch-can between calculating craft and established business attitudes.

This recital by no means exhausts Young's qualities for business success. But from outside his direct business exper-

ience one can adduce equally important personal characteristics. His technical skill and scientific training commended him to his first employers and led him to produce his great paraffin patent of 1850, but also it was the basis for his producing a number of improvements, schemes and patents that did not add materially to his fortunes. A full list of his patents is given in the Appendix, but their real significance is as a form of imaginative escapism. Young never gave up scientific enquiry and inventing; the longer he lived, the greater the time and the financial resources he was able to devote to science. He must have found great pleasure in his laboratories at Bucklersbury, Limefield, Kelly and Durris.

But there were generally commercial possibilities in his work. The greatest in scope was certainly his idea of a Channel Tunnel. He was to have presented a paper on this subject to the Glasgow Philosophical Society (as it was then known) in the November of 1857:

> "... but owing to an alteration of the arrangements of the proceedings of that evening, and the length of time which those who did not read their communications occupied in speaking, Mr. Young's paper had only a hurried notice after 10 o'clock, so that the Society neither had time to have the full benifit (sic) of Mr Young's views upon the subject, nor to hold any satisfactory discussion which was likely to have resulted from such a novel and important communication ..."

Fortunately The Engineer[1] published details and comments upon Young's scheme. Young imagined that the tunnel could be constructed upon the bed of the Channel in a shallow trough. He

1. The Engineer, 22 January 1858

had the ingenious idea of a plough-shaped shield working within a sideways-placed cylindrical tube; the shield would be pushed forward hydraulically along the sea-bed to win an extensible space within the cylinder and so to allow the progressive building of a tunnel of cast-iron blocks, five inches thick, "... being segments of a circle, and made to fit tightly with grooves ..." Within this structure there was to be an inner cast-iron lining:

> "... leaving a space between the two, to be filled up with asphalt or other material impervious to water ..."

Editorial comments make it clear that Young had provided:

> "... against the influx of water, and yet for allowing the cylinder shield to be moved forward like the slide of a telescope, also for pressure against this movement ..."

For modern observers the outstanding point of interest may well be that Young estimated that for such a tunnel, fourteen feet wide, the cost would be three and a half million pounds, an interesting comparison with the 1959 estimate of £100 million. James Napier, sent a copy of this article to Young while he was in America and hoped "... to see your Tunnel question taken up in America ..."[1]

Young was firmly convinced that mechanisation was an inevitable law of production. Machinery was cost-reducing and profit-making - he was forever looking for new machinery and

1. M.S. Letter, James Napier to Young, 2 March 1860 enclosing copy of the article in The Engineer

new methods. He thought of mining shale by machine; he financed extensive research in many different processes and pieces of equipment; reputedly he spent £15,000 on retort research and anticipated most modern developments.[1] He was actively and successfully concerned with producing a continuous flow method of production in 1860-61;[2] he assisted his son James to produce a short-lived method of turning heavier fractions into burning oil[3] so that by 1865-66 it was possible to produce 90% burning oil to 10% lubricating oil and other fractions. But his view of mechanisation was more than a rationalised version of cost reduction. He looked to new methods of production to make life easier and safer. After the Barnsley mining disaster of December, 1862 he was pressing forward the idea of lighting mines by electricity:

> "... I need not tell you that anything that would prevent such dire calamities as that of last Monday at Barnsley is a matter of the utmost importance to humanity ..."[4]

Young became the intermediary between McIvor, one of Playfair's assistants in Edinburgh, and John Ferguson, a Lesmahagow coalmaster,[5] which enabled McIvor to try his ideas down the mine. Many years later, in the 1870s, he was encouraging Professor George Forbes to carry out experiments to produce an instru-

1. I am grateful to Dr. Stewart of Scottish Oils, Ltd., an expert on the history of retorting, for this judgment.
2. British Patent, No. 486, 25 February 1861, "Improvements in Apparatus for the treatment or distillation of bituminous substances."
3. British Patent, No. 3,345, 27 December 1865, "Improvements in treating hydro-carbon oils."
4. Letter Copybook, 1860-63, Young to John Ferguson, 11 December 1862.
5. Ibid., Young to McIvor, 10 December 1862; to Ferguson, 11 December 1862; to McIvor, 11 December 1862

ment to detect fire-damp.[1]

More amusing was Young's attempt to establish a perfectly fair way of determining the fares to be paid on Glasgow's trams.[2] Indeed it was the subject of one of his many patents. On 12th April, 1876, he read a paper, "On a method of Checking the Distances Travelled by Passengers in Wheel Carriages", to the Glasgow Philosophical Society.[3] He did not agree with the idea of arbitrary fare stages; he preferred to link fares to the exact distance travelled. He, therefore, suggested that an indicator of distance should be fitted to every vehicle; this would not eliminate the need for a conductor. He would issue each passenger with a ticket pierced on entry; this ticket would be checked against the distance indicator by the conductor when the passenger wanted to leave the vehicle. At this stage the fare would be collected.[4] It was far too complicated a system for actual operation.

Right up to the time of his death Young remained an inveterate experimenter and a constant producer of patents. He did work for the Admiralty on the corrosion of hulls caused by sea-water in the bilges and successfully suggested that caustic lime be tried to prevent this. He retained a constant interest in the preparation of dyestuffs and bleaching agents.

With Edward Meldrum in 1855 he took out a patent for "Improve-

1. In 1878 and again in 1880 George Forbes described their efforts in the Proceedings of the Royal Society of Edinburgh vol. ix., 1878, pp. 613-614 and vol. x., 1880, pp. 365-367
2. British Patent, No. 1,689, 6 May 1875 "Distance Indicator for Vehicles"
3. Proceedings of the Glasgow Philosophical Society, vol. x., 1875-77, p. 134
4. The Glasgow Evening Citizen, 14 May 1883

ments in the manufacture of certain salts of sodium and potassium"[1]; in the early 1870s he was concerned with improving the manufacture of carbonate of soda, and carbonic acid.[2] He took a great interest in the preservation of food and in the treatment of sewage to extract ammonia and to prevent danger to public health.[3] He tried out early telephone systems at Limefield and Kelly; with George Forbes he did experiments with practical electrical systems and involved himself in the theory of light waves by attempting to analyse the differences in speed of white and blue lights transmitted across the Firth of Clyde.[4] He was elected to the Royal Society of Edinburgh in 1861,[5] and, as the friend and benefactor of David Livingstone, became a Fellow of the Royal Society in 1873.[6] For services to science, industry and education the honorary degree of Doctor of Laws was conferred upon him by the University of St. Andrews in 1879. In 1876 he gave a £100 to the Chemical Society's Research Fund and during the period 1879-1881 was Vice-President. In 1878 he gave a £1,000 to the Royal Society.

1. British Patent No. 2,220, 4 October 1855, "Improvements in the manufacture of certain salts of sodium and potassium".
2. British Patent No. 2,122, 11 August 1871 and British Patent No. 2,558, 28 September 1871, "Carbonic Acid"; British Patent No. 2,557, 28 September 1871, "Carbonic Acid".
3. British Patent No. 299, 4 February 1864, "Improvements in the preservation of vegetable and animal matters"; British Patent No. 3,562 and No. 4,659, 27 July and 30 September 1882, "Treating Sewage"; British Patent No. 332 and No. 434, 20 January and 26 January 1883, "Treating sewage water and other liquids."
4. Forbes and Young, "Experimental Determination of the Velocity of blue and of coloured light" in Proceedings of the Royal Society, vol. xxxii., 1881, pp. 247-249, c.f. also Chemical News, vol. xliii., 1881, p. 249 and Philosophical Transactions vol. clxxiii., 1883, pp. 231-289
5. Notice of his election on 1st April 1861 was retained by Young and is in his Private Papers.
6. Proceedings of the Royal Society, vol. xxii., 1874, p. 2

Despite this great scientific and technical emphasis on being modern, Young recognised the importance of the past. He was an indefatigable antiquarian with a wide range of interest from objets d'art to early printed books. The greatest indication of this is, of course, the Young Collection of books on the history of chemistry which he began in the 1850s. Young's choice of material was probably greatly influenced by his friend, Robert Angus Smith; together they combed the bookshops of the continent, particularly those of Italy. By the time of his death, Young's collection housed nearly 1,400 items in 1,300 pamphlets and books. When it was catalogued by Professor Ferguson of the University of Glasgow, it became clear that Young possessed the finest single collection of books on the history of alchemy, in Europe.[1] What is surprising is that Young began this Bibliotheca Chemica at the busiest period of his life, that while he was making his own fortune he was providing for the study of the early history of chemistry.

He was never ashamed of his own past. When he revisited Riddings in 1868 it was with an open-hearted, almost naive nostalgia but his interest was still practical for as he walked around he noted details of output.[2] The exoticism of the past attracted him: the temples of Karnak, the Holy places in Jerusalem, the memorials to past civilisations

1. J. Ferguson, Bibliotheca Chemica Catalogue of the Collection of James Young of Kelly, Glasgow 1906 pp. vvi-xi
2. Pocket Diary 1868, 1 February 1868

around the Mediterranean's shores. But the stark past also attracted him: the archaeology of Iceland, the folk-tales of Celtic Scotland, the heritage of a disappearing agrarian society.

Self-made men often long to forget their own past. They tend to make a fetish out of achievements but not circumstances; they exercise an inverted snobbery against those less successful than themselves, particularly if they find personalities to remind them of their humble origins. Not so Young. He remained constant in his admiration of his student-day acquaintances and he was prepared to establish his own cult of self-made men whom he admired. Thomas Graham related in 1863 how Young thought himself in very good company indeed when placed between two great self-made men, Sir Rowland Hill and Sir William Armstrong, at a dinner in the Royal Society Club.[1] Young, in fact, personalised his own achievements with reminders of other great men: his son, Thomas Graham Young, was so named in thankful memorial to his old teacher;[2] the street names in Addiewell and West Calder are testimonies to his favourable impressions of the work of George Stephenson, Michael Faraday, James Watt and others.

But Young was also practical in his acknowledgements to his friends and helpers. When Thomas Graham became Master of the Mint in 1855 he required a surety of £5,000; this Young

1. R. Angus Smith, The Life and Works of Thomas Graham, Glasgow, 1884, p. 59
2. Graham's response is given in M.S. Letter, Graham to Mrs. Young, in the possession of Miss A.M. Thom.

provided.[1] This personal concept of indebtedness was further satisfied by Young's commissioning Brodie's statue of Graham, now in George Square, Glasgow, and by his commissioning Robert Angus Smith to edit Graham's works in 1876.[2]

Young tried his best to help his friends. When in 1862 the Chair of Chemistry in the University of Aberdeen became vacant, he tried unsuccessfully to secure the appointment of Robert Angus Smith, but Smith soon secured a worthwhile position as the first Government inspector of Chemical Works.[3] Young's gratitude to Lyon Playfair and Hugh Bartholomew was in some measure repaid by his making them directors in his limited liability company. He had less material reason to help David Livingstone; yet his philanthropic sense was never called into account for a better object. His work with the Livingstone Trust was undertaken at a very busy and anxious period in his business career, and although his attempts to regulate the lives of the Livingstone family were not entirely successful, at least the attempt was meritorious. It seems that Young's regard for David Livingstone was based on a multitude of factors: the idea of supporting a friend who was also a great romantic character, the recognition of Livingstone's social idealism and self-sacrifice, the mystery of knowing a saint.

1. Letter, Graham to Young, 18 April 1855
2. The first note of Young's intention to pay for this edition is in Pocket Diary, 1874, 20th July 1874, "Graham's papers to be printed same size of paper and type as the book of Landed Estate one vol." Ed. R. Angus Smith, Graham's Chemical and Physical Researches, Edinburgh 1876, lead papers inscribed from James Young and R. Angus Smith.
3. R. Angus Smith, The Life and Works of Thomas Graham, Glaggow 1884, p. 55 and p. 59

Young himself seems to have been latitudinarian in his approach to religion. At nineteen the habit of regular church attendance was already part of his adult nature.[1] Although he attended Church of England services in Lancashire, he preferred the United Presbyterian Church of Scotland - he was never anglicised.[2] But the moral code of Christianity was more important to Young than details of observance. When he returned to Scotland, he joined the Martyrs Church in Edinburgh before settling in Glasgow where he attended the Reformed Presbyterian Church in Great Hamilton Street. According to Dr. Goold, the minister of the Martyrs Church, Young was not inclined to be argumentative about religion, but he liked to discuss religious subjects. Unlike many nineteenth century scientists he never felt any qualms about the relation of science to religion. As he once said to Dr. Goold:

> "... I believe in miracles but they do not impress me so much as other considerations. Science reveals more and more so many wonders in nature that it is vain to limit the Almighty to any direction. But one thing I cannot get over: science may take vast strides in our day and after we are gone, but I cannot conceive an age when the ideal of moral excellance, as embodied in Paul's conception of a righteous man, will ever be surpassed or superseded..." [3]

Roman Catholic ceremonies impressed Young with their colour, but like most Presbyterians he was astounded that Italy was so staunch in its religious allegiance. He was in Rome at the opening of the Oecumenical Council of 1869-70:

1. Journal, 1830-31, passim
2. The Christian Leader, 31 May 1883
3. Ibid.

> "... we took a run by rail to Rome & saw the grand procession at the opening of the council we think of going back to see the Christmas services ..." 1

But the weather in Rome was so bad that he could find little pleasure in outdoor sight-seeing:

> "... This is a Holiday in Rome to do a hand's turn is a mortal sin so all the shops are shut that I would not care about but all the museums are shut also ..." 2

Young had little reliable information about the progress of the Council:

> "... We have had bad bad weather here plenty of Roman thunders if not thunders of the Vatican ... There are all sorts of stories going about the Council but nothing one can depend on the only real news comes round by England ..." 3

He was very surprised about the tolerance extended to the Rome correspondent of The Times who had attacked the Council but he suspected ulterior motives:

> "... I cannot understand why the times is not stopt unless it be that Cardinal Antonele allows it to annoy the getters up of the Council it is well known that he has all along been dead against it ..." 4

Young himself opposed the whole idea:

> "... my own idea is that the council is a downright blunder an infalible proof of the falibility of the Pope ..." 5

In his hotel smokeroom there were earnest discussions about religion:

1. Letter Copybook, 1867-73, Young to unnamed correspondent, December 1869
2. Ibid., Young to Alex Moore, 24 December 1869
3. Ibid
4. Ibid
5. Ibid.

> "... the inmates of the Hotel meet after dinner to smoke and talk and a good deal of theology has been discussed of late well discussed too indeed I fear we must give it up or expect police spies among us there are several papists who take part in the talk with perfect freedom and hold their views well ..." 1

Young's Mediterranean tour was the result of his retirement from business in 1869 through ill-health, but he tried to remain active:

> "... I have got out of business and for want of better to do have taken to yachting & find it rather an agreeable pastime ..." 2

Young's yacht, "Nyanza" - named appropriately after Livingstone's success - was perhaps the great example in Young's career of conspicuous consumption for it was a magnificent vessel, the envy of many other Clyde-based yacht-owners. The Nyanza was made of teak and iron, weighed 214 tons, and was reputedly one of the strongest British yachts afloat. It was well appointed and manned by a crew consisting of the Captain, a steward and fifteen others, and could carry ten passengers. The mainsail was very large with a boom 60 feet long; this tended to make its two masts look deceptively close together. Although not rigged for racing, Nyanza was capable of remarkable speeds. Young's scientific interests were catered for by the six barometers aboard from which he took daily readings. 3

1. Ibid.
2. Ibid., Young to unnamed correspondent, December 1869
3. R. Angus Smith, To Iceland in a Yacht, privately printed, Edinburgh, May 1873 and dedicated to James Young, pp. 6-7.

In the Nyanza Young, his family, and his friends sailed far and wide: in the Firth of Clyde, in and among the sea lochs of the Western Islands, to the Orkneys and Shetlands, across the North Sea to the Norwegian fiords and the Danish coast, out into the Western Approaches, south across the Bay of Biscay and through the Straits of Gibraltar into the Mediterranean. Occasionally, the weather made these trips hazardous. In a summer calm in 1871 off Mull the current began to pull the yacht onto the rocks, the crew having to take to the long-boat to haul her off.[1] On 21 June, 1872, the party of Young, his sons John and Thomas Graham, his daughters Eliza, Agnes and Annette, Agnes Livingstone, Wilson Thom and Robert Angus Smith set off for Iceland from Wemyss Bay at 3 p.m. Such a great storm arose that night that the Nyanza had to run for shelter, and Annette Young was so ill that she had to be put ashore. However, the weather improved, and the party went on their way via Oban, Tobermory and Stornoway. After trying to leave Stornoway another storm broke out and compelled them to put back. A day was lost there while "... we paddled about the bay and fished among the rocks, in a beautiful evening." An even greater gale engulfed them on July 1st, although Angus Smith at least did not lose his sense of humour:

> "... Our dinner went up with the table to our mouths, and down as the table struck our knees. All was in a constant motion and we caught bites in passing as we best could ..." [2]

1. Ibid., p. 11.
2. Ibid., pp. 18-28

At last they reached Reykjavik and spent an eventful month in Iceland. On 5th July Young and Angus Smith, pandering to their interest in education, visited the school in Reykjavik and then passed on to the library and reading room, in which Ion Arnasson, the inspector of schools, had a private collection of MSS on Icelandic history, consisting of 220 volumes. The warm springs in Reykjavik were a tourist attraction, and the two men spent some time there and also went bird-watching on the Island of Effersey. They went fishing with some success: Angus Smith relates how he, James and John Young caught in an hour about 130 fishes between them, none of any great size.[1]

On the following Sunday they went to Church. Although they could not understand a word of the heavy Lutheran sermon, with typical British superiority, they enjoyed gaping at the natives. They did the round of sight-seeing and tried with little success to buy Icelandic silverware: there were two silversmiths in Reykjavik and "... Mr. Young bought the last buttons from one of them ..."

The younger, more athletic group went off pony trekking for six days to the Great Geyser, while Young and Angus Smith had a more leisurely time, browsing through Arnasson's Icelandic MSS and day-tripping to local centres of interest. For instance, they went by pony to see the ruins at Krossnes; on arrival "the day was fine, and Mr. Young slept quietly on the dry grass near the ruins part of the time ..." They went also to see the druidical remains at Kjalarnes and everywhere they went, they took photographs.

1. Ibid., pp. 35-48

Eventually, the younger party returned from the Great Geyser, having had a grand time. Eliza Young had her father's grit and daring, having frightened the rest of the party by riding pell-mell down the Allmannagya. John Young revealed further elder Young characteristics by bringing back samples of silicified plants and jars of Geyser water for analysis. Thomas Graham Young caught an eider duckling "... a very graceful creature, of a light brown. After a while he gave it freedom ..."

The stay in Iceland ended with a champagne party on a visiting French frigate. Young and Angus Smith left with thoughts of approval for the social consciences of the wealthy in Iceland, for the custom of adopting children who were in want greatly impressed them.[1]

The following year, Angus Smith set out again with Young's party, this time from Durris. They boarded the Nyanza at Aberdeen and set out for St. Kilda. This set the fashion for many later visits to this lonely island. Young's sense of charity was greatly touched by the poverty of the islanders and their remoteness. His party distributed tea, sugar, tobacco, needles and thread among the inhabitants. Young and Angus Smith entertained the theory that the Celts had mysterious Middle Eastern origins, and Young was delighted when he noticed a wooden lock similar to those he had seen on his cruises in the Eastern Mediterranean. There were no Gaelic Bibles on St. Kilda, and yet the main language of the Islanders was Gaelic; on their return Young reported this to Dr. Goold,

1. Ibid., pp. 49-129

Secretary of the Bible Society and minister of Young's former church in Edinburgh, and so fifty Gaelic Bibles were sent to St. Kilda. To help their economy and to give them greater opportunities for communication with the outside world, Young made the islanders a more materialistic gift of a five ton boat. In his laboratory at Kelly, he and his two assistants began experiments with peat, attempting to simulate the conditions of its development and analysing its chemical composition.[1] Another visit to the Western Highlands in the Nyanza was the occasion for Angus Smith to produce "Loch Etive and the Sons of Uisnach", an essay into romantic and wildly inaccurate Celtic history.[2]

Young earned the reputation of being a "land improver". He bought Kelly and Durris after his purchase of Limefield. Like many good family men he laid great emphasis on what he could do to provide for his family: land he thought was an excellent investment. He did not need to rationalise the Victorian sentimental cult of the mediaeval rural life. For Young, land was a special kind of investment that provided not merely economic opportunities for future generations but also political power, social prestige and a distinctive, gentlemanly way of living. In addition, his scientific work benefited from the peace and quiet ofrural isolation; it was good for his health - Kelly had the advantage of being at the seaside; Durris and Limefield provided him with sport,

1. R. Angus Smith, A visit to St. Kilda in the "Nyanza" Glasgow, 1879, passim.
2. R. Angus Smith, Loch Etive and the Sons of Uisnach, London, 1879, passim.

and colourful gardens. He enjoyed the occasional party with his family and friends around him. Plaintively he wrote to Hugh Bartholomew in 1862:

> "... the birds want shooting and I want hare soup when will you come or come without saying when ..." [1]

To Robert Bryson he was more jocular:

> "... they (i.e. the birds) have had so little disturbance this year and if they are not shot at they will get impudent ..." [2]

To George Rae, with Livingstone on the Zambesi, he recounted the aesthetic delights of Limefield in autumn.[3]

Back to the gardens and conservatories at Kelly Young brought[4] seeds, plants and flowers from the Mediterranean countries. His own sense of pleasure he tried to convey to other people. David Fortune, President of the Glasgow Working Men's Flower Show Committee, always found Young prepared "to foster a taste for floriculture among the working classes of the city." Young, in fact, took a very active interest in those flower exhibitions and sent along enough rare and choice plants from the Kelly conservatories to form a leading feature of the shows. Inevitably, he was an honorary Vice-President.[5]

1. Letter Copybook, 1860-63, Young to Bartholomew, 15 September 1862
2. Ibid., Young to Bryson, 15 September 1862
3. Ibid., Young to George Rae, 3 November 1862
4. Pocket Diary, 1876. Lead papers, passim
5. The Glasgow Daily Mail, 25 May 1883

Young's appreciation of natural beauty was complemented by his regard for the visual arts of photography, painting and sculpture. Because of its three-dimensional scope the latter probably provided him with the greatest aesthetic pleasure for like the great chemist, John Dalton, James Young was colour-blind. But when he was nineteen it seems that he started to paint,[1] although there is no later record of direct participation. His first industrial employer may have stimulated Young's artistic interests for James Muspratt was an avid collector of statuary and paintings.[2] Young did most of his collecting in the sixties and seventies and he patronised living artists like Craig and Bough and sculptors like Brodie and Mossman, who, respectively, sculpted the Glasgow statues of Thomas Graham and David Livingstone.[3]

Although some of Young's collection was bought in London and Paris, most of it was purchased in Italy. His chief adviser on Italian art - and, indeed, his agent in Florence in 1877 - was Dr. W.B. Robertson, formerly the great revivalist preacher in Irvine. Young had met him first in the Andersonian in 1836-37, and after the purchase of Kelly in 1867, Robertson was a frequent visitor. Young greatly enjoyed his company because Robertson was an urbane cosmopolitan with a

1. Journal, 1830-31, 4 February 1831
2. J. Fenwick Allen, Some Founders of the Chemical Industry, London, 1906, p. 98
3. Letter Copybook, 1860-63, Young to Craig, 5 March 1861 suggesting portrait of J.B. Neilson; to Bough, 5 May, 1862; There are several references to Brodie and Mossman in the Pocket Diaries of 1860s and 1870s. Letter Copybook, 1867-73, Young to Mr. Clark, 16 September 1872 arranging for payment of pictures. Letter, Playfair to Young, 15 February 1866

great fund of anecdotes and a wide-ranging sense of fun. In addition, his knowledge of French and Italian mediaeval and Renaissance Art was quite outstanding, although he, modestly[1], did not claim to be an expert. He intended to write a book about the Etruscans and their civilisation but never did, even though in 1881 Young leased to him, as a scholar's retreat, the extensive mansion of Westfield near West Calder on preferential terms. This "favour of our Modern Prometheus" was one of the several recompenses[2] for the work of picking and buying paintings in Italy. Young's taste does not appear to have been distinctive; he seems to have shared the common pre-Raphaelite taste although he also bought paintings of the seventeenth century Dutch school. One pseudo-Rembrandt 'Portrait of An Old Man, aged 89' recently brought the top price in a Glasgow art sale. Inevitably, a nineteenth century painting of "Galileo before the Inquisition"[3] satisfied his scientific and protestant biases.

Young's business success did not destroy his early political and social idealism, although he makes no mention of any political activity in the 1850s. His Scrap-book reveals that he followed[4] the fortunes of the North in the American Civil War with close attention. Just as he opposed slavery

1. James Brown, The Life of W.B. Robertson of Irvine, Glasgow 1888, p. 20; p. 227; p. 318; pp. 345-6. A. Guthrie, Robertson of Irvine, poet-preacher, Ardrossan 1889, p. 157, passim.
2. J. Brown, op. cit., p. 389 and p. 403; A. Guthrie, op. cit., p. 313
3. Pocket Diary, 1876, 8 April 1876
4. Scrap-book of James Young

in America, so he believed in the enfranchisement of the working classes in Britain. He distrusted totalitarians like Napoleon III and believed that democratic institutions should be extended to continental countries dominated by despotisms. He opposed Austrian and French rule in Italy and Turkish control of the Balkans. Garibaldi, the self-made man of action in Italian politics, was one of his greatest heroes:

> "Garibaldi good good man may the giver of all good be with him ..."

he writes in his diary for 1875.[1] Indeed, family legend has it that Young intended to adopt and educate some of Garibaldi's children, but, like other Britons, he was deterred by the moral question of their legitimacy.[2]

Far safer to support John Bright. In his diary for 1868 he records how he went to hear Bright speak in the Glasgow Music Hall during the General Election; he then went away and duly voted Liberal.[3] His friend, Lyon Playfair, entered the Commons at this election, and in Young's Scrap-book is a report of Playfair's maiden speech on the University Test Acts.[4]

More significant, a decade later, was Young's intervention in Gladstone's Midlothian campaign of 1879-1880. The third meeting of this campaign was held at West Calder in:

> "... a large wooden pavilion in which nearly 3000 persons were crowded together ..."

1. Pocket Diary, 1875, 6 April 1875
2. I am grateful to Miss A.M. Thom for telling me this
3. Pocket Diary, 1868
4. Scrap-book of James Young

Young's importance can be gathered from the fact, that, together with his son, James, he sat on the platform and was named in the reports immediately after the M.P.s. Gladstone, as was his wont during this first Midlothian election, gave an impressive display of his oratorical virtuousity and then:

> "... resumed his seat amid great cheering and waving of hats and handkerchiefs, having spoken for an hour and forty seven minutes ..."

Young was then called upon to propose the vote of thanks; this he did, shortly and sweetly:

> "... We have been treated to an intellectual feast of no ordinary kind from one who has ever been first to reform abuses and promote the freedom and welfare of the nations of Europe. What I have to propose does not require a single word - I have to move a vote of thanks to the Right Honourable W.E. Gladstone (Loud Cheers) ..."

A gesture, significant and symbolic of Young's contribution to political balances in the Lothians, was made by the Non-Electors of West Calder. Mr. A. Alison, junior, presented the Grand Old Man with an address in a beautiful casket mounted in silver and as Alison explained:

> "... The casket in which the address is contained may possess some value in your eyes from the fact that it is made from the shale from the Torbane Hill - that mineral being the first from which paraffin oil was taken - an invention which has added lustre to the name of the gentleman who proposed the vote of thanks, and the manufacture of which now forms a very important industry in this district ..."

To the plaudits of electors and non-electors alike, Gladstone drove to the station. West Calder had joined the national fervour which was to sweep Beaconsfield from power: the roadside was packed with cheering crowds; the village was illum-

inated by Chinese lanterns, a bon-fire and exploding fire-works and also as if at Young's behest, by "... the simple shape of lighted paraffin candles in each window-pane ..."[1]

When Gladstone next visited West Calder, it was for his Eve-of-Poll meeting on 2 April, 1880. This was held in the United Presbyterian Church, and Young took the Chair. In his opening remarks he indicated that he had recently given an address to the electors of West Calder in which "... I mentioned some of the grievances under which the nation had laboured in my young days ...", but, unfortunately, neither report nor notice of this address have come to light. Young, then, introduced Gladstone as the man "... who has spent the working part of a long life in removing these grievances ..." Young's personal character was revealed by his remark <u>en passant</u> that he was not in the habit of making speeches - he clearly thought that was best left to Mr. Gladstone.[2]

The Grand Old Man left no one in any doubt that he was in the habit of making excellent speeches. In a changing mood of jubilation, pity and vituperation, he sank Beaconsfield's administration in a flood of polemics, and in the process brilliantly analysed for the audience what he wanted them to believe about the record and intentions of the Liberal

1. The Scotsman, 28 November 1879; c.f. also Liberal Political Association, Political Speeches in Scotland, November and December 1879, by the Right Hon. W.E. Gladstone, M.P., Edinburgh 1879, vol. i., pp. 95-129
2. The Scotsman, 3 April 1880

Party. He concluded his ninety minute address by an appeal to the country beyond Midlothian:

> "... The Nation ... has found its interests mismanaged, its honour tarnished, its strength burdened and weakened by needless, mischievous, unauthorised and unprofitable engagements, and it has resolved that this state of things shall cease, and that right and justice shall be done ..." [1]

Afterwards, the formality of proposing Gladstone as the Liberal candidate for Midlothian caused Young to reveal his quiet sense of humour. He said, after this proposition had been put, that he was informed that two hands were held up to signify opposition to Gladstone "... but he must say he did not see them. (Laughter and Cheers) ..." [2]

West Calder and district proved to be a Liberal stronghold into which Tories ventured only cautiously and anonymously. The Scotsman, a pillar of Liberalism, reported a complete absence of Tory placards and posters; even vehicles carrying Tory voters to the polling station had few emblems to reveal the political identity of their occupants. This was probably of little use since the non-electors had gathered at the polling station and with all their partiality cheered Liberal voters and jeered at Tories:

> "... Among those who on arriving received a hearty welcome were Mr. McClagan, the Liberal candidate of Linlithgowshire, who voted at this station, and Dr. Young, who it will be remembered presided at the great meeting held in West Calder on Friday last in connection with Mr. Gladstone's candidature ..."

1. Speaches in Scotland by W.E. Gladstone, Edinburgh 1880, vol. ii., pp. 326-356.
2. The Scotsman, 3 April 1880

The poll was remarkably high; of a total local electorate of 226, 215 actually voted: 162 for Gladstone and 53 for his opponent, Dalkeith.[1] Gladstone's majority in the constituency as a whole was only 211. Despite the landed influence of Rosebery and the contrary power of the Duke of Buccleugh - whose son and heir Lord Dalkeith was - and allowing for the superior organisation of the Liberal party,[2] it was the new capitalists of the shale mining and shale oil industry with their tied cottages who were in fact to decide the future destiny of this seat; Gladstone had no great difficulty at the next election after the 1884 Reform Act.[3] One Tory pamphleteer unconsciously recognised the new force in Gladstone's favour:

'West Calder saw the Woodman nigh
And raised the Venetian poles on high
Triumphal arches decked the roads
And evergreens in waggon loads,
Combine with flags to grace impart
To pilgrimage of Midlothian's Art.
"Let there be Light," McLagan cried,
And such was plentifully supplied
By lamps the sweetest that have been,
Since first they burnt "pure paraffin" ....' [4]

Although Young's inventive genius had assured Gladstone's safe return at the 1885 election, Young himself did not live to see it. He caught a cold at the end of 1882 while working

1. The Scotsman, 6 April 1880
2. R.R. James, Rosebery, London 1963, pp. 91-104; H.J. Hanham, Elections and Party Management: Politics in the Time of Disraeli and Gladstone, London 1959, pp. 159 sqq.
3. R.R. James, op. cit., p. 174 notes Gladstone's enormous majority of 4,600, but does not attempt any explanation.
4. National Library of Scotland, Anonymous 6d. pamphlet, "The Art of Midlothian and the Lay of the Lost Minstrel by Sir Scalter Wott", London 1880.

on the stone floor of his laboratory at Kelly - his experiments were concerned with the public health of towns: the sewage problem.[1] He was confined to the house from the New Year onwards, and despite the attention of his family doctor and four Glasgow medical professors his condition worsened by the end of January.[2] The winter was very mild, and by the end of February Young seemed to be regaining strength, but this was flattering only to deceive. At the end of March he had a relapse, lingered and died in his 72nd year at 7 p.m. on Sunday, 13 May, 1883.[3] His death was peaceful and without pain. He remained in full possession of his faculties up to the moment of his death; his wife's name was the last word on his lips.[4]

On the hillside, above the Clyde, in the little churchyard of Inverkip was buried the body of James Young in the family grave; above his head an imposing gravestone for the cabinet-maker's son and an appropriate epitaph:

> "The Righteous and the Wise and their Works are in the hands of God."

Shortly after Young's death, that popular magazine, Titbits, assessed his career in typical Victorian terms: he was that ideal, the poor boy who had made good by his own efforts.[5] But there was far more to James Young than that.

1. The Christian Leader, 31 May 1883
2. The Glasgow Herald, 15 May 1883
3. The Glasgow Evening Citizen, 14 May 1883
4. Ibid., Christian Leader, 31 May 1883
5. Titbits, 24 November 1883

In a generally favourable article, The Baillie, earlier, described Young as careful with his money, impatient of contradiction[1] and eager to assert his personal control over others. But J.S. Jeans, the editor of The Star, thought Young amiable and distinguished not merely for his public but also for his private philanthropy.[2] As is to be expected, Young was a mixture of contradictory characteristics. He could take pity on a person in need and also say no in the shortest possible form of words. If he had good reason for disliking a person, he was relentlessly consistent; he did not forgive easily. He did not seek vendettas but he knew how to finish them.

This much must be said for Young: he was certainly more prone to help the young than many rich industrialists. Not for him the suspicion of youth that George Stephenson entertained for Joseph Locke and Charles Vignoles, nor the lack of hospitality that marred Humphrey Davy's relationship with Michael Faraday. Young began, like James Watt, as an instrument maker in academic life - but generosity was not one of Watt's traits. Neither did Young really need the aid of a commercial partner to take charge of selling; he was his own Matthew Boulton. He had many of Boulton's commercial and civilised qualities but did not have the advantage of a career-making marriage as Boulton did.

1. The Glasgow Baillie, 19 November 1879
2. J.S. Jeans, Western Worthies, Glasgow 1880, p. 68

It is to be constantly emphasized that James Young was fortunate in being in the right place at the right time with the right patent. Other great technologists were not so fortunate. R.W. Thomson in 1846 invented a pneumatic tyre with an inflatable inner tube and outer casing before the invention of the motor car - and well before John Boyd Dunlop.[1] It is doubtful whether Young possessed greater technical ability than F.W. Lanchester, one of the most versatile mechanical engineers of the early automobile age, but Lanchester was so able that he was regarded as eccentric. Eventually, he died in poverty, after trying to market a high quality radio transmitter at a time of slump.[2] Young's decision to leave Thomas Graham prepared the way for his successful business career; it is some coincidence that another giant of the oil industry, Calouste Gulbenkian, having been befriended by Kelvin at King's College, London, intended to become a professor of Physics but was diverted from this course by a gift of £30,000 at the age of twenty-one and instead became a civil engineer.[3]

Young's foundation of the oil-shale industry was a fortunate growth-point for the Scottish economy which set up a momentum of demand for a number of diverse industries: lamp-making, chemicals, refining and retorting equipment, mining, quarrying and metallurgy, timber for casks, bricks and other building materials. Landowners benefited by the general rise

1. L.T.C. Rolt, Great Engineers, London 1962, p. 182
2. Ibid., pp. 207-235
3. R. Hewins, Mr. Five Per Cent, The Biography of Calouste Gulbenkian, London 1957, p. 16

in land values: the price of Addiewell was about £27 per acre, nearly four times the general rate for good agricultural land prevailing in the forties.[1] Mineral rights became an increasingly important source of wealth. A twenty-one year lease of minerals in the estate of Livingston made in 1866 to Edward Meldrum and his new partner, George Simpson of Benhar, by Lord Rosebery, provided for an ascending annual rent scale: the first year, £100; the second, £200; the third, £400; and the remainder £800 - or royalties at the landlord's option.[2] Wage-rates in the area also rose: a good ploughman could expect to earn between £14 and £20 a year in the forties and handloom weavers in Bathgate, before the foundation of Young's works, earned as little as 4/- per week; by 1869 an unskilled labourer working in the oilworks could expect to earn 19/- per week.

But Young's industry brought its social problems to the Lothians. Population tended to increase faster than social amenities such as housing. The landscape began to be littered with bings, and refinery smells and effluents became a serious problem.[3] Violence and civil crimes increased in the area. Because there was considerable Irish immigration, racial and religious tensions developed; from 1862 the Orange Marches tend to be accompanied by violence.

1. L.J. Saunders, Scottish Democracy, 1815-40, Edinburgh 1950, p. 37
2. Scottish Oils MSS., Copy lease, 17 July 1866
3. Chemical smells were the subject of one of Rosebery's bon mots: when a guest at Dalmeny said that he did not like the local scent, Rosebery replied that he was only interested in the per cent. R.R. James, op. cit., p. 205

There were undoubted benefits to British society brought by this new industry. It cheapened the cost of burning oil and brought efficient lamps onto the market. Almost every Victorian print of an interior shows a family group around an elegant paraffin lamp; in many localities there was no supply of gas until comparatively recent times and in isolated rural areas the transition to electricity was direct from the paraffin lamp era.

Young's efforts with the distillation of coal were part of a widespread movement in several industries - gasmaking, whisky distilling, sugar refining, dyestuffs manufacture - where attempts were being made to produce old or new products by more scientific methods than the world had seen before. Young's industry was part of the development of chemical theory and techniques, a creator of opportunities for chemical engineers and research scientists. The techniques and products of the shale oil industry stimulated science itself. Analytical chemistry benefited, and so did geology. In the University of Glasgow Professor Thomas Anderson and his assistant, C. Greville Williams - later to be Professor of Chemistry in Swansea - investigated the less well-known products derived from Boghead coal[1], just at the time that A.W. Hofmann's young assistant, W.H. Perkin, produced the first aniline dye from coal-tar. The shale-oil industry engendered so many geological controversies beginning with the Torbanehill Mineral Case that academic geology could not help but benefit. It was

1. Philosophical Transactions of the Royal Society of London, 1857, vol. 147, pp. 447-462 and pp. 737-744.

also significant that the first counties in Scotland to be satisfactorily surveyed by the Geological Survey were the Lothians.

The permanent effects of the profits of this industry on scientific education were indirect through the philanthropy of Young and his son, Thomas Graham Young. Young endowed the Young Chair of Technical Chemistry in the Andersonian while his son founded the lectureship in Metallurgical Chemistry in the University of Glasgow. Generations of students have felt the benefit of their philanthropy. In some ways more significant was Young's appreciation that science had to take its place in the central core of higher education.

Young's significance as a business man employing the attitudes of the large-scale corporation must not be missed. His emphasis on the importance of favourable publicity, his attempts to mould public opinion by advertising, his insistence on cost accountancy, his belief in fully integrated economic activities from the production of raw materials and refining agents to the distribution and sale of finished products, his attitude to foreign competition, all were anticipatory of attitudes common to more modern large-scale enterprises. On the other hand, overcapitalised as his £600,000 enterprise certainly was, it was, in size, untypical of normal British business. Young's belief in the importance of research and the application of scientific methods in production was a recognition of future trends. His employment of trained scientists foreshadowed the recruiting policies of large-scale cor-

porations in the twentieth century:

> "... he, being a man of great scientific attainments, knows full well that the persons most likely to carry out his views to their legitimate results are those who are possessed of theoretical chemical knowledge together with practical manipulative skill; such persons will not work by "rule of thumb" and take their chance of results, they must know why one process rather than any other is preferred, and are always ready to give a "reason for the faith that is in them"; nay, they know that certain things being done they can predicate results that are as certain as that light will follow the darkness, or the evening the day ..." [1]

On the wider front, Young's work in beginning the commercialisation of non-edible oils was deeply significant for humanity. It was no longer necessary or economic to use edible oils for lubrication or for burning in lamps. British whale fishing, which had been kept alive by government subsidies and the needs of special industries such as the jute industry of Dundee,[2] fitfully persisted; there was no automatic destruction of the industry and no heroic saving of whales. Far more significant was the influence of shale-oil pioneers on the world's petroleum industry. Selligue, Du Buisson, Luther Atwood, Joshua Merrill and James Young - even Abraham Gesner - established the refining system which was just as essential to the petroleum industry as it had been for coal oil. Their methods were improved but never supplanted in a natural, not a revolutionary, technological progression.

1. Daily Review, 17 February 1866
2. Young tried to produce a "batching" emulsion for softening the jute fibres, but this did not supplant whale oil. (Business Journal and Laboratory Notebook, 1856-61, 14 May 1858). I am grateful to Professor S.G.E. Lythe for making this clear to me.

Oil was to become the basis of many industries in the twentieth century. There were signs that this would be so in Young's own lifetime, although the petroleum and shale-oil industries were still mainly geared to the production of illuminants and lubricants. Charles Griffin in 1864 demonstrated a model of an oil-fired furnace in which he melted and[1] fused metals. It was only a piece of laboratory equipment, but a sign of things to come: by the end of the 60s a number of patents had been enrolled for tar, oil and petroleum - burning furnaces. To the Pharmaceutical Society of Edinburgh in 1866, John Mackay gave an account of Dr. Redwood's new process for preserving beef, mutton and "other animal substances used for food." Redwood, in the summer of 1865, had immersed meat in paraffin wax at 250° F. and found that it was still[2] fresh a fortnight later. After reports of American experiments in 1862 with petroleum as a fuel for ships, the British Parliament authorised experiments to test the value of petroleum and shale oil as substitutes for coal in marine boilers. At Woolwich, Richardson's Petroleum Boiler was demonstrated and it was found that oil was too expensive compared with[3] coal - but oil prices were to fall sharply in the 70s and 80s.

1. Journal of Society of Arts, 8 January 1864, vol. xii., p.121
2. Pharmaceutical Journal, 1865-66, vol. vii., pp. 560-561
3. House of Commons, "Report of Experiments with the view of testing the value of Petroleum and Shale Oil as substitutes for coal in raising steam in Marine Boilers", Parliamentary Papers No. 503, 26 July 1866

In October, 1868 Dorsett and Blyth patented an oil-vapourising engine and demonstrated it to British and Russian naval observers in the 500 ton "Retriever".[1] A foretaste of twentieth century diesel locomotion occurred in September, 1868, when Napoleon III travelled 28 miles from Chalons to the army manoeuvres in a train which used petroleum as a fuel.[2]

More humane possibilities were in sight. Joshua Merrill in 1861 produced the most volatile fraction ever refined from coal-oil at Downer's works and called it "kerosolene". This was more volatile that ether and less toxic than chloroform; Henry Bigelow, a Boston surgeon used it as a local anaesthetic the same year.[3] In the United States progress towards the modern age of oil was more rapid than in Great Britain, despite the start given by Young. Refined paraffin wax, the staple product keeping American coal-oil refineries in business, was being used for a multitude of purposes; as a sealing agent for jellies, as a coating for bon-bons, as a seal on beer barrels, as a substitute for other waxes and oils in making ointments and coating pills, as a dental moulding agent for making impressions for dentures, as insulation on electric batteries, as laundry and textile sizing, as a preservative for timber, as a reinforcement for wrapping paper and as an impregnation on matches to improve their ignition.[4]

1. The Colliery Guardian, 17 October 1868
2. Ibid., 12 September 1868
3. Journal of Gas Lighting, 17 December 1861; H.F. Williamson and A.R. Daum, The American Petroleum Industry, The Age of Illumination 1859-1899, 1959, p. 235
4. Williamson and Daum, op. cit., pp. 249-250

Following the work of Young and Kirk on the refrigerator, the Americans produced cymogene from petroleum, a very light fraction, and this became an outstanding refrigerant and the basis for a number of machines designed to manufacture ice.[1] In 1863 Downer's plant in Boston was producing petrol, which was first used for enriching the gas supply by vapourisation but heralded the advent of the internal combustion engine.[2] At the trivial end of the scale, by 1865 paraffin wax from coal-oil was being used for the manufacture of "paraffin chewing gum", and by 1870 one American manufacturer in Maine was taking 70,000 tons per annum.[3] The penetration of the lower ranks of popular culture in Britain by this new age of oil was completed in the 1870s by Rosebery. His two greatest brood-mares, he named Paraffin and Illuminata, and their progeny provided Rosebery with many of his greatest turf successes.[4] Young would, no doubt, have approved of the roars for "Paraffin".

1. Ibid., pp. 239-240
2. Ibid., p. 235
3. Ibid., p. 249
4. R.R. James, op. cit., p. 54, p. 56 and p. 220

APPENDIX I

Average price of Boghead Coal at Pithead and Young's Contract prices (January 1850 - March 1864)

Year	Price per ton	Price paid by Young
1850	11/-	Agreed price: 13/6 - but no deliveries
1851	11/9	13/6
1852	12/6	13/6
1853	14/6	13/6
1854	16/-	13/6
1855	20/-	13/6
1856	22/-	13/6
1857	25/-	26/-
1858	25/-	26/-
1859	40-45/-	26/-
1860	32/-	26/-
1861	46/-	26/-
1862	40-46/-	30/-
1863	34-35/-	30/-
1864	36/-	30/- *

* This was the highest price paid by Young

Notes:

1. The casual price at pithead by 1854 was about 3/- - 4/- per ton higher than the average price; this tendency increased steadily by 1864
2. Average price takes into account contracts and their tendency to prices lower than casual prices
3. No transport charges are included.

Source:

Evidence of Robert Marshall, Fernie Trial, pp. 300-302.

APPENDIX II

AMERICAN COAL OIL INDUSTRY (1859)

Name of place of Works	Gallons
Downer, Boston, Massachusetts	1,500
Glendon, Boston, Massachusetts	1,000
East Cambridge, Massachusetts	800
Page & Co., Massachusetts	600
Suffolk, Massachusetts	300
Portland, Maine	500
New Bedford	300
Hartford, Connecticut	200
Kerosene, New York	2,500
Columbia, New York	800
Carbon, New York	300
N.Y.C.O.Co., New York	400
Empire State, New York	200
Several others in New York	500
Philadelphia, Pennsylvania	500
Pittsburg (four firms)	2,000
Great Western, Ohio	500
Newark Region, Ohio	2,500
Wheeling,Virginia	200
K.C.C.M. & O.M.Co., Kanawha, Virginia	300
G.R.C. & O.Co., Kanawha,Virginia	300
Greer, Kanawha, Virginia	200
Staunton, Kanawha, Virginia	-
Atlantic, Kanawha, Virginia	-
Maysville Co., Kentucky	400
Union Co., Kentucky	600
Ashland, Kentucky	-
Covington, Kentucky	-
Breckinridge, Kentucky	250
Newport, Kentucky	300
Eureka, Cincinnati, Ohio	600
Rosecrans & Co., Cincinnati	300
Phoenix, Cincinnati	200
St. Louis, Missouri	200
Otherwise	3,500
Total number of gallons daily	22,750

Hunt's Merchants Magazine, December 1859, p. 245.

APPENDIX III

YOUNG'S PARAFFIN LIGHT AND MINERAL OIL CO.

SHAREHOLDERS OR PARTNERS (1868)

	Name	Place	Shares
	Alexander Abercrombie	Glasgow	20
	George James Allan	Edinburgh	10
*	James Arthur, Barshaw	Paisley	200
	Mrs. Jane Arthur, Barshaw	Paisley	10
	Michael Balmain	Glasgow	15
*	Hugh Bartholomew	Glasgow	100
	W.J. Blackie & W.G. Blackie	Glasgow	50
	John A. Brodie	Glasgow	25
	Alexander Brown	London	50
	John Brown, Junr.	Glasgow	15
	William Brown	Glasgow	30
	Walter Buchanan	Glasgow	20
	John Cameron	Glasgow	10
	Alexander Cattenach	Paisley	10
	Robert Christison	Edinburgh	60
	Matthew Clark	Alexandria	13
	W.T. Clark	Glasgow	30
	Campbell Douglas	Glasgow	10
*	John Orr Ewing	Alexandria	250
	John G. Fleming	Glasgow	20
*	John Fleming	London	200
	John Fraser	Edinburgh	20
	Robert Graeme	Hamilton	10
	John Graham	Royal Mint, London	10
	Thomas Graham	4 Gordon Sq., London	50
	William Hamilton	Glasgow	20
	R.D. Heatley	London	100
	A.G. Kidston & Co.	Glasgow	50
	C.M. King	Glasgow	30
*	J. King	Glasgow	100
	R. King	Glasgow	20
	H.M. Lang	Selkirk	30
	G. Lumsden	Glasgow	50
	J. Lumsden	Glasgow	50
	John Millar	Glassford St, Glasgow	10
	Mary Miller	Hamilton	5
*	John Moffat	Ardrossan	250
	A. Moore	Glasgow	40
	J. Morgan	Paisley	20
	J. McAndrew	Glasgow	10
	W. McEwen	Glasgow	75
	A. McEwen	Kent	20
	A.B. McGregor	Glasgow	25
	Mrs. McGregor	Helensburgh	5
	R. McIlwraith	London	50
	I. Mackie	Manchester)	
	W. Nicol	London)	20
	T. Nicolson	Glasgow)	

	Name	Place	Shares
	Sir Andrew Orr	Glasgow	50
	J. Parker	Glasgow	50
*	John Pender	Manchester	750
*	Lyon Playfair	Edinburgh	150
	A.C. Ramsay	London	25
	R. Rattray	Glasgow	10
*	G. Readman	Glasgow	60
	J. Readman	Glasgow	18
	R. Readman	Glasgow	20
	J. Reid	Paisley	50
	G. Richmond, jnr.	Glasgow	9
	J. Robertson	Glasgow	50
	R. Ross	Glasgow	15
	J. Sanderson	Edinburgh	25
*	W.G. Simpson	Edinburgh	200
	R.A. Smith	Manchester	10
	J. Smith	Glasgow	10
	J. Stevenson	Glasgow	45
	G. Thomson	Glasgow	10
	J. Webster	Edinburgh	15
	A. Wm. Williamson	Univ. College, London	60
	P. White	Glasgow	50
	W. Wotherspoon	Paisley	20
*	James Young	W. Calder	1000
*	James Young, jnr.	W. Calder	500
	Mary Ann Young	W. Calder	100
	Annette Young	W. Calder	50

* Directors

APPENDIX IV

British Patents of James Young (1841-1883)

Patent No.	Date	Description
9,156	11 November, 1841	Manufacture of Ammonia and salts of ammonia; apparatus for combining ammonia, carbonic acid and other gases with liquids.
12,359	9 December, 1848	Preparation of certain materials used in dyeing and printing.
12,744	16 August, 1849	Treating certain ores and other matters containing metals; obtaining products therefrom.
13,292	17 October, 1850	Treating certain bituminous mineral substances and obtaining products therefrom.
326	10 February, 1854	Gas-making: retorts.
2,220	4 October, 1855 (with Edward Meldrum)	Improvements in the manufacture of certain salts of sodium and potassium
2,982	1 December, 1857	Improvements in measuring liquids
489	11 March, 1858	Improvements in lamps
486	25 February, 1861	Improvements in apparatus for the treatment or distillation of bituminous substances.
487	25 February, 1861	Improvements in heating apparatus
227	27 February, 1864 (with A.C. Kirk)	Improvements in motive power engines (refrigerator)
299	4 February, 1864	Improvements in the preservation of vegetable and animal matters
1,349	31 May, 1864	Improvement in the treatment or distillation of bituminous substances
127	14 January, 1865	Improvements in producing gases and vapour in a heated state
571	1 March, 1865	Improvements in distilling bituminous substances and in apparatus employed therein.

Patent No.	Date	Description
478	15 February, 1866	Improvements in distilling coal shales and other substances.
625	1 March, 1866 (modification of above patent)	Improvements in distilling coal shales and other substances and in the apparatus employed therein.
992	6 April, 1866	Improvements in distilling
1,868	6 June, 1868 (provisional)	Improvements in treating hydrocarbons
248	30 January, 1871	Dyeing substances
2,122	11 August, 1871 (provisional)	Improvements in the manufacture of carbonate of soda
2,123	11 August, 1871	Hydrocarbon Oils
2,557	28 September, 1871	Improvements in manufacture of Carbonic Acid
2,558	28 September, 1871 (modification of No. 2,122)	Carbonate of Soda
413	8 February, 1872 (provisional)	Treating Natural Petroleum
459	14 February, 1872 (provisional)	Treating Hydrocarbons
617	28 February, 1872	Treating Hydrocarbons
618	28 February, 1872	Obtaining Hydrocarbons
868	22 March, 1872	Carbonate of Soda and Potash
1,268	27 April, 1872	Carbonic Acid
2,293	31 July, 1872	Obtaining motive power from steam engines
2,988	10 October, 1872	Treating Ammoniacal liquors
2,989	10 October, 1872	Carbonate of Soda
1,689	6 May, 1875	Distance Indicator for Vehicles
630	15 February, 1877	Generating Heat
4,526	8 November, 1878	Ammonia

Patent No.	Date	Description
212	18 January, 1879	Steam Boiler and other furnaces
121	10 January, 1880	Axle-boxes for bearings of locomotive engines
157	12 January, 1881	Colouring fibrous materials
1,725	20 April, 1881	Preparing colouring agents
4,702	27 October, 1881	Making sulphate of lime
653	10 February, 1882	Compounds for bleaching
3,562	27 July, 1882	Treating Sewage
4,659	30 September, 1882	Treating Sewage
332	20 January, 1883	Treating sewage and other liquids
434	26 January, 1883	Treating, sewage water and other liquids.

Summary: (including provisional)

Total Number of Patents: 46

Total Number in subjects:

Textiles	Oil Production etc.	Sewage	Others
16	18	4	8

APPENDIX V

SUBJECTS TAUGHT IN ANDERSON'S UNIVERSITY (1858-1883)

1 FACULTY OF MEDICINE	2 FACULTY OF ARTS	3 "POPULAR" EVENING CLASSES	4 CLASSES
Surgery	Mathematics	Natural Philosophy	Writing and Book-keeping
Institutes of Medicine	Natural Philosophy	Chemistry	Commercial Law
Midwifery	Chemistry	± Mathematics	Latin
Anatomy	± Mechanical Drawing	Anatomy and Physiology	Greek
Practice of Medicine	± Marine Engineering	Botany	Hebrew
Materia Medica	± Applied Mechanics	Music	Logic
Medical Jurisprudence	-	± English Literature	Elocution
± Public Health	± Technical Chemistry	± Geology	French
Botany		± Natural History	± German
Medical Chemistry			± Spanish
± Opthalmic Medicine and Surgery			Shorthand
± Dental Anatomy			
± Dental Surgery			
Mechanical Dentistry			
Aural Surgery			

Notes:

This table does not include short-course subjects

1. This faculty provided most of the full-time students, although it was possible to qualify by a part-time course.
2. This faculty had many full-time classes but also many evening courses.
   Note that by modern standards no Arts subject actually appears.
3. These classes were intended to provide learning for the layman.
4. Most of these classes were evenings only and varied very greatly in standard.

* Classes started or restarted by Young during his Presidency or afterwards.

APPENDIX VI

ANDERSON'S UNIVERSITY : TOTAL STUDENT

SESSION	1858/9	1859/60	1860/1	1864/5	1865/6	1866/7	1867/8	1868/9	1869/70
TOTAL	2450	2249	2349	1955	2112	2396	2369	2550	2541
INCREASE OR DECREASE		- 201	+ 100	- 394[2]	+ 157	+ 284	- 27	+ 181	- 9

Notes:

1. Excluding Technical Chemistry
2. This is a cumulative decrease 1861-65
3. This decrease is accounted for by:
   a. no return from 1 music class
   b. no classes in Natural Philosophy were held except Popular Evening class
4. This is a cumulative increase 1878-1883

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(i) 41 Diaries, Pocket Books and Notebooks of James Young covering the period 1830 to 1883:

3 undated Pocket Books, probably from 1840s
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Notebook, 1832-1834
Notebook, 7 May 1834 - August 1834
Notebook, 1834-40
Notebook, 1838
Diary, 1835 "Irish"
Pocket Book, 1844-1845
Pocket Book, 1844, Household Expenses
Pocket Book, 1844-1846
Pocket Book, 1846
Pocket Book, 1846-1848
Pocket Book, 1847-1849
Pocket Book and Diary, 1848
Notebook, 1850
Pocket Book, 1850-1851
Pocket Book, 1851-1852
Pocket Book, 1852
Pocket Book, 1853
Notebook, 1853-1856
Pocket Book, 1854
Pocket Book, 1855
Pocket Book, 1856
Notebook, 1857
Pocket Book, 1857
Large Laboratory Notebook, 1857-1862
Business Journal and Laboratory Notebook, 1856-1861
Notebook, 1858-1859
Memorandum Book, 1859-62
Large Laboratory Notebook, 1863-1865
Account and Valuation Book, 1865-1867
Pocket Diary, 1866
Pocket Diary, 1867
Pocket Diary, 1868
Pocket Diary, 1874
Pocket Diary, 1875
Pocket Diary, 1876
Pocket Diary, 1879
Pocket Diary, 1883, lead papers only

(ii) Letter Copybooks and loose letters:
(Specific reference is made to loose letters by correspondent and date in the text).

Letter Copybook, 1860-1863
Letter Copybook, 1867-1873
Many loose letters, 1858-1860 regarding Young's American patent
Many loose letters about the Clydesdale Chemical Company's infringement of Young's patent
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Correspondence between Young and his partners, 1854-1860; between Lyon Playfair and Young, 1845-1850 and 1866-1882; between R. Heilmann and Young, 1847-1854.
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Patent specifications, especially for Stannate of Soda process.
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