

SUSSEX INDUSTRIAL HISTORY



WINDMILL HILL MILL HURSTMONCEUX

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Ricardo at Shoreham – Windmill Hill Mill – Portslade Brewery
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Edited by Dr. Brian Austen, 1 Mercedes Cottages, St. John's Road, Haywards Heath, West Sussex RH16 4EH (Tel. 01444 413845). The Editor would be interested to hear from prospective contributors of articles of any length. Shorter notices can be included in the Society's *Newsletter* which is issued four times a year.

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Membership enquiries to the Hon. Secretary, R.G. Martin, 42 Falmer Avenue, Saltdean, Brighton BN2 8FG (Tel. 01273 303805).

RICARDO AT SHOREHAM

Dr. Cecil French.

INTRODUCTION

Bridge Works, the offices and works of Ricardo Consulting Engineers Ltd. at Shoreham-by-Sea has been an international centre for the design, development and research into internal combustion engines for the past seventy five years. Operations started at Shoreham with the opening of the works on 1 or 2 July 1919 under the leadership of Harry, later Sir Harry, Ricardo. He was later to be aptly described as the "High Priest" of the Internal Combustion Engine and he and his team and their successors have built up an enviable reputation for engine design, development and research and for the development and exploitation of leading edge technology in this area.



Fig.1 Sir Harry Ricardo, LL.D., F.R.S., F.I.MECH.E

Research and development have always played an important part in the growth of the Company and have contributed greatly to its reputation. A substantial part of the Company's profits have been ploughed back year on year into research aimed at increasing the knowledge base upon which it relies for obtaining contracts from a world wide list of clients including by far the greater part of the world's manufacturers of reciprocating engines. This internally funded growth of knowledge is augmented by the results of sponsored research paid for by both

individual clients and by consortia which might well include Ricardo as one of the contributors. A very wide range of engines is covered including both spark ignited and diesel with a size range from small engines of a type used to power lawn mowers to the largest diesel engines used for power production and for marine propulsion. From the early 1920s the Company's clients came from a wide spectrum of the developed world including European countries, the United States and Japan and this client base has since widened to include most of Europe including the Eastern Bloc and the greater part of Asia.

The only engines to be manufactured at Shoreham are experimental and prototype units but many vehicle and other engines manufactured in the world today either have their origins at Shoreham or have been worked upon and been improved by the Company's engineers.

THE EARLY YEARS

The 1971 issue of *Sussex Industrial History* contained an article by Michael Worthington Williams describing the brief history of the Two Stroke Engine Company of Shoreham and of its two products, the Dolphin engine and the Dolphin car. While Harry Ricardo was the designer of these engines he had also in 1907 joined his grandfather, Sir Alexander Rendel's firm of Consulting Engineers, Rendel and Robertson, later to be Rendel, Palmer and Tritton. In this capacity he was involved in the design of mechanical engineering equipment for use in civil engineering operations. He did not however lose his interest in the spark ignition engine and continued with research into combustion abnormalities in a workshop installed in 1912 in the garden of his home at Walton-upon-Thames. He also designed Dolphin type engines for both Lloyd and Plaister for a 'cycle car', and Britannia engineering for driving a dynamo.

Various patentable ideas arose from Walton research work and Ricardo was obviously keen to advance the experimental work and to exploit his ideas. Capital was however required for this purpose. Through a mutual interest in piston engines, Ricardo had already met Sir Dugald Clerk who had written the, at that time, classic text on internal combustion engines. After taking advice from Clerk, Ricardo was introduced to Mr. Campbell Swinton who with some friends had earlier given financial support to Sir Charles Parsons in his development of the steam turbine. Campbell Swinton agreed to support Ricardo and a company was registered as Engine Patents Ltd. on 10 August 1915.

At the first meeting of the directors held in Campbell Swinton's office at 66, Victoria Street on that date, the following were present:-

Mr. A.A. Campbell Swinton – Chairman
 Mr. Stuart de la Rue
 Mr. B.R. Beale
 Mr. H. Ricardo
 Mr. R.H. Houston
 and Mr. Campbell Farrar.

Consent had been obtained from the Treasury for the issue of £2,000 of shares. Arrangements had been made for Messrs. Doughty of Walton-upon-Thames to assist in the test work by making modifications and alterations to equipment up to a limit of £3 a week! Work carried out for third parties by Engine Patents Ltd. would be charged out at two shillings an hour plus materials and a Mr. Campbell from Scotland had been engaged as a draughtsman. Drawings of an experimental engine had been completed.

At a further meeting on 17 September, shares were allocated as follows:-

Viscount Combermere	250
A.A. Campbell Swinton	250
Richard Boorman White	250
Stuart de la Rue	250
Bertram Robert Beale	150
Campbell Farrar	150
F. W. Harboard	150

Campbell Farrar was appointed Managing Director and Secretary. Over the next year, licence agreements were reported with a number of major companies including Rolls Royce and Armstrongs and by August 1916 it was agreed that Ricardo should be paid £750 a year in anticipation of profits and Campbell Farrar was to receive £500 a year as Managing Director. Harbord who was a consulting metallurgical chemist was to receive £100 a year for his services. The board was considering applying for patents in Russia and Japan, an early indication of the international interest which was ultimately to become so important for the company. In September it was reported that Capt. Halford was to complete the design of a 300 horse power aero engine in association with Mr. Ricardo and it was recommended that a new single cylinder unit be built.

The board meeting of 10 October 1916 was particularly important. Engine Patents Ltd. took over the "R" Syndicate who were interested in 'developing a Car Engine' and which according to Soar¹ in his History of Bridge Works had been formed earlier also to support Ricardo. Two members of the Syndicate, Mr. S.F. Staples and Mr. F.C. Goodenough, the General Manager of Barclays Bank, joined the Board. More importantly, Ricardo reported that he might be asked to co-operate with Mirrlees, Bickerton and Day in designing the engine for the new "Tanks" At the

meeting on 1 November it was reported that the design² was taking place and on 7 November a royalty rate of 4% of the selling price of the engine was proposed. Things obviously moved quickly under the pressures of wartime Britain because by 19 December the Board received a report that orders had been placed for 600 tank engines with a probable 300 more. (Fig. 2).

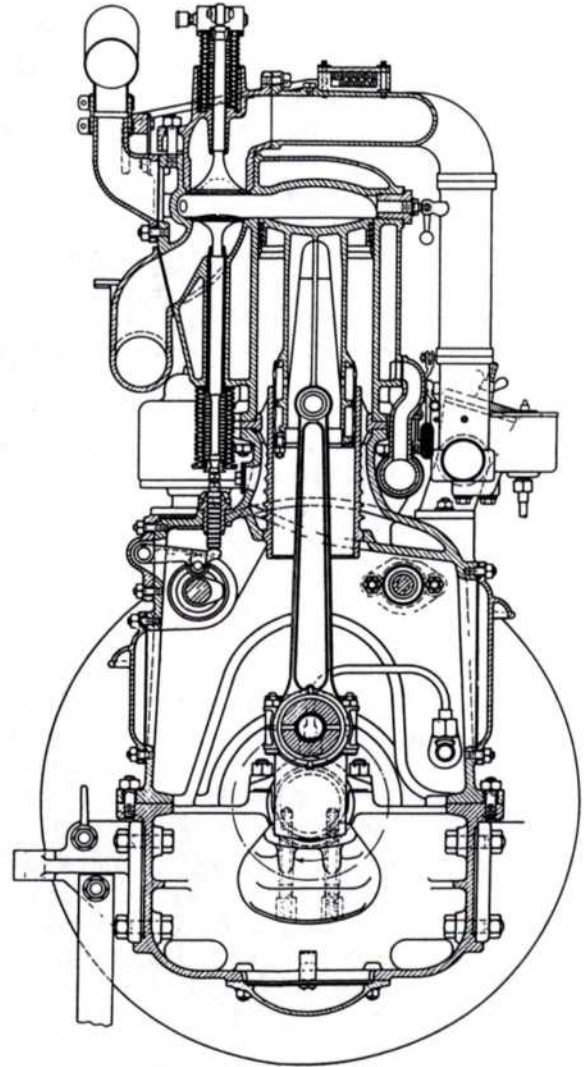


Fig. 2 150 BHP Tank Engine.
 6 Cylinder, 5.625 in. Bore, 7.5 in. Stroke.

Under these pressures, it was agreed to add a further temporary structure to Ricardo's workshop at Walton-upon-Thames and further test work was agreed to be carried out at the Elstead works of W. Hamilton Gordon. Peter Brotherhead had been added to Mirrlees as builders of the Tank engine. Premises for a design office were rented at 21 Suffolk Street which remained as the Company's London office for nearly forty years and the bank account was transferred to the Pall Mall branch of Barclays where it remained for over seventy years. On 29 August 1917, it was reported

that the War Office had agreed to pay £30,000 in satisfaction of the Company's claim in respect of 1,400 Ricardo 150 bhp Tank engines. It was subsequently agreed to send £10 to the draughtsman, Denis Plunkett, late in their employment, in recognition of his services. Plunkett rejoined the company upon his release from Military service, stayed with them until his retirement in 1963, and died in 1994 at the age of 98.

With the prospect of substantial royalty income, the company decided that much larger premises of their own were required for the design of engines and for the manufacture and modification of experimental equipment, together with test facilities. Ricardo suggested a site at Shoreham to the west of the toll bridge, which the Two Stroke Engine Company might have acquired if it had been more successful and had required facilities for the large scale production of motor cars. An important date for those of us who are interested in the development of Ricardo at Shoreham was 27 November 1917. It was reported to the Board that:-

"Although the Air Board has intimated that they were not prepared to give their consent for the erection of a factory at the site at Shoreham which had been inspected, the Tank Department have intimated that if the Company could finance the project without referring to the Treasury, they would give what support was necessary to obtain plant etc. "

It was then resolved to instruct a surveyor to advise the Company on the costs involved in making the land serviceable. This included draining and building up together with advice on the value of the land, the possibility of using it as a site for tipping, and on the availability of water and gas supplies and sewerage facilities. The results of this survey were obviously encouraging because the decision to proceed at Shoreham was taken on 1 January 1918 although there appears to have been some delay as the decision was reconfirmed on 28 May.

A parcel of three acres of land was purchased from Lord Leconfield on 14 August for £225. Access to the road had to be negotiated with the London, Brighton and South Coast Railway who owned the Pad Road, leading to the toll bridge. Harry Ricardo was fond of recounting later that when he protested to the Secretary of the Railway that the demand for £500 was blackmail, he agreed that this was so but refused to reduce the figure.

The works, – Bridge Works – as it was named almost immediately, was designed in the style of a Sussex farm house by Ricardo's father, Halsey Ricardo who was an architect (Fig. 3). He had been responsible amongst other buildings for designing a number of

houses and other structures in West London. He appears to have been paid just over £1,200 for his work. The buildings were constructed by J.E. Whitier of Shoreham and while the total cost is not available, the cost to the end of June 1919, when the experimental equipment was transported to Shoreham from Walton-upon-Thames, and the first locally recruited member of staff, Mr.L.J. Ellsey, was appointed, was just over £15,000.

With the opening of Bridge Works, all the Company's experimental activities were located at Shoreham but design remained centered in London. A small design office was installed at Shoreham however from the start and by 1924 it became clear that it was essential that all design and experimental activities be located on one site. Consequently it was decided to move the design office from London to Shoreham. The Board resolved that this was to take place but the move must not cost more than £1,000 !

In the course of the experimental work which he had carried out at Walton, employing what was probably the world's first variable compression engine, Ricardo had successfully identified the difference between detonation and pre-ignition and had shown that some hydrocarbons were more resistant to detonation than were others. During the Tank Engine project he had also become acquainted with Sir Bernard Waley Cohen, the Chairman of Shell, and had told him of his findings. This was of considerable interest to Shell since the compression ratio and hence the efficiency of a spark ignition engine is limited by detonation, and there would be commercial advantages in being able to identify and supply improved fuels. Shell therefore placed a contract with Ricardo to test a wide range of fuels in the new E35 variable compression engine. This work, which was later extended under the auspices of the Empire Motor Fuels Committee, paved the way for a very close collaboration between the two Companies over a wide range of mutual interests in the areas of engines, fuels and lubricants. The studies, which included combustion and its abnormalities continued for over thirty years and was to prove to be very valuable to Ricardo as well as to Shell.

THE TURBULENT HEAD

With the end of the First World War, the work on the Tank engine and its higher power derivatives ceased. Arising out of his studies of detonation however, Ricardo had been intrigued by the reduced detonation tendency of the more compact overhead valve engine as compared with the cheaper side valve type. He set out therefore to try and improve the detonation resistance of side valve engines and in the course of this work developed the so called Turbulent cylinder head. In this device, the inherent squish effect increased the turbulence of the charge which increased

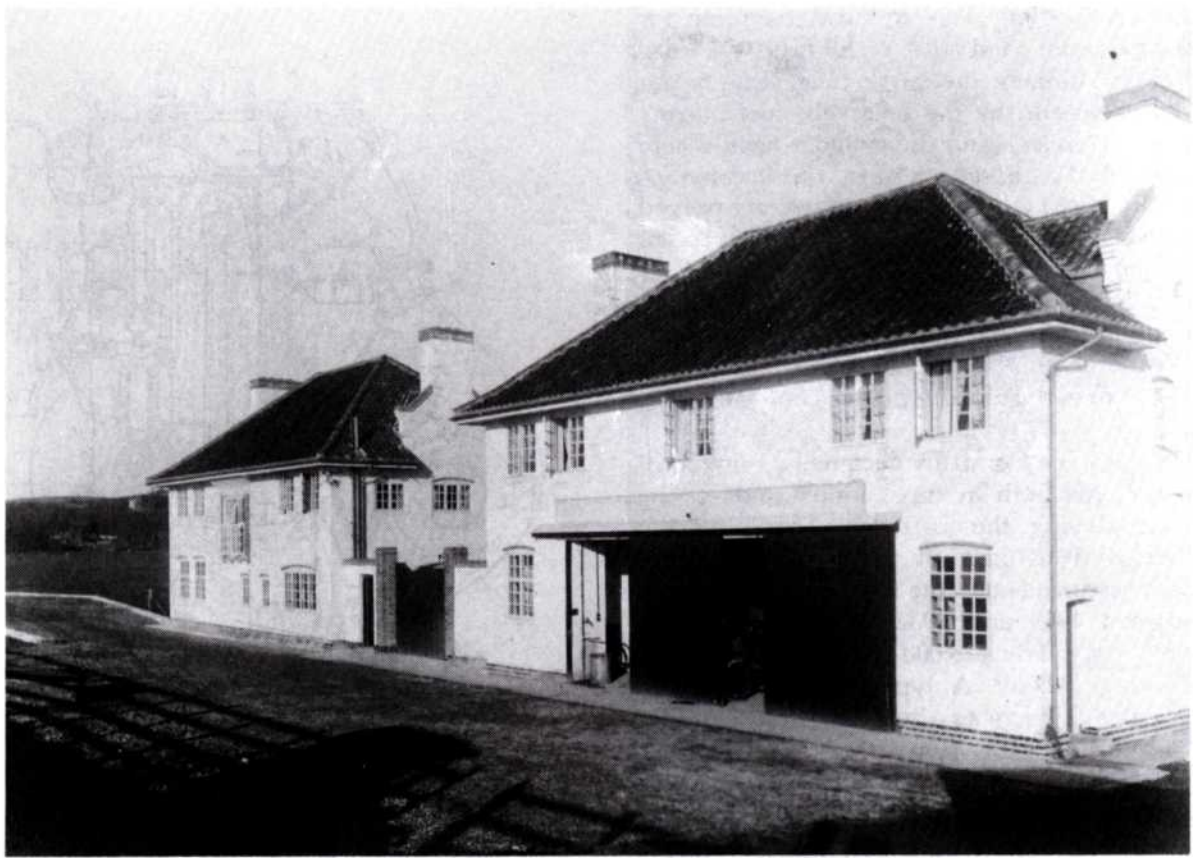


Fig. 3 Front Elevation of Bridge Works, 1919

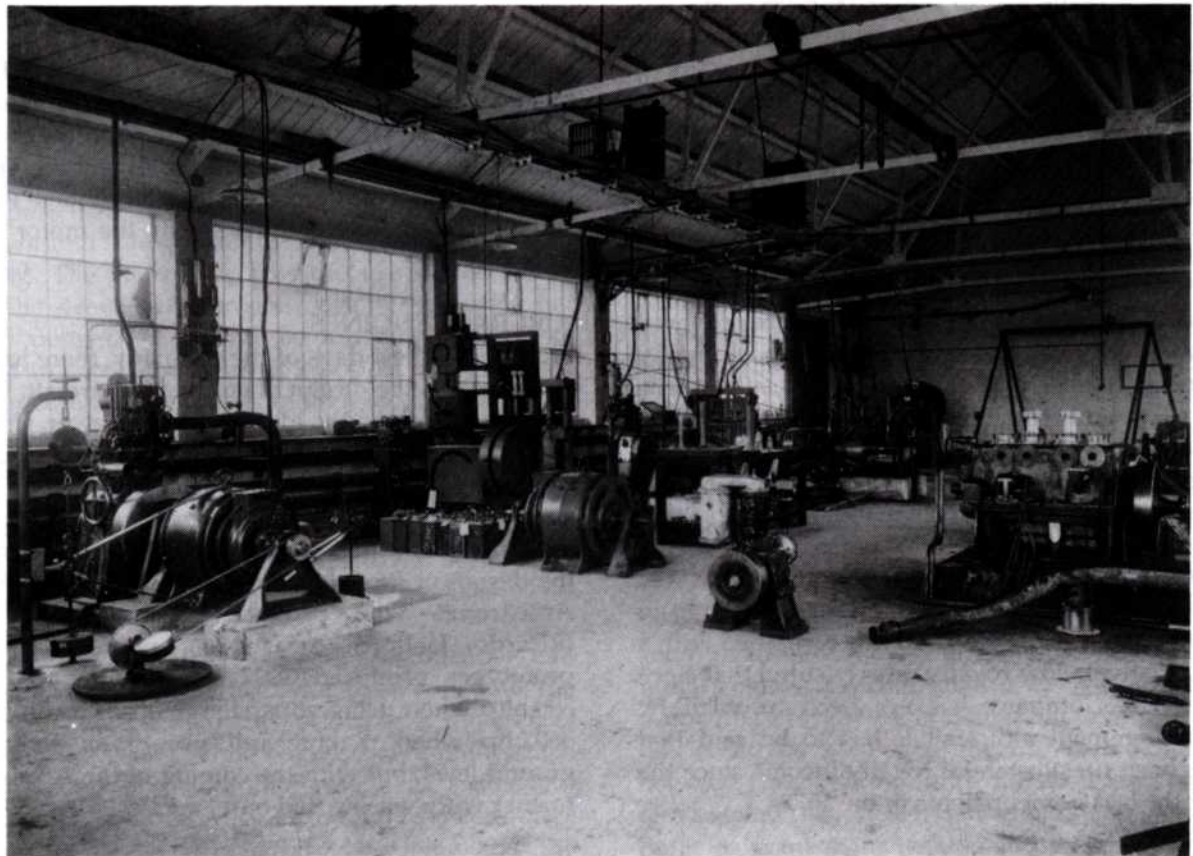


Fig. 4 Test Shop, 1919

the rate of combustion. This reduced the time for detonation to occur and the resistance was also increased by positioning the spark plug close to the hot exhaust valve and by the relatively cool narrow zone between the piston and the cylinder head where the last part of the charge to burn was located. A patent covering these features was granted and proved a valuable source of income. By the use of the Turbulent head, side valve engines could achieve a twenty per cent increase in power, with a similar improvement in fuel economy arising from the increased compression ratio that could be employed. This was similar to the fuel economy of overhead valve engines of the time.

During the 1920s, the Company designed a number of engines for clients both in this country and on the Continent employing the Turbulent head and the royalties received became an important source of income. Soar³ estimates that the total income from the patent between 1919 and 1932 was approximately £40,000 of which nearly £25,000 was received during the peak years 1927-30. A typical engine was the French Le Zebre.⁴ This was a two litre, four cylinder designed in 1922 (Fig. 5). The car was of particular interest in that Ricardo not only designed the engine but also the chassis and in addition provided a number of schemes for bodies. While a number of licensees were involved in building engines incorporating the patent, the design became widely pirated. Towards the end of the 1920s it became clear that a number of such cars were being imported into the United Kingdom from the United States. In view of the importance of royalty income, the company decided that it had to make a stand and on 25 November 1931, a writ was issued against Humber, Hillman, Commer, the Rootes Group, alleging patent infringement. Acting on the advice of Counsel, a substantial amount of experimental work was then carried out at Shoreham to provide back-up material to demonstrate the importance of the features covered by the patent, prior to the court hearing which finally took place in October 1933. Stafford Cripps, afterwards Sir Stafford, who became better known as a politician in the post war years, led for the Company. Judgement was found for the Company, following which Rootes and a number of other British manufacturers settled although it was February 1935 before Ford finally agreed to do so. It was very important that the Company had demonstrated that it was prepared to go to court to defend its patents and this combined with a policy of relatively low royalty rates ensured that since that time, the Company has not been troubled by patent infringement although it has to be said that there has been no substantial royalty income since the expiry of the last Comet patents in the 1970s.

While there was some emphasis in the 1920s on the use of the Turbulent head, Ricardo did not hesitate to

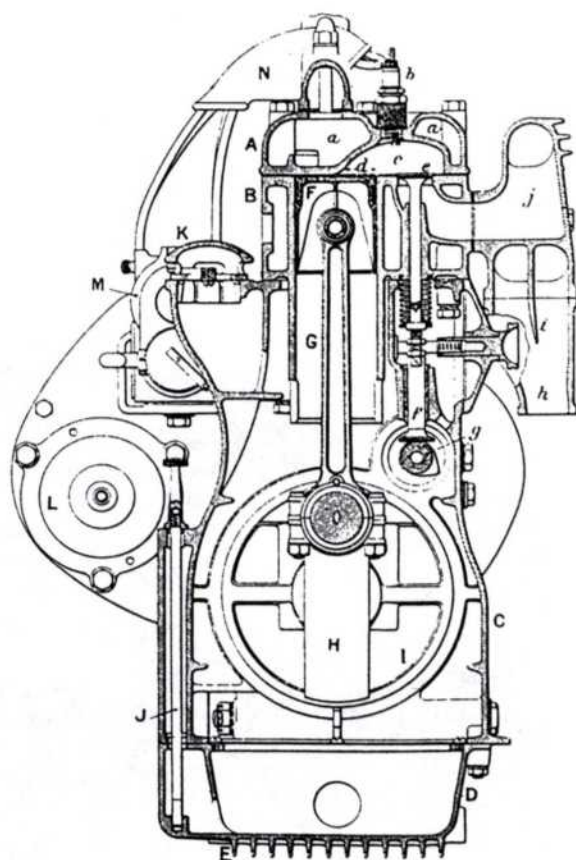


Fig. 5 Le Zebre Engine, 1912
4 Cylinder, 69 mm Bore, 132 mm Stroke

employ overhead valves when he felt they had an advantage. Two examples that became prominent in the public eye were the engines used in the Vauxhall Three Litre racing car of 1923⁵ (Fig. 6) and the Triumph Ricardo (Fig. 7) motor cycle of similar vintage which is still spoken of with enthusiasm by the motor cycling fraternity.

AIRCRAFT ENGINES

From the earliest days of the company, there had been an interest in the design of engines for aircraft. In 1915, Ricardo conceived the idea for a high power, stratified, supercharged engine initially as the power plant for a long range flying boat, but later for use in fighter aircraft which could be employed against high flying airships. While this project was not proceeded with, the design of Ricardo's engine was in 1917 handed to Armstrongs who produced a number of RHA (Ricardo, Halford, Armstrong) engines. These first prototypes produced 260 bhp without supercharge, 300 bhp when using supercharge air as a diluent and 360 bhp when making full use of supercharge at ground level, but with the coming of the Armistice no further work was carried out.

In the early 1920s however, the authorities again became interested in long range aircraft which might

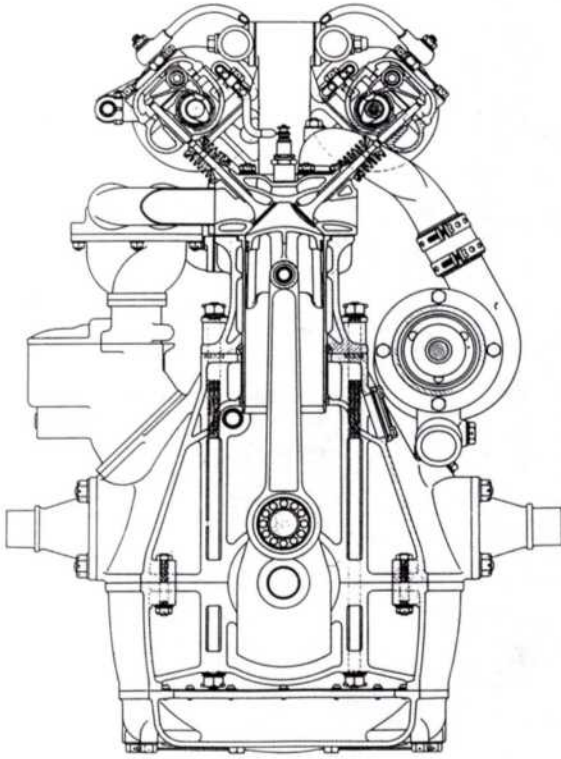


Fig. 6 Vauxhall 3 Litre Racing Engine, 1923
4 Cylinder, 85 mm Bore, 132 mm Stroke

be employed against submarines in the North Atlantic and Ricardo was asked to consider ways of obtaining a very good fuel economy under cruise conditions. Some work on light weight diesel engines was already under way at Farnborough and Ricardo suggested two alternative lines of attack. One was stratified charge, where part load is achieved without throttling and hence without the pumping losses associated with throttling. The alternative was the use of the sleeve valve. The sleeve valve engine does not feature a hot exhaust poppet valve and as a result it is more resistant to detonation than is a poppet valve engine. A higher compression ratio can therefore be employed with improved fuel economy. At a later date, fuel additives such as tetra ethyl lead were developed to resist detonation and the use of sodium cooled poppet exhaust valves reduced valve temperatures so that poppet valve engines were then able to run at the same compression ratios as were sleeve valve engines.

The theoretical advantages of charge stratification had been of interest to Ricardo since his youth and the Company came back to this principle a number of times over the years. While engines were built which would operate over a limited range of loads and speeds, the difficulties inherent in a wide speed range engine were never satisfactorily overcome and the only stratified charge engine which has been widely used is the diesel engine! Sleeve valve engines have

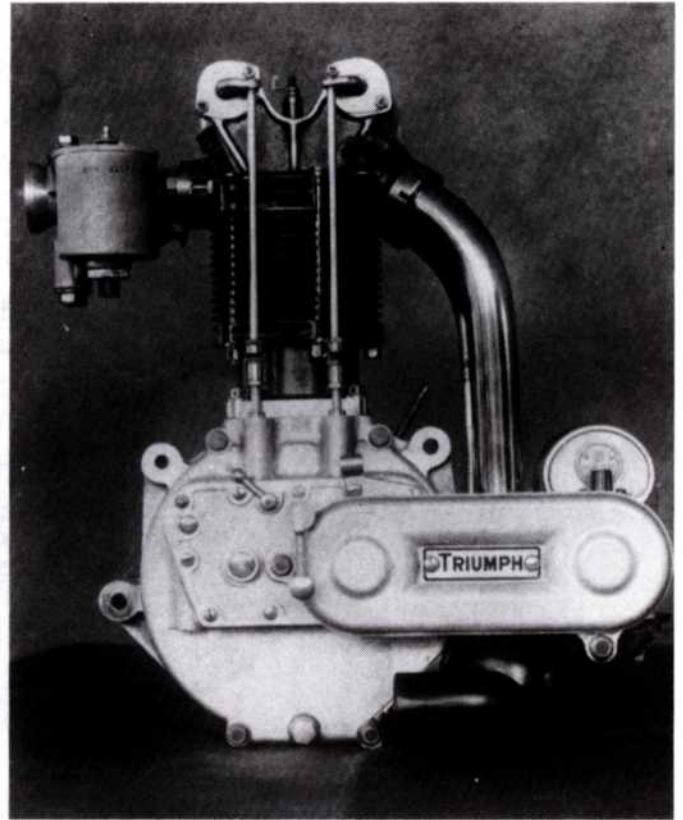


Fig. 7 Triumph Ricardo Motorcycle Engine, 1923

however had a much more successful history. Ricardo had already had some experience of testing engines with the straight reciprocating Knight sleeve valves but these experienced problems with the lubrication of the sleeves. The Burt McCollum single sleeve with combined reciprocation and rotary movement was however more successful in this respect. Between 1921 and 1951 the Company designed no less than 78 different engines incorporating this mechanism.

Arising out of the original experimental work at Shoreham came the range of Bristol radial engines such as the Hercules and the Centaurus, the Napier Sabre 24 cylinder 'H' engine and the Rolls Royce Eagle. The Bristol and Napier engines played an important part in powering British aircraft during the Second World War. According to Ricardo⁵, over 200 million horse power of sleeve valve engines were built by 1945.

In the early 1920s, the Company also produced a solution to the problem of big end bearing design in radial engines. Bearing seizure was becoming a major problem, but rig work at Shoreham demonstrated that this could be solved by the use of a floating bush between the bearing and the journal. While this necessitated the redesign of the engine to incorporate a built up crankshaft, needed to assemble the bearing with its unsplit bush, the feature ultimately became widely employed.⁷

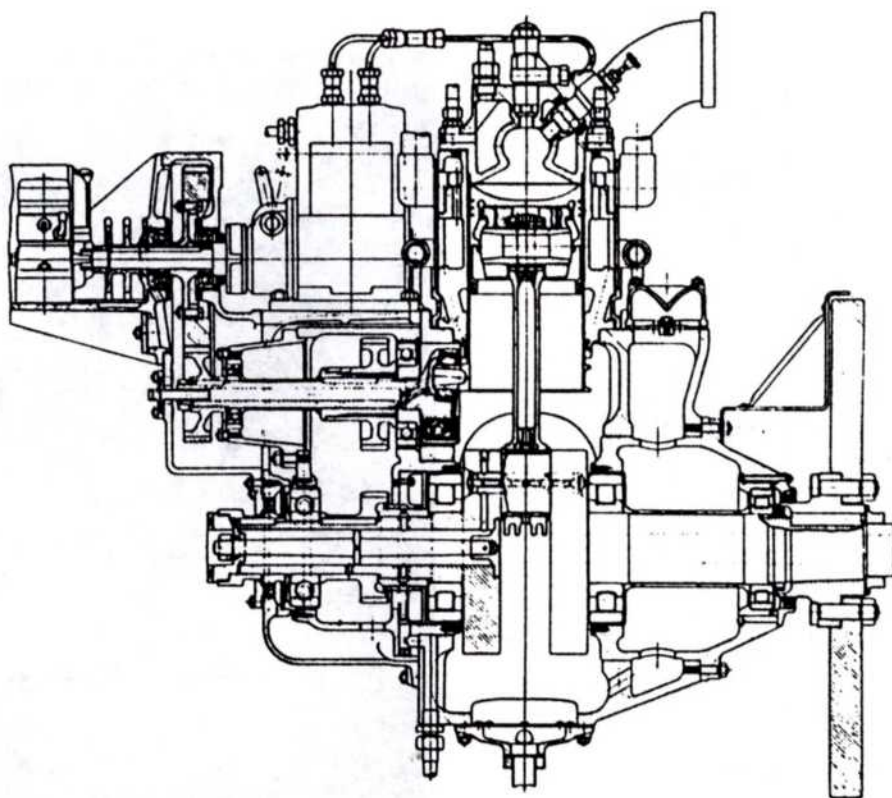


Fig. 8 Longitudinal Section of E65 Engine, 4.81 in. Bore, 5.5 in. Stroke

A special purpose engine developed at Shoreham towards the end of the 1920s was a sleeve valve engine for the R100 airship.⁸ This engine was developed to burn kerosine as a fuel, augmented by burning hydrogen which otherwise had to be vented to maintain the required buoyancy as the kerosine was consumed. While a satisfactory performance was achieved, all British airship work was abandoned following the crash with heavy loss of life of the competing R101.

All the sleeve valve engines mentioned so far have been of four stroke design. In the 1930s however, with a need for still further power output, Ricardo suggested that a high powered two stroke, sleeve valve engine be developed. Work started in 1936 on such a power plant and two single research units were designed and built, the E65 (Fig. 8) and E54 engines. These engines were separately supercharged and were run extensively both at Shoreham and after 1940, when the Company was evacuated, at Oxford. Experimental running was carried out at up to very high ratings including short duration tests towards the end of the programme at 354 lb./sq.in. brake mean effective pressure at 4000 rpm. and this power was only limited by the capacity of the fuel injection pumps. This work, together with parallel work at Rolls Royce, formed the basis of the twelve cylinder Rolls Royce Crecy engine (Fig. 9) which would have replaced the Merlin and Griffon engines had it not been overtaken by the advent of the gas turbine. The Crecy engine in its

developed form would have produced 5,000 bhp for a gross weight of 2,000 lb. and with little more frontal area than that of the Merlin or Griffon.

DIESEL SLEEVE VALVE ENGINES

With the growth of the use of petrol engines for trucks, buses and passenger cars in the 1920s, the oil companies became keen to increase the use of the middle distillate from their refineries. They looked therefore for a much wider use of the diesel engine to use this fuel. In 1925, the Anglo Saxon Petroleum Company, a subsidiary of Shell, signed an agreement with Ricardo to develop diesel engines for industrial use.

A year or two earlier, Ricardo had been carrying out experimental work on sleeve valve diesel engines for aircraft aimed at obtaining improved fuel economy, a reduced fire risk and no electrics, which at that time were unreliable. It seemed natural therefore to develop an industrial sleeve valve engine and, initially in association with Brotherhood, following preliminary work on a smaller engine an engine of 7½ inch bore and 12 inch stroke was developed⁹ (Fig. 10). A family of engines was produced giving 50 bhp per cylinder and claimed to be the World's first sleeve valve Diesel engines. Engines were later built by Mirrlees, Vickers and in Holland by Thomassen. A two cylinder engine was installed in the Power House at Shoreham and a six cylinder in the Power Station at Worthing where it remained until the station was decommissioned in the 1960s.

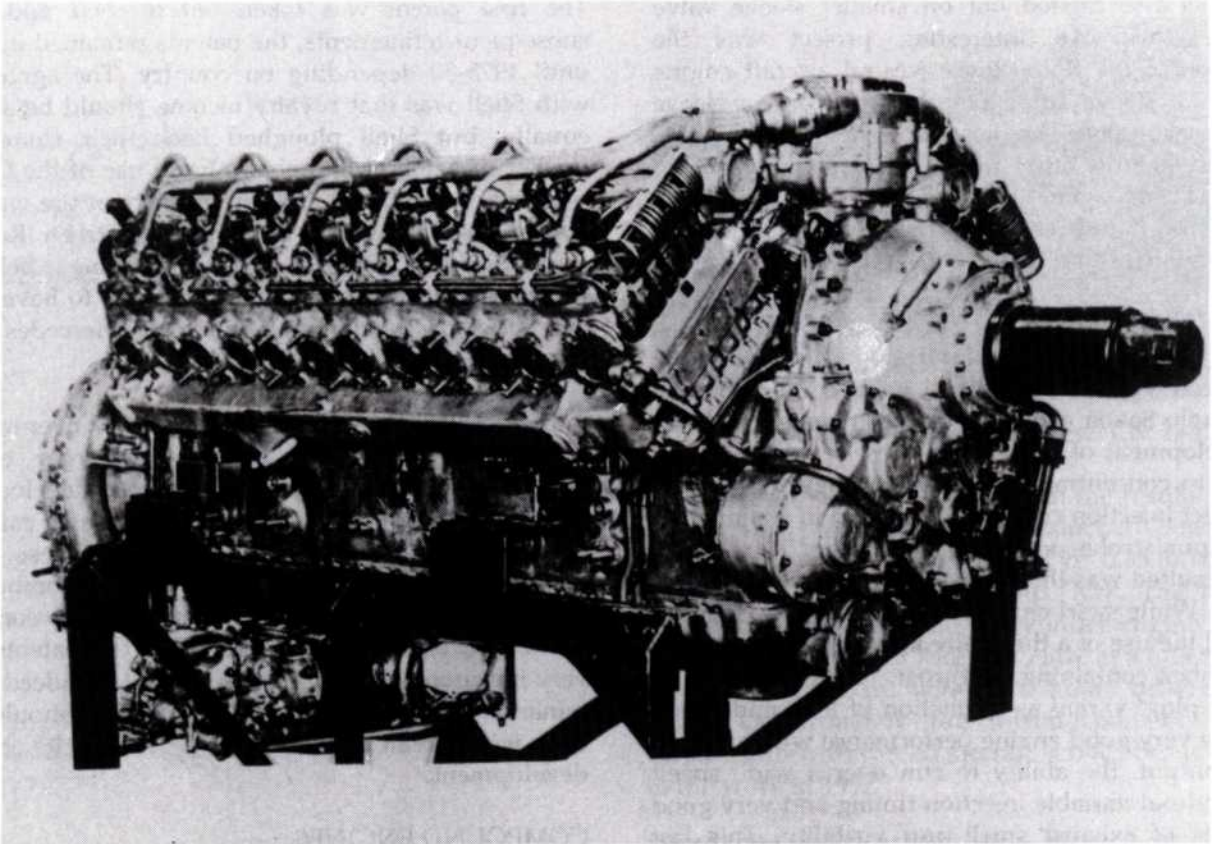


Fig. 9 Rolls Royce Crecy Petrol Injection, Two Cycle, Sleeve Valve Engine. 5.1 in. Bore, 6.5 in. Stroke

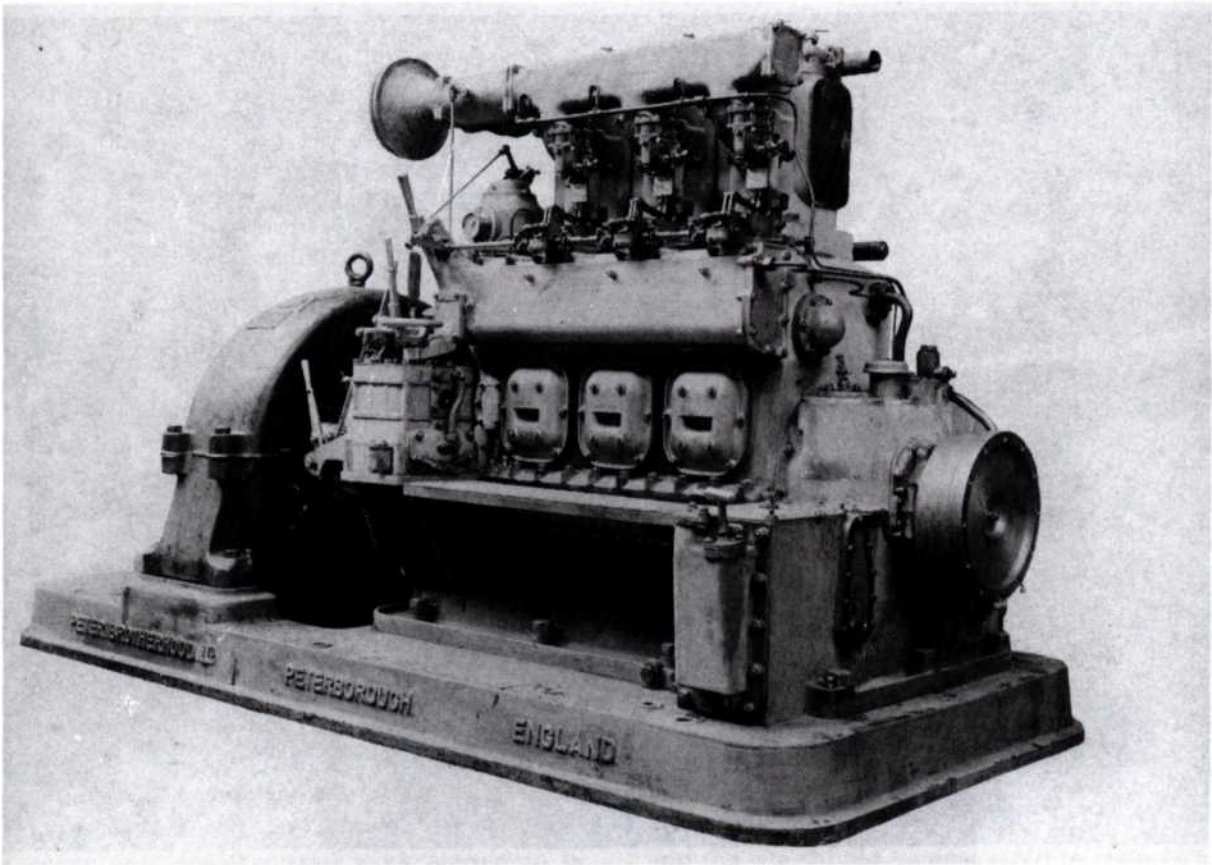


Fig. 10 3 Cylinder, Brotherhood Sleeve Valve Diesel Engine, 1929, 150 BHP 7.5 in. Bore, 12 in. Stroke

Work was also carried out on smaller sleeve valve diesel engines. An interesting project was the conversion of the Rolls Royce Kestrel aircraft engine into both a sleeve valve petrol engine and a sleeve valve diesel engine. The diesel unit, the RRD, (Fig. 11) was subsequently fitted into George Eyston's racing car, the *Flying Spray*, which in 1936 established a world's land speed record for diesel cars at 159 miles per hour which stood until 1953.

COMET COMBUSTION SYSTEMS

Ricardo failed however to interest the market in the high speed sleeve valve diesel engine and when in 1927, Anglo Saxon extended their agreement to cover the development of high speed diesel engines, it was decided to concentrate efforts on the development of an indirect injection combustion system in conjunction with a four stroke poppet valve engine. The system which resulted was the Ricardo Comet swirl chamber, (Fig. 12). While swirl chambers were not new, Ricardo invented the use of a thermally insulated lower half to the chamber, containing the throat. The temperature of this 'hot plug' varied as a function of load and speed and gave very good engine performance with a higher power output, the ability to run over a wide speed range without variable injection timing and very good standards of exhaust smell and visibility. This last feature became more and more important as time went on!

The first patent was taken out in 1931 and with subsequent refinements, the patents remained in force until 1975-80 depending on country. The agreement with Shell was that royalty income should be shared equally, but Shell ploughed back their share into further research at Shoreham. Early use of the Comet was in London buses and the majority of pre war use was in buses and trucks although the Citroen 'Rosalie' car of 1935 (Fig. 13) with its 1750 cc engine is believed to have been the world's first diesel car to have gone into series production, antedating the Mercedes by at least a year.¹⁰

In the post war years, direct injection took over rapidly for buses, trucks and most other larger engine applications but there was a wide spread development of diesels for light duty use – taxis, passenger cars and light trucks. The great majority of these have employed and still employ, the Comet combustion system, and while the last patent expired some 15 years ago, the royalty income from the patents was very important to the Company and it is indeed quite remarkable that the basic Comet concept should still be in widespread use over sixty years from its original development.

COMPOUND ENGINES

With the need for still higher powers for aircraft, interest was aroused in the 1930s in the use of a

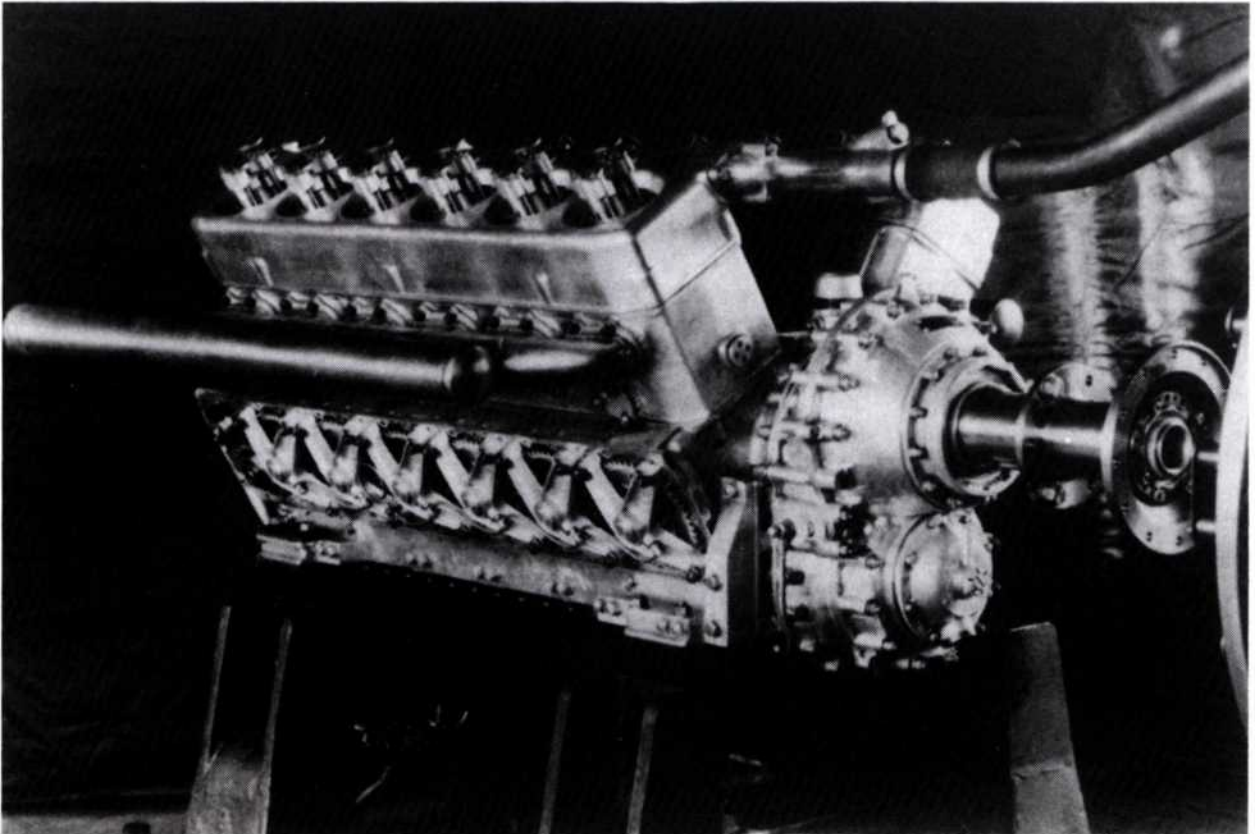


Fig. 11 RR-D Diesel Car Speed Record Engine with Cover Removed to Show Sleeve Valve Drive

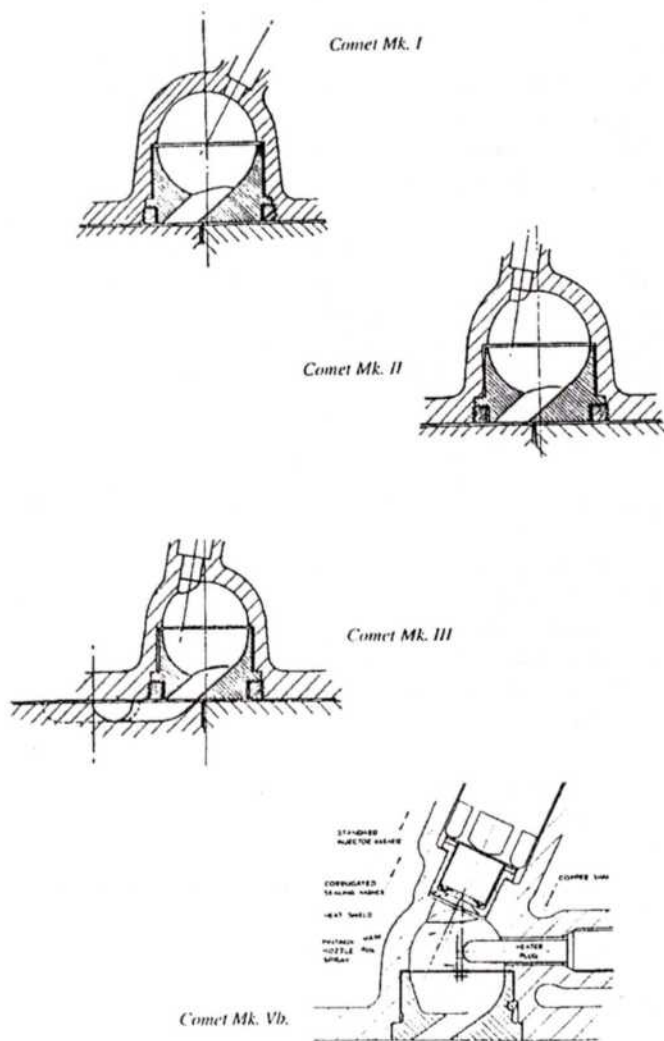


Fig. 12 Development of Ricardo Comet Combustion System

compound engine. A high pressure ratio compressor is used to supercharge the reciprocating engine, which then exhausts at high back pressure, and further power is obtained by expanding the exhaust gas down to ambient pressure. The power balance is such that, depending on the supercharge pressure chosen, the whole unit can be mechanically coupled together or alternatively the compressor may be driven either by the reciprocator or by the final expander with power being taken from the remaining unit. During the 1930s single cylinder engines were run at Shoreham both diesel and spark ignited. Early work showed that the onset of detonation prohibited the use of spark ignition and it was also established that a two cycle diesel unit would be superior to a four cycle in terms of power output and specific weight. Two alternative simple ported engines were run by Ricardo together with a sleeve unit. Experimental work started in 1939 and continued until 1952 with an initial aim of producing 3,000 bhp from 24 cylinders with a very

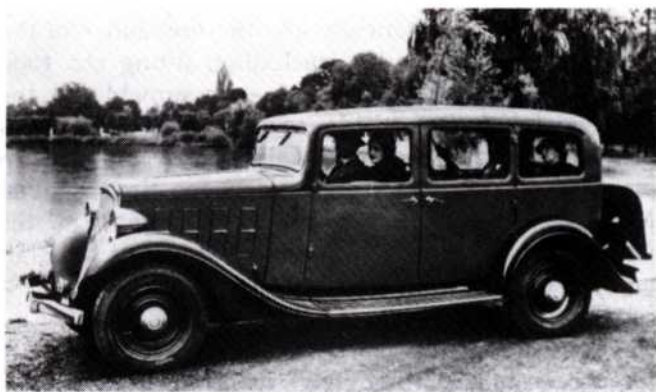


Fig. 13 Citroen 'Rosalie' Diesel Car 1935

good cruising fuel economy. From the results of these tests it was predicted that a production power plant would produce a fuel economy of 0.35 lb./bhp./hr. with a power output of 70 bhp./litre. The resulting prototype Napier Nomad 12 cylinder engine actually produced 3046 bhp or 74.2 bhp./litre at a fuel economy of 0.359 lb./bhp./hr. with 1000 hours between overhauls. Unfortunately the introduction of the gas turbine into widespread aircraft service brought a halt to the work in 1952.

DEVELOPMENT OF THE SITE

Some three acres of land were purchased in 1918 and as can be seen from the photograph (Fig. 3) and the site plan (Fig. 14)¹¹, the buildings principally consisted of an office block and a garage block with two wings, one consisting of a machine shop and stores and the other of a test shop altogether with a coppersmiths and a smithy. The early provision of allotments for the employees, a facility incidentally still provided today, will be noted. The mess room shown on the plan was in fact the test shop building from Walton-upon-Thames which had been brought to Shoreham in 1919.

With the need for further drawing office space consequent upon the move from London in 1924, a first floor connection was made between the two front blocks and during the 1920s, extensions were made northwards to both the machine and test shops and westwards to the front office block. Two further test shops, Nos. 5 and 6 were also added¹² (Fig. 15). In 1936, a further parcel of land was purchased for £110 and a decision was made to build yet another test shop, No. 4. The next major change to the company occurred following the fall of France in 1940.

On 24 June 1940 it was reported to the Board of Directors that "the Military and the RAF Authorities had said that with no warning of air attacks possible, the personnel during the day were very vulnerable and the site should be evacuated as soon as possible" By the end of the month, the staff and the equipment had been moved to Oxford where some of the test

work was carried out in the University Engineering Department Laboratories, while the remainder of the test work together with machining, fitting etc. took place in Hartwell's garage, due presumably to the influence of Mr. Percy Kidner who was a director both of Ricardo and of Hartwells. Cliff Walder, a long term employee of the Company, and a one time General Manager has recently written a reminiscence of the Oxford years¹³ and it is clear that many of the staff enjoyed their time here.

The return to Shoreham from Oxford took place largely over the first few months of 1945. An agreement having been signed in November 1944 between the Company and the Shoreham and District Electric Lighting and Power Company to supply the site with electricity, Ricardo was no longer dependent on its power house. This remained available as a standby and proved invaluable during the power cuts of post-war Britain. From the point of view of the future of Ricardo at Shoreham, the most important action was the purchase of the 83 acre Pad Farm in the summer of 1946 for £8,000. The Company now owned the whole site between the Pad Road, the Coombes Road and the River Adur. This ensured that sufficient land was available for any future development that could be envisaged, provided of course that planning permission could be obtained. Things were to be complicated later however towards the end of the 1970s with the construction of the Shoreham By-Pass, which cut the developed site off from much of the Pad Farm land and which provided a natural boundary to further building development to the north. Also included in the purchase was Pad Farm House, other farm buildings and some farm cottages on the road to Lancing College. While these were used for some time for employee housing and for storage and other purposes, they have in time all been sold off.

Following the purchase of Pad Farm, there was a steady but in many ways an accelerating development of Bridge Works, mainly by building on the newly acquired land but also by redevelopment of the old site.

No. 8 test shop was built by the Admiralty in 1948 for experimental work to be carried out by the Company into propulsion systems for submarines and torpedoes. In 1950 an office block was built on the first piece of Pad Farm land to be used. This was for ever after to be known as the Kremlin, due presumably to its geographical isolation for the next ten years from the remainder of the Works! In 1960 a new design office was built to the north of the Kremlin, although this is now used as a technical library as a yet still larger new design office proved to be required in the 1980s together with a two storey computational office.

During the 1960s it became clear that very substantial development would be required in the engine test area. With the exception of No. 8 shop and to a lesser extent, No. 4 shop, the test bed environment had changed little since the early days of the Company. The majority of the testing still took place in open test shops with a number of engines together with the associated test equipment located under one roof. With the considerable increases in the complexity of test methods, the introduction of more accurate electronic and other test equipment, and with increasing interest being taken in health and safety at work implications, including environmental noise, it was decided that it was going to be essential to separate the engine together with its dynamometer from the operator together with the sensitive electronic instrumentation. The first block of twelve test cells was completed in 1970 to be followed by a second block – Nos. 12 and 13 shops. These were rapidly followed by a test shop suitable for two locomotive or large industrial engines of each up to 5,000 bhp and then by a test shop and offices dedicated to the testing of single cylinder research and development engines – 15 test beds located in three cells with separate control rooms (Fig. 16)

The World-wide growth in environmental legislation has proved very valuable for the Company. Substantial contracts have been obtained in the areas of engine exhaust emissions and engine and vehicle noise reduction. Fuel price rises together with vehicle fuel economy legislation in the United States have also given clients incentive to place contracts with the Company. In order to carry out this plant however it has been necessary to invest heavily in buildings, plant and equipment. A small vehicle emissions measuring facility incorporating a chassis dynamometer was provided in 1966 but it has proved to be necessary to expand this facility on several occasions since then.

Engine exhaust emissions measurement and control continue to be major areas for study and development and it has been necessary to provide emissions measuring equipment on the majority of the 80 or so test beds at Shoreham. This equipment is expensive and somewhat bulky and this together with the provision of other additional test equipment has led to the need to provide larger test cells and larger control rooms as each of the new test areas have been designed!

Engine and vehicle noise reduction is also a topic of considerable interest. A first engine noise test cell was built in the early 1970s to be followed later by four more and within the last year a comprehensive vehicle noise testing facility has been added.

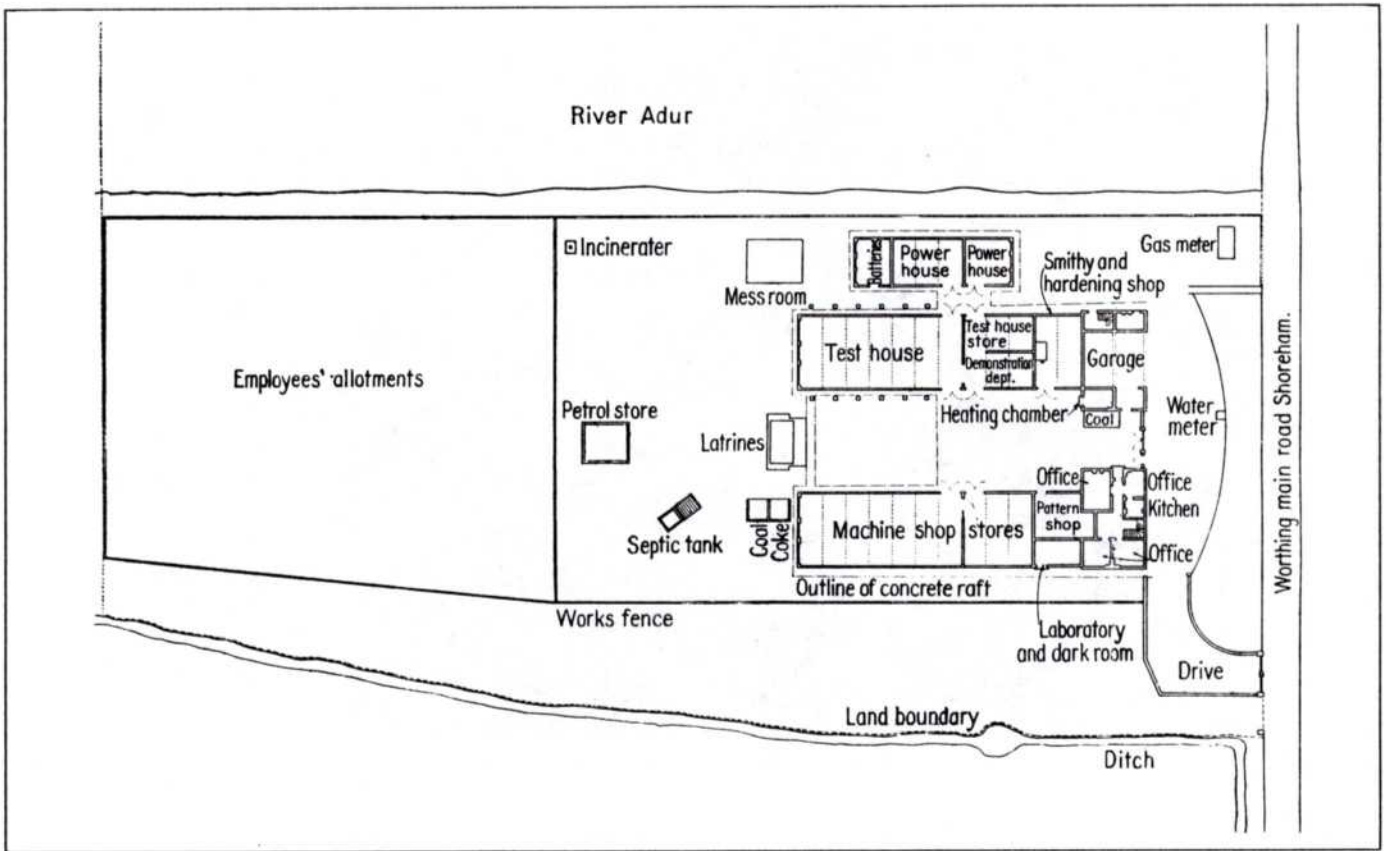


Fig. 14 Plan of Bridge Works, 1919

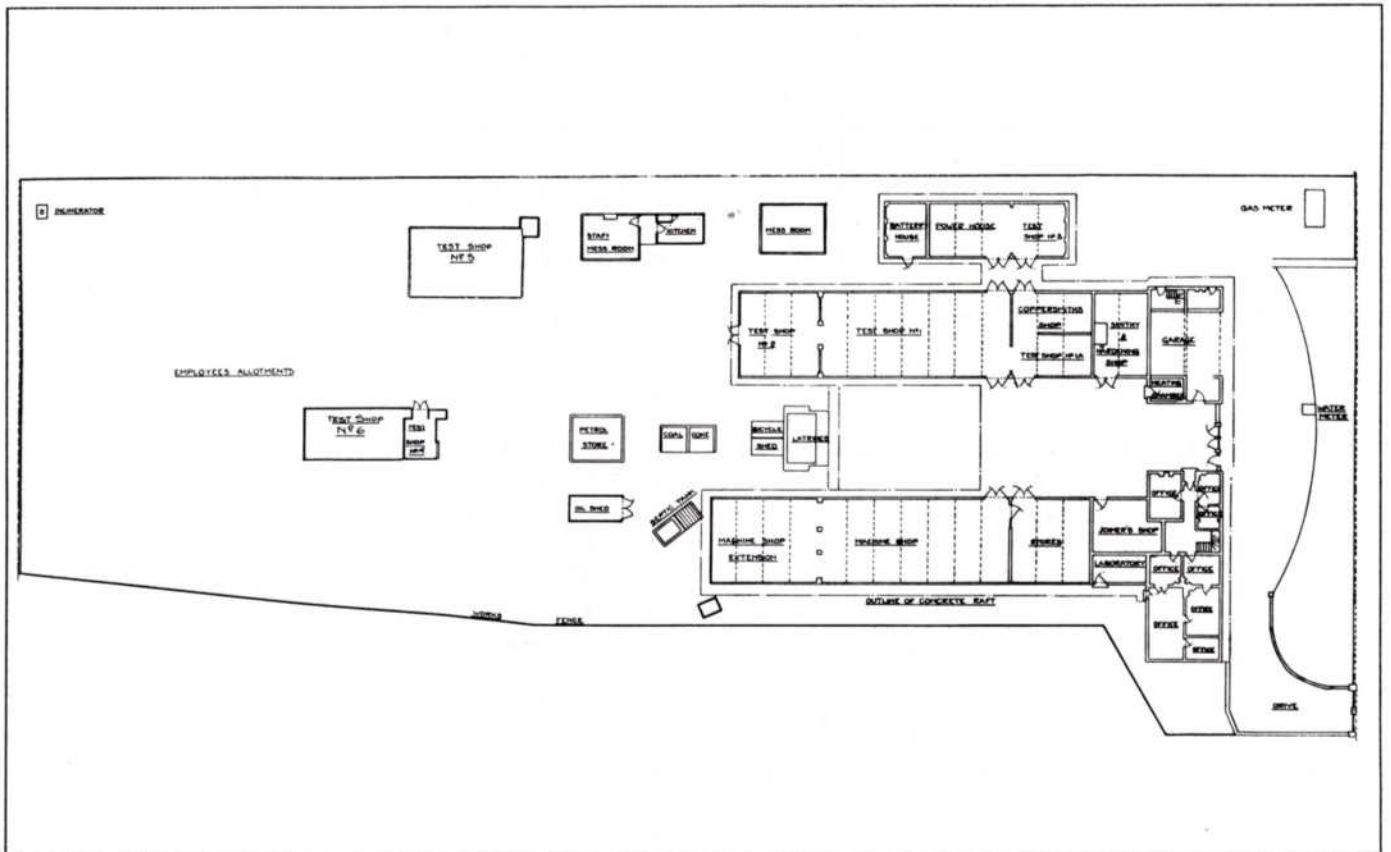


Fig. 15 Plan of Bridge Works, 1930

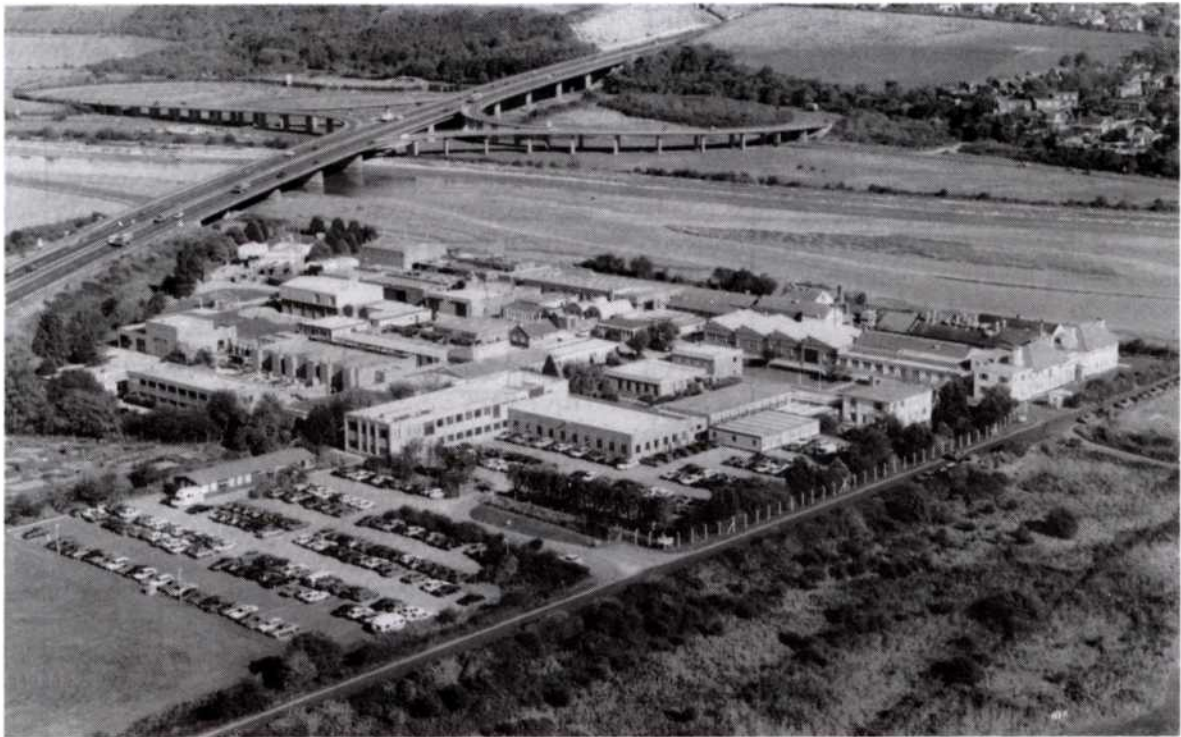


Fig. 16 Recent Aerial View of Bridge Works

The ability to carry out engine cold starting tests has been necessary for many years. Initially it proved adequate to have a portable cooling plant operating on "dry ice" which could be taken from engine to engine and which circulated coolant through the engine coolant jackets and would additionally cool enough induction air to enable a cold start to be carried out. In time however, this proved inadequate and a cold chamber capable of going down to -40° was constructed. This has been augmented when necessary by the use of commercial refrigerated trailers "Reefers" as used for carrying a refrigerated food cargo. While they cannot achieve such a low temperature, they are adequate for many tests.

COMPANY DEVELOPMENTS

In March 1920 the name was changed to Ricardo and Company Engineers Ltd. and following a financial reconstruction in 1927 the name was changed to Ricardo and Company Engineers (1927) Ltd. In 1930 Harry Ricardo became Chairman, a position he retained until 1961 although he then continued as Technical Director until he retired finally in 1965.

In 1929 an annual staff bonus was introduced, paid at Christmas, at an initial figure of 4% of salary. With the coming of the Depression things became more difficult for the Company however and Saturday morning working was suspended in October 1932 leading to a 9% reduction in all salaries. Saturday morning working was still suspended at the end of 1934 but

there appears to be no record as to when it was reintroduced. A Company Pension Scheme was introduced in 1948.

The Company remained as a private company until 1962 when it became clear that it was desirable for the benefit of the shareholders if the shares could have a definite market value on the basis of a Stock Exchange quotation so that they could be accepted by banks for security and by the Inland Revenue for probate. Although the Company then went public its name was unchanged.

In 1964, as a diversification, Ricardo acquired the old established firm of G. Cussons Ltd. of Salford. This Company had been a major manufacturer of teaching equipment especially in the areas of physics and engineering and had for many years been Ricardo's agent for the sale of variable compression engines and viscous flow air meters. Following the acquisition, substantial technical expertise was fed into the products from Shoreham and a new range of industrial testing equipment was introduced. In time however, with a substantial downturn in both the educational and industrial markets, coupled with appreciation that Cussons did not fit in well with Ricardo's mainstream business, Cussons was sold to a management buy out in 1987.

In 1978, the the Company's name was changed to Ricardo Consulting Engineers Ltd, the name under which it had traded for some years and in 1988 a

Group structure was created with a small Group Holding Company under the name of Ricardo Group PLC. but with the operations at Shoreham still being carried out by a Company known as Ricardo Consulting Engineers Ltd. The Group became the subject of a hostile bid in early 1989. This was successfully fought off but the problems associated with maintaining the independence of a small PLC had been emphasised and following consideration of a number of potential partners, the Group was merged in early 1990 with SAC International PLC, a Bristol based Company of similar size to Ricardo, and providing design services in the Aerospace, Nuclear, Power Generation and General Manufacturing Industries. While since 1990 there have been a number of management changes both within the Group and at Shoreham, further development of Ricardo Consulting Engineers Ltd. and of the facilities at Shoreham have continued.

Over the past five years it has proved to be necessary to establish an operational establishment with design and test facilities in the United States, which has always been an important centre for clients since the first agreement with the Waukesha Company of Wisconsin in 1920. Accordingly, acquisitions have been made in the Chicago and Detroit areas and these have been further developed by the installation of test facilities on the Chicago site. While Shoreham remains the headquarters, the American units are not just satellites. As appropriate, leading edge technology is developed both in the United States and at Shoreham and it is then available for exploitation throughout the Group.

TRANSMISSIONS

While reciprocating engines have been the backbone of Ricardo work, there have always been peripheral activities which have been carried out. The power plant cannot be considered in isolation from what is driven by it and consequently transmissions and transmission design have played a part over the years. Transmission design expertise has been built up and during the last year this has been greatly augmented by the acquisition by the Group of FFD, a Coventry based transmission design and manufacturing operation with a substantial USA subsidiary.

COMPRESSORS

Compressors are another area where, over the years, research, design and development have been carried out. Work on reciprocating compressors has ranged from integrally supercharged engines and an engine driven three stage air compressor for a transportable oxygen plant intended to provide oxygen to air crews at high altitude to a two stage water lubricated oxygen compressor used for charging oxygen bottles on aircraft carriers.

A very quiet, high speed, multi-cylinder wobble plate compressor¹⁴ was originally envisaged as a super-charger for diesel engines but was displaced by the development of the small turbocharger and found a market for the supply of air used to unload flour and cement tankers in built up areas where silence was vital.

WORK FOR THE ADMIRALTY

Test work on submarine and torpedo engines has already been mentioned. No. 8 shop was built with reinforced walls, doors and roof in order that it might be used for test work involving HTP, High Test Peroxide, as an oxidant in power plants for underwater use.

A range of projects was carried out¹⁵ (including recycle diesel engines where, as a diluent for the oxygen provided for combustion, exhaust gas is recycled in place of the nitrogen which would be present if air were the incoming charge. Another project, aimed at torpedo propulsion used decomposed peroxide steam (a mixture of oxygen and steam) as the working fluid for a high pressure, high temperature steam expander. A still more extreme project involved the design, building and testing of an engine in which vaporised kerosene was taken into the cylinder during the induction stroke and liquid HTP was injected around top dead centre as an oxidant. Since HTP plus lubricating oil acts as a high explosive, dramatic failures of the piston occurred when the HTP came into contact with lubricating oil in the piston ring grooves. Both the Admiralty and the British Ship Research Association sponsored quite widespread programmes at Shoreham aimed at obtaining fundamental design information on engine heat flows both gross and local, and heat transfer coefficients for the water side conditions of cylinder heads and cylinder liners and for oil cooled pistons where inertia effects are present.

ALTERNATIVE POWER PLANTS

In the early post Second World War years, another project involved the development of a complete small steam plant for use in India and other, at the time, underdeveloped countries. This was designed to live off the land, burning straw, coal, wood, dung etc. as available, and incorporated a cast aluminium boiler and a two cylinder steam expander. While the project was a technical success, the wide availability of small spark ignition engines together with their hydrocarbon fuels proved to be more acceptable in the market.

Attention to steam returned in the 1970s when the United States Environmental Protection Agency were attracted by the very low levels of exhaust emissions which might be achieved with such a power plant. Ricardo carried out a paper study of a plant for General Motors and subsequently, in association with

another American company, SES, designed a novel four cylinder steam expander¹⁶ as part of a complete power plant which was installed and tested in a motor car. This prototype did achieve low levels of exhaust emissions but unfortunately, the large rises in fuel prices in 1973 together with a growing American concern on their dependency on imported fuel supplies emphasised the importance of fuel economy, where the steam engine had no hope of competing.

Other alternative power plants upon which the Company have worked include the gas turbine, rotary engines and the Stirling engine. During the last war, Ricardo developed and then manufactured in some numbers governors and fuel control devices including altitude fuel controls for the Whittle gas turbines. Later, in association with the Shell Company, they developed a gas turbine combustion chamber for burning heavy fuel oil and still later, under a Government contract carried out fundamental experimental studies into the performance of small turbine rotors, both inward flow radial and axial. While the small gas turbine has thus far failed to find a very wide use, the data obtained has been used in the design of turbines for small turbochargers.

In the area of Stirling engines, Ricardo designed¹⁷ and then manufactured a batch of the mechanical sections of the Stirling engines for United Stirling when that Swedish company took over Stirling engine development from Phillips who had been responsible for the preliminary work.

Ricardo work on the spark ignition Wankel rotary engine was confined to the testing of proprietary engines from NSU and Mazda but more fundamental work was carried out on the two stage Diesel Wankel in association with Rolls Royce.

FUNDAMENTALS OF COMBUSTION

In the early 1940s, some twenty years after Sir Harry Ricardo had carried out his classic studies into detonation and pre-ignition, Ricardo's received a contract from the Shell Company to pursue further fundamental studies into mechanisms involved in detonation, employing the more advanced techniques which had by then become available.¹⁸

By employing high speed sampling valves derived from Atlas electrically operated diesel fuel injectors, to extract samples for analysis, it was possible to follow the chemical nature of the combustion process. By this means it was possible to forge a link between the engine studies at Shoreham and the more fundamental work on combustion which was being carried out elsewhere on laboratory type apparatus. Subsequently the work was extended under sponsorship from the manufacturers of detonation suppressants to study the

mechanisms of operation of tetra ethyl lead and other chemicals and to explore pre-ignition.

The method developed for this later work involved the use of artificially heated hot spots within the combustion chamber to induce pre-ignition independently of engine conditions.

Studies of diesel combustion employing high speed photography¹⁹ started at Shoreham in the early 1950s. Extensive work over a number of years clearly demonstrated the mechanism of operation of a number of widely different combustion systems. It also showed why a number of novel ideas did not work as expected. No successful new diesel combustion system was however developed as a result of this work. Later, the studies were extended by the use of high speed sampling to follow the mechanism of the formation in the cylinder of exhaust pollutants. Still later, Ricardo were early users of laser anemometry to study air motion and its influence in diesel combustion.

DESIGN INFORMATION AND TECHNIQUES

Within the limits of available resources, Ricardo have always endeavoured to be at the forefront of research and development in the engine field. This was achieved by recruiting high quality staff, by the extensive in-house funded programmes already mentioned, by the maintenance of a large technical library with computer search capability, by attendance at National and International Conferences and by the catholic nature of the funded research programmes which they have succeeded in attracting. Studies of the fundamentals of combustion and of engine thermal loading and cooling have already been mentioned. Advanced design techniques²⁰ have been developed to use the results of these and other programmes. The availability of high speed digital computers made it possible to employ finite element analysis in design, initially using a Bureau computer but the company soon found itself embarking on the acquisition of computer facilities at a frightening rate in terms both of complexity and cost. This process shows little signs of slowing down!

The introduction of computer aided design has had an important impact on design and more recently this has been integrated with computer aided analysis; with boundary element analysis added to finite element analysis as tools to be employed by Ricardo. Advanced cycle analysis programs have been developed in-house and the study of air motion and combustion has been extended by the development also in-house of a very advanced program for the application of computational fluid mechanics to induction, in-cylinder and exhaust flows and to the fuel injection and mixing processes. Engine and vehicle noise reduction projects

have been assisted by the development and application of dynamic finite element studies, modal analysis, statistical energy analysis and acoustical energy techniques.

INDIVIDUAL HONOURS

Harry Ricardo was elected a Fellow of the Royal Society in 1929 and was created a Knight in 1948. During his lifetime he was awarded a number of medals, honorary membership of professional institutions and honorary degrees including the James Watt International Medal in 1953. He delivered the Horning Lecture to the American Society of Automotive Engineers in 1955.

Sir Harry died in 1974 in his ninetieth year and until shortly before his death he came to Bridge Works several times a week where he particularly enjoyed technical discussions with his younger colleagues, including many who were at the start of their professional careers.

Two of Sir Harry's successors as Chairman of the Company were honoured by the award of the CBE. Jack Pitchford and Diarmuid Downs and J.F. ('Charlie') Alcock by that of the OBE. Diarmuid Downs was further honoured by a knighthood in 1985 and also by election as a Fellow of the Royal Society in the same year. The Company has also provided four Presidents of the Institution of Mechanical Engineers – Sir Harry in 1944, Jack Pitchford in 1960, Diarmuid Downs in 1978 and the present author in 1988. It has also provided Presidents of both major international technical engine societies, FISITA for automobile engineering and CIMAC for larger diesel and gas engines and gas turbines, Jack Pitchford and Diarmuid Downs being Presidents of FISITA in 1961-63 and 1978-80 respectively and the present author of CIMAC in 1983-85.

Additionally Jack Pitchford, Diarmuid Downs, Douglas Taylor, Michael Monaghan and the present author have been elected as Fellows of the Royal Academy of Engineering for their engineering achievements while members of the staff of Ricardo.

ACKNOWLEDGEMENTS

The author would like to acknowledge his thanks to the Directors of Ricardo Consulting Engineers for giving him access to the Minute Books and the early Cash Books of the Company and for other assistance including permission to publish photographs from the company archives, He also acknowledges the extensive use which he has made of the unpublished 1975 "History of Bridge Works" by E.N. Soar and the many articles and papers which have been written concerning the Company and by members of the staff over the years, some of which are referred to in the

bibliography, but which are too numerous to give as a complete list. He must also thank past colleagues and friends who have read the manuscript and offered helpful comments and suggestions.

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WINDMILL HILL MILL HERSTMONCEUX

Martin Brunnarius & Ron Martin.

During the 1994 Society mill tour of East Sussex we visited Windmill Hill post mill to view the work described by Ron Martin later in this article. This has saved the mill from possible collapse.

This hand winded post mill is particularly noteworthy not least for its size, in height certainly. The massive bulk of the body has dropped considerably during the occupation of the site. Allowing a foot (0.3 m) for this, then the roof ridge would have been at 50 ft. (15.2 m) above the ground, some 5 ft. higher than Cross-in-Hand post mill 5 miles north west of here. The body is also the largest standing in the county. The Exceptional height is due to the whole being raised on lofty piers which place the trestle inconveniently above the first floor as illustrated on Ron Martin's drawing.

Various maps record occupation of sites in the vicinity, a mill being shown here on the first edition of the 1" O.S. map. Notices indicate that the mill that we see today was erected between 1814 and 1819.¹ Many of the timbers are of oak and appear aged enough to suggest that this was a rebuild. It seems that there was a need to raise the mill at some time in order to improve its command of the wind, for the cross trees bear numerous jack marks. Also, the piers and the roundhouse walls are not unified as a planned new construction.

Early on, the Beeny Family were prominent in working the mill and business and are shown in directories from 1845.² A happy and unusual merger changed this when brothers Joseph & Charles Hammond from Clayton married sisters Ada Selina & Sara Beeny from Herstmonceux respectively in 1865.³ Joseph was here during the time of the brother's interest which was shown from 1878⁴ James Harmer worked the mill and bakery continuing until Henry Harmer took over entirely from the Hammonds in 1892.⁵ The family were here continuously until 1969 when Mr. Reg. Buckmaster bought the whole property which included the mill and mill house plus the adjacent bakery. At that time there was much evidence of the 150 years of service to the local community. Mr. Buckmaster continued this at the bakery and his shop in Herstmonceux village. He was followed by R. Arlbach in 1984. Then came A. Montague in 1991. The present owners Mr. and Mrs. Frost, have recently moved into the bakery building. They have shown great concern for the wellbeing of the remaining structure.⁶

The mill body still dominates the site above the mill house and garden. The sweeps were taken down when steam working was introduced by Henry Harmer in 1893. Neve Brothers, who were local millwrights, installed a pair of engine driven stones at trestle floor level. The ground floor and southern roundhouse extension were also utilised for this method of working. The body and roundhouse roofs were weathered in with sheet iron which has saved the mill⁷, as was the huge tailpole, no longer used for winding the mill.

Of the wind working itself two pairs of stones were fitted, peaks in the head, removed to lighten the load on the floor many years ago, and French burrs in the tail. Above, between the grain bins, the windshaft is of iron and being rather slender this had to be stiffened with stout oak planks between head and tail wheels to reduce torsional vibration when working with the tail stones. At the back of the bin floor, Charles Hammond's sweep governor was fitted⁸. This was an ingenious device patented in 1875 and based on water mill practice. The actual speed of the mill was to be controlled, wind permitting, by applying a large stone governor to two cone clutches which in turn set or unset the shutters of all four sweeps through the existing patent gear. Very much a notable mechanism and unique in windmilling today, this is at present at Clayton, moved for safekeeping in fear of collapse, a serious concern before the recent work described by Ron Martin.

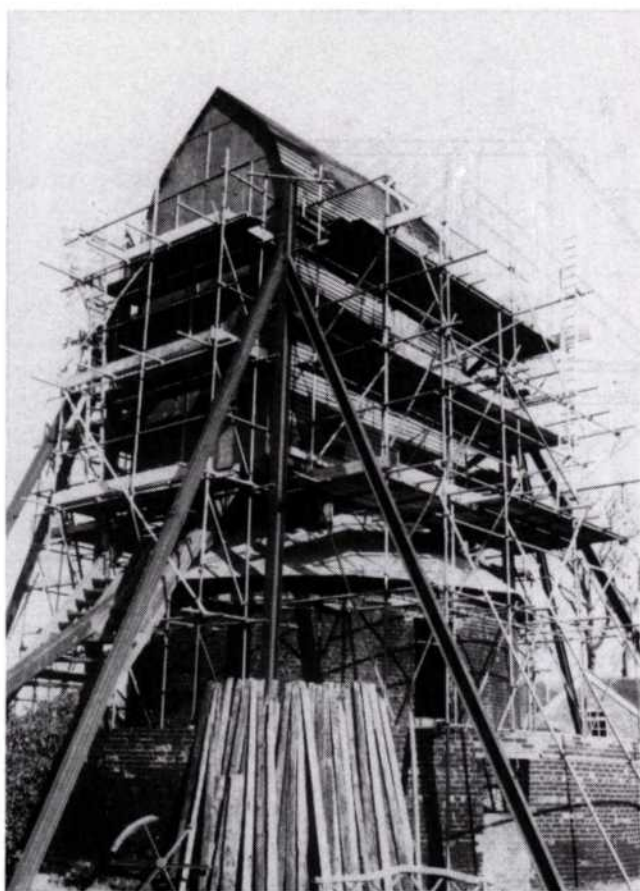
Other machinery within the body includes the remains of the dresser, a separator and grain cleaner. The method of drive to these was by a belt from a skew gear cross shaft at the brakewheel.

Various millwrights were involved here, Upfield who operated out of Rushlake Green would no doubt have been concerned previous to Neves as mentioned above, also Medhurst, particularly Boaz who followed Samuel in 1870. Some of his ironwork is still to be found within.

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Martin Brunnarius



Windmill Hill Mill under restoration April '94
photo. by Ron Martin

The windmill at Windmill Hill is very tall post mill with a two storey roundhouse, with an outer single storey roundhouse around a bit less than half the circumference. All the roundhouse walls are one brick thick and are in reasonably sound condition. The 3.5 m high piers are not bonded to the roundhouse wall and are battered on the other three faces. They taper from about 1.5 x 1.6 m at the base to 1.2 x 0.7 m at the top. It is known that the mill was raised at some time but it is difficult to see in the roundhouse walls where this was done. On the other hand the piers definitely do not show any signs of being raised, the rate of batter being even and as the top is only 0.7 m wide it seems possible that at the time the mill was raised the piers were rebuilt from the bottom.

The roof of the outer roundhouse does not exist, with only the joists in position. The main roundhouse roof has been rebuilt since the mill ceased working and is octagonal with a plywood covering on softwood rafters. In this form the buck would be unable to rotate. The trestle floor housed the third pair of stones and it is wondered how easy it was to work these as the cross trees are about 2 ft. 2 in. above floor level so that moving around the area would be very awkward.

The trestle and post are in excellent condition and show no signs of distress. The crown tree appears to be sound for most of its length. However at both ends at the intersection with the side girts it is badly rotted, in fact both side girts are completely non-existent at the point of bearing on the crown tree. Of the posts only the northwest corner one seems to be badly affected, but as a result of the defective side girts the whole of the outer framework of the mill has dropped and both the stone floor and particularly the spout floor falls away from the centre post. At spout floor level this has had the effect of breaking the back of both sheers. The south side lower side girt is also virtually non-existent.

Externally the tail pole has been sheathed in steel sheet and has been reduced in length. The steps are looking a bit sad with many treads missing. The external steps to the upper trestle floor level have recently been replaced.

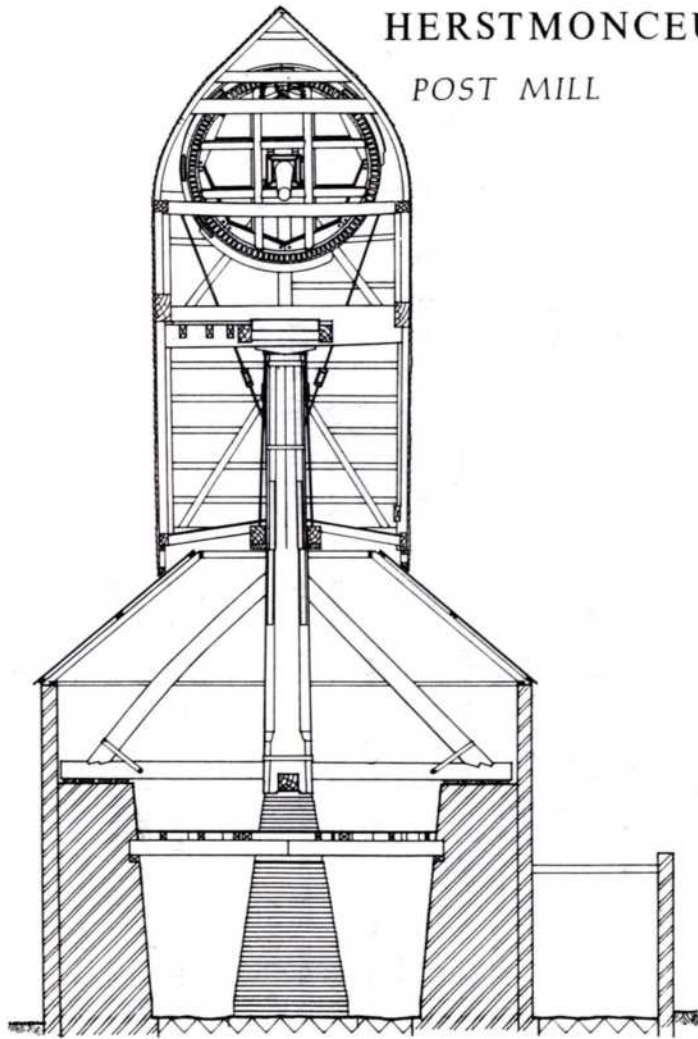
Of the machinery, the windshaft and tailwheel are intact. The brakewheel and brake is badly rotted at the bottom edge but much of the remaining machinery and bins are intact. There are no stocks or sweeps.

Some years ago the windshaft had been propped on steel joists supported on timber posts sitting partly on the front bed stone which had been removed and is resting on the crown tree, and partly on the crown tree and in that state it successfully withstood the 1987 storm. The mill was purchased by Mr. and Mrs. Frost in December 1993 since when an additional steel supporting frame has been constructed, comprising four steel columns each braced in two directions, with transverse joists supporting the principal members. Externally the steel sheathing has been removed and the weather boarding repaired and creosoted except for the tailend which has been sheathed in plywood. In this state this mill should be safe from further deterioration until such time as proper restoration can be put in hand. The Society and all windmill aficionados are very grateful to Mr. & Mrs. Frost for helping to save this important mill. The drawings show the mill as it existed in 1994, although the machinery and bins have not been shown, nor has any of the supporting steelwork.

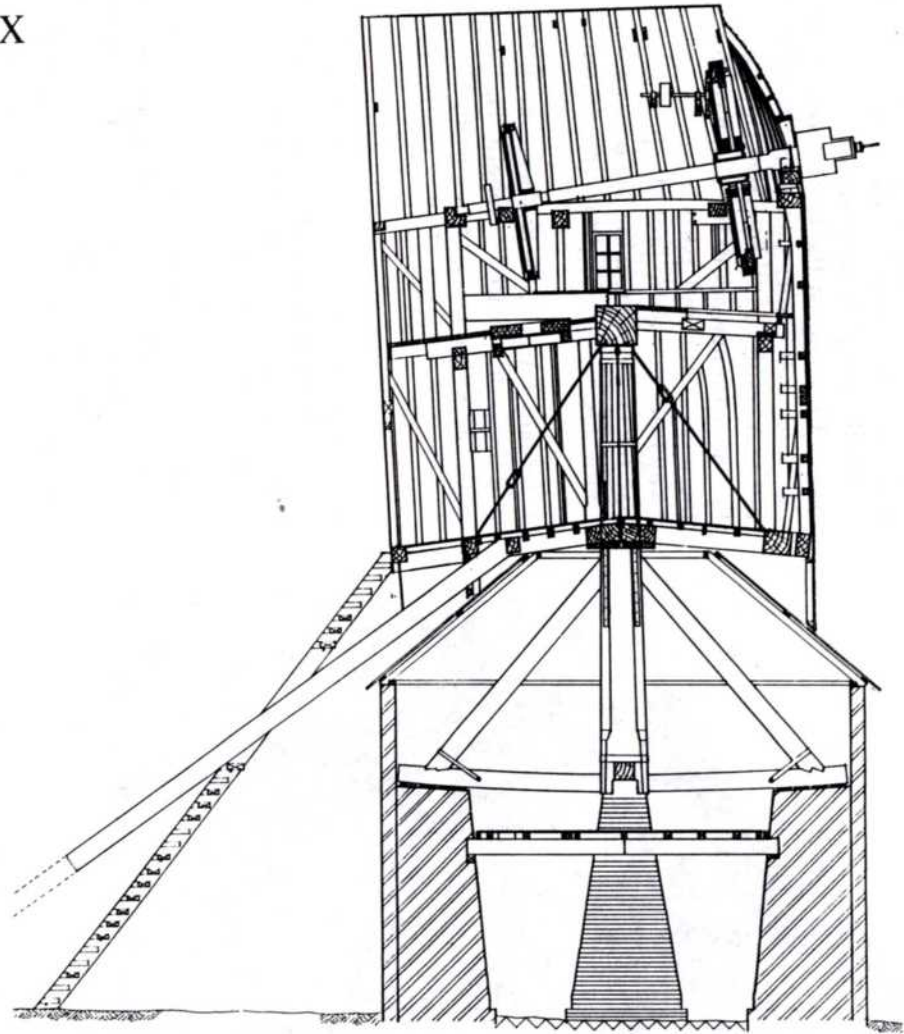
Ron Martin

WINDMILL HILL HERSTMONCEUX

POST MILL



SECTION A-A



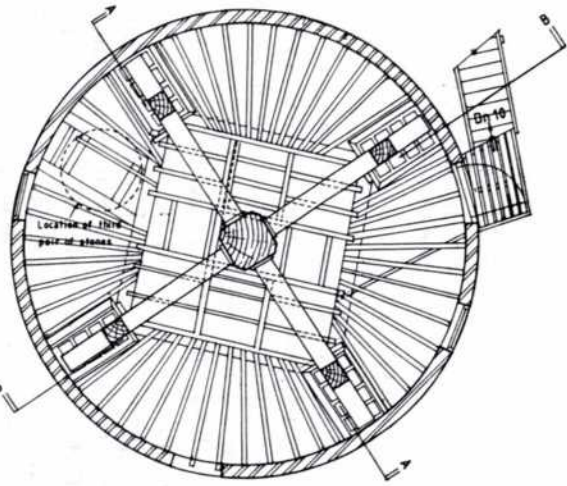
SECTION B-B

SCALE
0 1 2 3 Metres

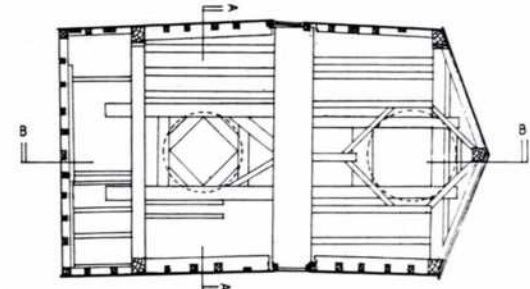
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1994

WINDMILL HILL HERSTMONCEUX

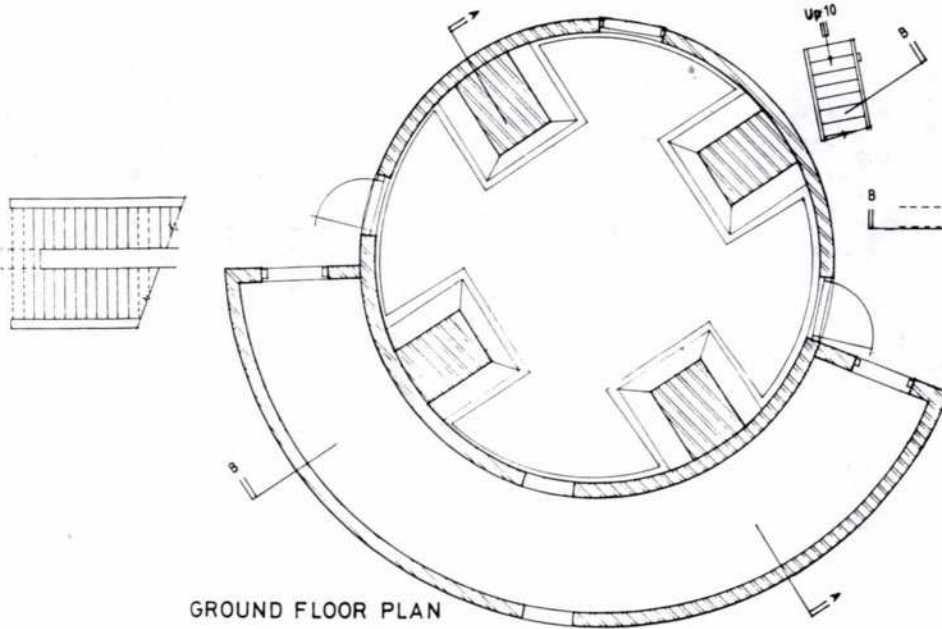
POST MILL



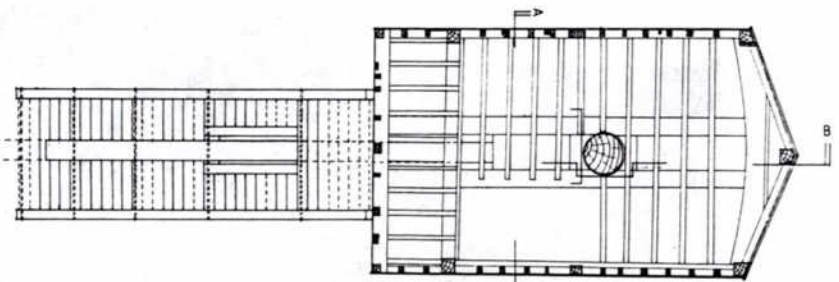
PLAN OF TRESTLE FLOOR
(SHOWING TRESTLE FLOOR CONSTRUCTION)



PLAN OF STONE FLOOR
(SHOWING FLOOR CONSTRUCTION)



GROUND FLOOR PLAN

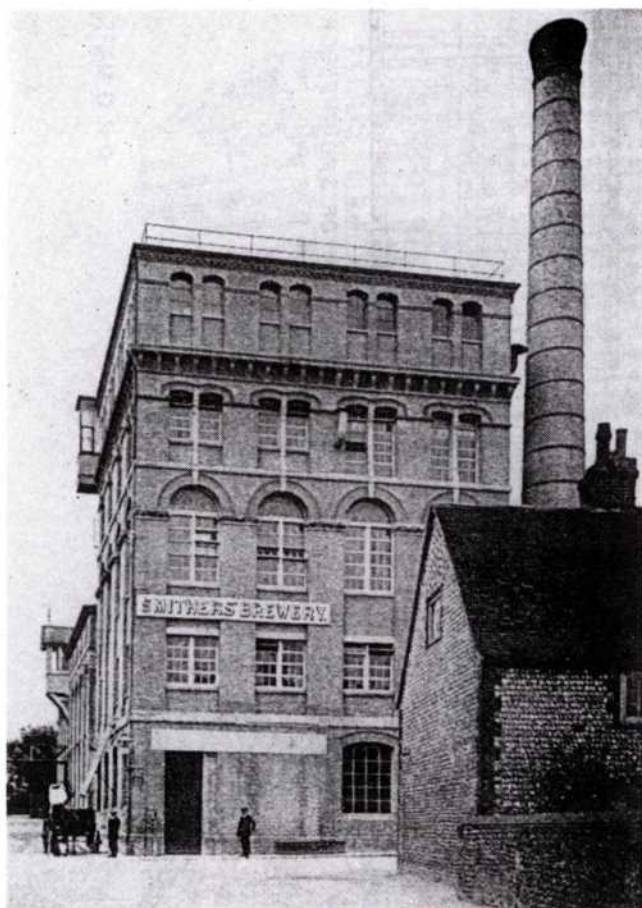


PLAN OF SPOUT FLOOR
(SHOWING FLOOR CONSTRUCTION)

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THE PORTSLADE BREWERY

Peter Holtham



Smithers' Brewery, Portslade

In the centre of Portslade old village is the impressive yellow brick building once Dudney's "Southdown Brewery" that even today still dominates the scene.

John Dudney was born at Shermanbury and lived at Henfield where his three daughters were born. He moved to Portslade when in his late thirties and here his sons John and William were born.

He founded the "Southdown Brewery" in 1849, although at that time there was another Southdown brewery owned by J. & A. Hillman at Lewes. The original brewery was situated to the west of the later building on the other side of the cobbled South Street behind the "Stags Head" a pub also owned by Dudney.

In 1869 he was joined in business by his sons although in 1858 John Dudney junior had been recorded as a grocer in Portslade.

In 1881 the business of Dudney and Sons expanded into a purpose built four storey tower building topped

by an elegant pitched roof in the French chateau style. An adjacent tall chimney decorated at the base with hops and ears of barley is inscribed "D & S 1881". The architects were Scamell & Colyer of London. A malthouse built to the North probably dates from this time as it does not appear on the 1873 ordnance survey map.

From 1884 to 1919 the business was run by William Dudney in partnership with the brothers Walter and Herbert Mews although they continued to trade as Dudney Sons & Co. Between 1893 and 1899 Walter Mews was shown as living at "The Elms", Portslade and Herbert at "Raglan" possibly later renamed "Whyhcote". In 1899 the home of Walter Mews was "Loxdale" (later the "Swedish Folk High School") situated behind a high wall and trees bordering Locks Hill, sold after the death of Mrs. Mews in 1928. John Dudney senior continued to live at Lindfield House, Portslade until his death in 1896. From 1890 the brewery became known as the Portslade Brewery and sometimes as Mews' Brewery.

In 1919 it is thought that the brewery was first purchased by the Kemp Town Brewery of Brighton who then immediately sold it off together with some of the licensed houses to the Brighton brewers Smithers & Sons Ltd. The Smithers family had operated the North Street Brewery on a site covered by Marks & Spencer in Western Road, Brighton, since before 1839. In 1906 they had formed a limited company when they merged with the Brighton brewers Ashby & Co. who owned the Bedford and Castle Breweries. A further amalgamation was effected in 1913 with the long established Brighton firm of the West Street Brewery.

Smithers realising the necessity for expansion owing to the increasing popularity of their products, and for the provision of an up-to-date plant, rebuilt and enlarged the Portslade Brewery, replacing the graceful roof by a rather ugly flat roofed fifth storey. In November 1920 when rebuilding was complete they moved their brewery operations from Brighton. Their old brewhouse in the part of North Street that later became Dyke Road was sold off. It became a motor show room and in 1984 when demolished was a furniture warehouse. A malthouse in Cheltenham Place acquired from the Ashby Company was closed and use was made of the larger Kingston malthouse of the former West Street Brewery company. The old malthouse to the North of the Portslade Brewery became the engineers shop. The company's head-office was moved from 201, Western Road, Brighton to what they described as "commodious premises" at 42, Castle Street, Brighton, a building that today belongs to the R.A.F. Association.

To describe the reconstructed Brewery plant at Portslade I cannot do better than quote from Smithers' own company guide in which they describe their "modern hygienic plant" as probably being the most up-to-date in the Kingdom, and go on to say that when the brewery was acquired the well was found to be only 87 feet deep so a bore hole was sunk 162 feet deeper. At this depth an absolutely pure supply of water was obtained. To avoid the possibility of its contamination by pumping machinery the water was blown from the bore hole to the surface by compressed air and thence pumped by electricity to the top of the brewery. The "Wort", the unfermented beer, was boiled under pressure in totally enclosed coppers. The fermenting vessels were steel, lined with glass. The public were cordially invited to inspect the brewery any Wednesday from 3 p.m. The Bottling stores built in 1914 at Regent Hill, Brighton were retained, the beer being transported in Aluminium tanks from Portslade and forced by compressed air into glass-lined storage tanks. Company photographs show a splendid fleet of electric and steam delivery vehicles. Employees were housed in model dwellings, participated in a profit sharing scheme and benefited from a pension scheme.

Public Houses in the Brighton area were The Olive Branch, The Sutherland Arms, The Star in the East, The Castle Inn, The Lord Nelson, The Compton Arms, The Preston Park, Ye Olde Kings Head, The Rutland, and the Hollingbury.

Sadly it was not to last. The beer duty rose forcing prices up. Beer consumption declined due to the low wages and unemployment amongst many of their customers, There was just too much spare capacity in the beer trade and the number of breweries nationally had been halved since World War I. Finally on 28 January 1930 the Brewery plant was offered for sale by auction although it does not appear to have been sold then continuing possibly in receivership until liquidated on 21 August 1930. However, Mr. W.D. Standen, a former employee of Smithers and later Tamplins, says Smithers did not go into voluntary liquidation but were simply taken over by Tamplins, two of the directors Louis Cecil Ashby and Herbert Smithers being opposed to the transaction but overruled. Most of the newer brewery building was brought by Shepherd's Industries Ltd. the first of a series of engineering firms to operate there in addition to a pickle factory.

The licensed houses were bought by Tamplin & Son's Brewery Brighton Ltd. on 20 March 1931, after possibly first leasing them and one third were sold on to the Kemp Town Brewery Brighton together with the Kingston malthouse.

Part of the original brewery on the west side of the

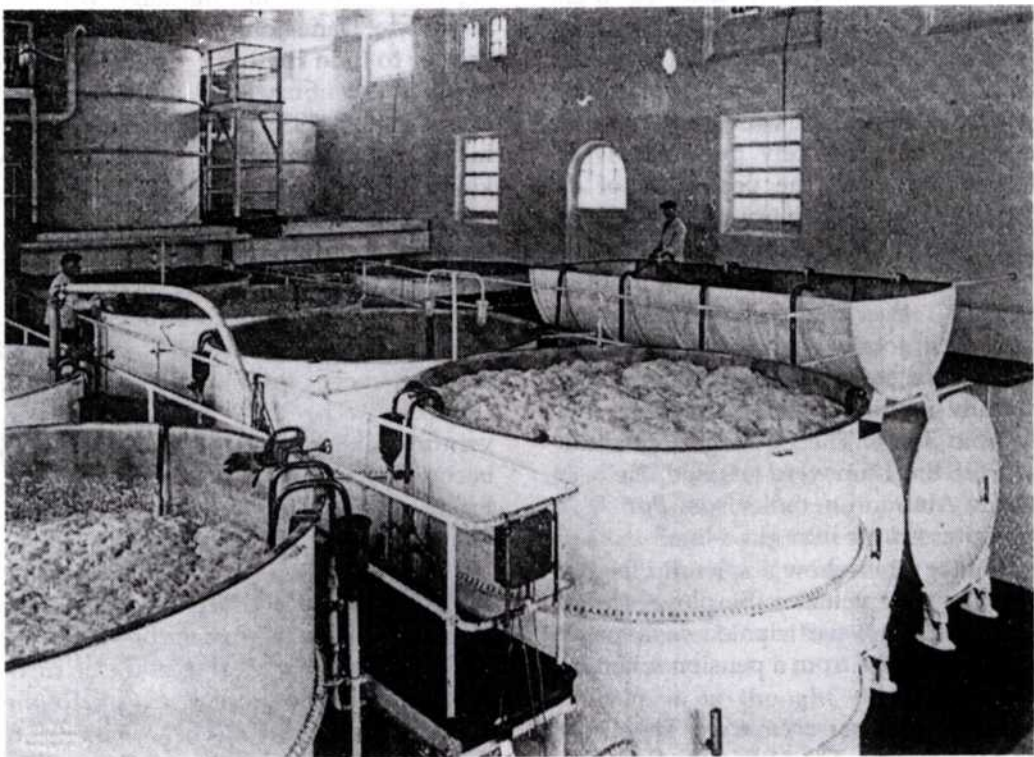
road, later used for cask filling, was bought by Eric Stanford who had began his career as pupil in the brewery. When his pupilage was finished he had moved to Dane John Brewery, Canterbury as junior brewer to Jude Hanbury Co. Ltd. After the acquisition of Jude Hanbury by Whitbreads he was made redundant in 1931 so decided to commence brewing his own. Trading as Stanford & Co. he produced three kinds of "near beer" with under two degrees of proof spirit that did not attract Beer Duty. He supplied unlicensed restaurants and clubs and also owned two off licences. Depots were opened in Ramsgate and London and he supplied outlets along the South Coast as far as Southend. Later he commenced brewing full strength beer trading as the Portslade Brewery Company. The 1939 war brought an end to the venture. Other accounts suggest that he may have become bankrupt. He later became head brewer at Frome United Breweries and finally in 1955 joint managing director of the Lamb Brewery, Frome.

From 1940 to 1946 C.V.A Ltd. located their chuck and spanner shop in the former brewing premises together with their vacuum cleaner and electric iron production plant. In 1947 the present occupier of the new brewery building, Le Carbone (Great Britain) Ltd. commenced the manufacture of batteries. During World War II the Home Guard H.Q. was here and there was an anti-aircraft gun on the top of the tower. The old Original brewery has since been put to a variety of separate light engineering uses.

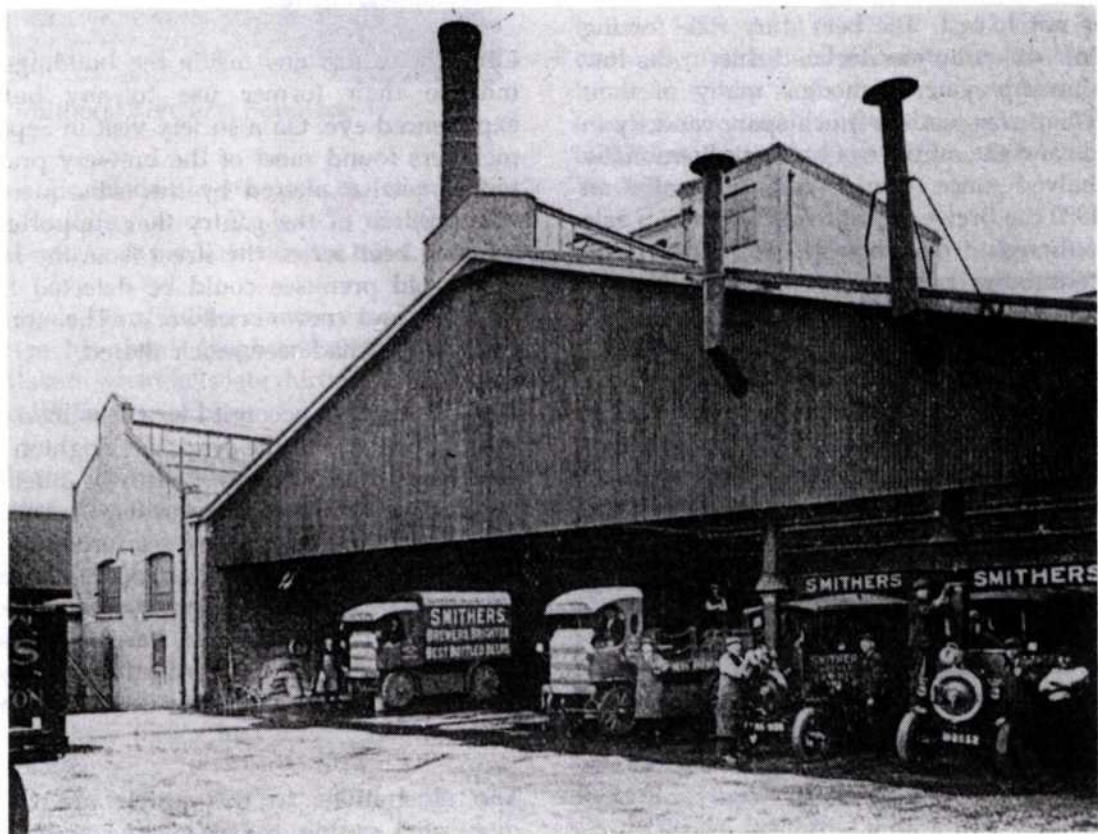
Little today remains inside the buildings that could indicate their former use to any but the most experienced eye. On a society visit in September 1994 members found most of the brewery premises intact but somewhat altered by the subsequent occupiers. The position of the gantry that supported pipework carrying beer across the street from the new brewery to the old premises could be detected from cut off remains and new brickwork. The former roofed loading dock had been much altered.

In preparing this account I have obtained much of the information from the various Brighton area trade directories. I am, however, greatly indebted to Judy Middleton for information on the Dudney and Mews families, to Hugh Fermer for information about later use of the premises (his article in *Sussex Industrial History* No. 23 includes a photograph of the brewery as it appears today), the Labologist society for information about Eric Stanford's brewery and Keith Osborn for bringing Smithers' 1920s company guide to my attention.

The illustrations to this article are taken from a descriptive guide to the works published by the Smithers Brewery in the early 1920s.



A corner of the fermenting room, Smithers' Brewery



Loading dock of the Portslade Brewery

BRIGHTON GENERAL HOSPITAL

Ron Martin

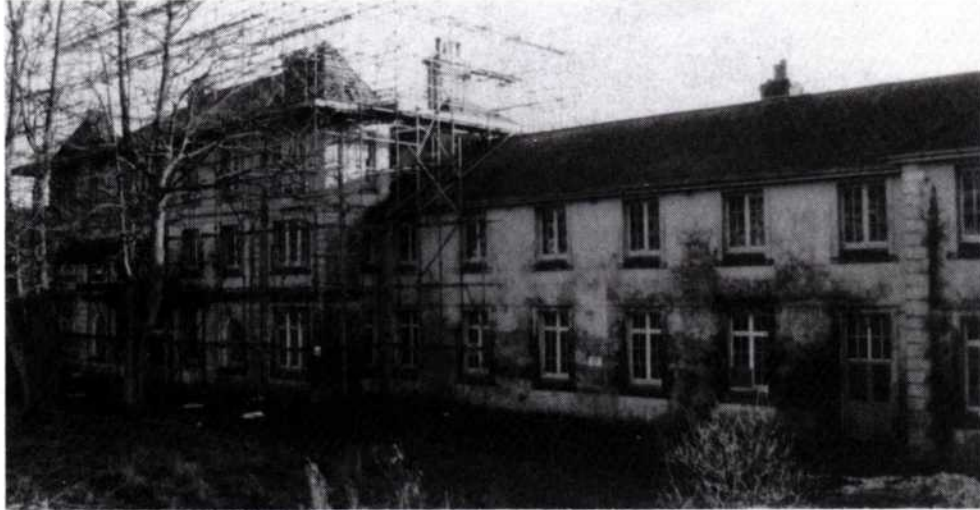


Fig. 1 Front (North) Elevation, Warren Farm Industrial School

The 1834 Poor Law Amendment Act advocated the formation of unions at several parishes to operate efficient new workhouses. The Brighton Guardians had already built a new workhouse only twelve years before, located above St. Nicholas' churchyard to the north of Church Street (TQ 307047). For this reason Brighton was the only parish in East Sussex not to conform to the pattern of joining a union to carry out the policy of the New Poor Law. However by the late 1840s the existing workhouse was found to be inadequate and the Guardians decided to build a larger one and also an industrial school. The latter was built in 1859 to the designs of George Maynard, the parish surveyor, on the land occupied by Wick Farm (TQ 351056). It comprised a two storied E-shaped block fronting onto Warren Road, the central seven bays and the central wing behind being three stories high. The design is plain with rendered walls and a hipped slate covered roof and mainly casement windows with mullions and transoms. (Figs. 1,2)

The necessity for a supply of water was paramount for both the school and the new workhouse which was to be built at the top of Elm Grove and a contract was placed in 1858 for a hand dug well. This proved to be a major feat of engineering. The initial contract was for a well 6 ft. in diameter and 400 ft. deep but as no water had been reached at 438 ft. various lateral tunnels were dug. Work continued with a 4 ft. diameter shaft and digging continued for a total of four years and finally on March 16 1862 at a depth of 1285 ft. the water broke through and filled the well to a depth of 340 ft. from the surface. Had it not been for the fact that this

event took place during a change of shift there might well have been many casualties. There was great rejoicing at the success of this effort and church bells all over Brighton were rung in celebration.¹ The well is considered to be the deepest hand dug well in the world. It provided water for both sites until 1878 when connection to the main supply was made.

The school which was known as the Warren Farm Industrial Schools ceased its original function and became a children's home in the 1930s and subsequently had various other uses. In about 1955 it became the Fitzherbert R.C. Secondary School and was finally closed in 1987. It was proposed that it would become one of the new City Technology Colleges but this came to nothing and the buildings were finally demolished in 1994.² Currently a Nuffield Hospital is being erected on the site.

In 1866 the Brighton Workhouse was built in Elm Grove (TQ 328052) on a seven acre site to the designs of George Maynard. The buildings erected at that time comprised the Workhouse proper (A Block, now Arundel building, Fig. 4), Casual Wards adjacent to the main entrance (now demolished), the Infirmary (F Block, now Fletching Wards,³ Fig. 5), Workhouse Nursery (G Block, now Glynde Building), Lunatic Wards (H Block, now Hollingbury Building),⁴ Fever and Foul Wards (probably J,K or L Blocks, now Jevington Building, Keymer Building and Lancing Building), together with a complete range of service buildings. Most of these buildings survive to this day but have been changed from their original use in many cases.



Fig. 2 Rear (South East) Elevation, Warren Farm Industrial School

The principal workhouse building is an imposing T-shaped structure with a frontage of 318 ft., four stories high with four projecting sections each finished with a gable. At the centre of the front elevation is the projecting main entrance, above which on each successive floor are single and three light windows. It is surmounted by a clock tower capped by a cupola. Behind the main block in the stem of the "T" was located the Chapel (now used as the restaurant and kitchen). These original buildings are all of a rather stark appearance with plain rendered walls relieved sparingly with banded rustication. All the original windows were double hung sashes in cased frames divided into small panes. Some of the windows to the front of a block and to the chapel had semi-circular heads but most were flat headed (Fig. 4). Most of the ancillary buildings were built in coursed flint rubble with red brick quoins, dressings and horizontal and vertical lacing courses. All the roofs were covered with Welsh slates. The lunatic Ward, Block H, had a third

storey added in 1871 and an additional wings at its south side.⁵ The clock in the tower of Block A was installed in 1874. A strip of land approximately 64 ft. wide was leased in 1880 along the west side of the site on which was built in 1887 the new Casual Wards on the Elm Grove frontage. These were B Block (now Bramber Building) and were also to the design of George Maynard and similar in style to the earlier building.

Two new Infirmary Blocks D and E (Fig. 6) (now known as Dyke and Edburton Wards) were built in 1891 on the south west of the site to the design of Benjamin H. Nunn.⁶ These were T-shaped blocks mostly of three stories in yellow stock brick in Flemish bond with straight rusticated quoins and red brick plinth and band courses. In the top of the "T" was a recess with open verandas, now infilled. The windows were double hung sashes and the roofs were hipped and covered with slates. A third Infirmary Block C

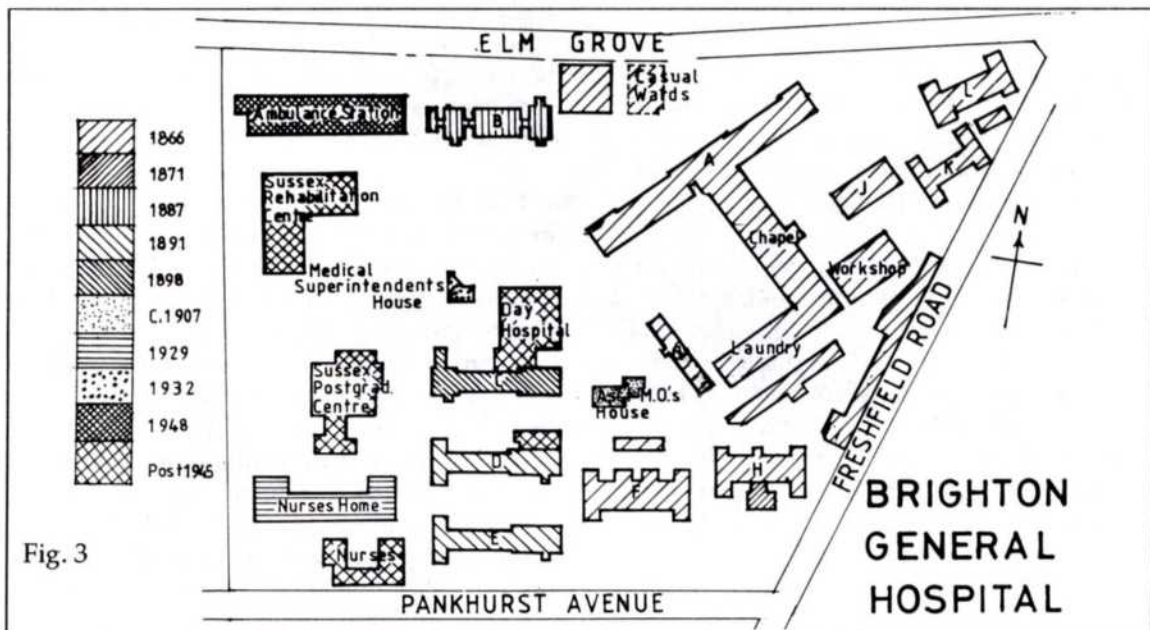


Fig. 3



Fig. 4 Brighton General Hospital Arundel Building "A" Block, built 1866

(now known as Cuckmere Wards), of almost identical design, was built in 1898 to the north of Block D. This was the last ward block to be built on the site. The assistant Medical Officer's Bungalow (now Hilltop Nursery School) was built probably before WW1 at TQ 82850511. Although its construction was authorised in 1906 it was not shown on the 1911 O.S. map.

Early in 1914 the name was changed to The Brighton Poor Law Institution but in 1915 the establishment was taken over by the military authorities and became the Kitchener Indian Hospital with additional hutted accommodation provided on the 4 acre field to the west. The

buildings reverted to their former use in July, 1920.

The next major development on the site was the erection of the Nurses Home in Pankhurst Avenue to the designs of the borough surveyor, D.J. Howe (Fig. 7). This is a massive block 14 bays wide and 6 stories high with buff brick walls in Flemish bond with red brick rusticated quoins and arches and with some rusticated panels around the entrances. A new house for the medical Superintendent was built in 1932 to the north of C Block.

In 1935 some of the buildings were taken over as the Brighton Municipal Hospital and Blocks C,D,E and F,



Fig. 5 Brighton General Hospital "F" Block Fletching Wards, built 1866



Fig. 6 Brighton General Hospital "E" Block Edburton Wards, built 1891

the Nurses Home and various other areas were handed over to the new authority. A Block was used by the hospital during the war and finally in 1948 the name was again changed to The Brighton General Hospital and the acceptance of casual patients ceased.

Post WWII developments include the Sussex Rehabilitation Centre, the Sussex Post Graduate Centre and the Briggs Day Hospital, all uninspiring modern low flat roofed structures. The ambulance station of 1948 on the Elm Grove frontage is a utilitarian building and an annexe to the Nurses Home on the Pankhurst Road elevation has a pleasing domestic feeling to it.

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 5. ESRO HB 103/2 (1 and 2)
 6. ESRO HB 103/3 (1)
 7. ESRO HB 103/6



Fig. 7 Brighton General Hospital Nurses Home, built 1929

SUSSEX INDUSTRIAL HISTORY – A QUARTER CENTURY

Brian Austen

With the publication of issue 25 of *Sussex Industrial History* it was thought appropriate to review briefly the history of the publication and to list the articles contained in the various issues.

Sussex Industrial History was first published in late 1970 as a bi-annual periodical of the then Sussex Industrial Archaeology Study Group. The first editor was John Farrant and the publishers Phillimore of Chichester. The price to non-members was set at 15s (75p) per annum. Apart from the articles a section entitled "Notices and News" provided general information about the industrial archaeological surveys being undertaken and the programme of visits and talks, information which now is published in our quarterly *Newsletter*. By issue five (winter 1972/73) it was clear that insufficient sales were being made by Phillimore's to non-members for the publication to be viable. Issue six did not appear until late 1973 and it was noted that "this is the last issue of *Sussex Industrial History* to appear under the Phillimore imprint. Sales have alas not been sufficient to make the journal financially viable." With a subscription of £2 per annum the chance that the Society would be able to provide an equivalent journal from its own resources seemed unlikely and it was at this stage that the quarterly *Newsletter* appeared as a replacement. Issue 1 appeared in January 1974 though the Sussex Industrial Archaeology Study Group had published five Newsletters between April 1968 and April 1970 before *Sussex Industrial History* first appeared.

By 1976 the Society felt itself confident enough to try again. Issue seven dated spring 1976 commented on the "growth in the stature of the Society ... the

increasing interest ... shown by the general public as well as by various official bodies" as the reasons for "the Committee of the Society to decide that the time was appropriate for a revival of the journal". Once more shorter items were included under the heading "Field Projects". The existing editor of the *Newsletter*, Professor E.O. Taylor, additionally took on the editorship of *Sussex Industrial History*. The cost of setting type and printing by conventional methods was however found to be beyond the resources of the Society and with issue eight of 1978 only the cover was typeset and the text printed from typed originals. As a further economy measure the cover of issue ten (1980) was changed and the use of glossy paper to reproduce illustrations was abandoned. This enabled the cover price to be reduced from £1.80 to £1. With issue thirteen (1983) Professor Taylor retired as Editor. Briefly John Upton took over and produced several Newsletters. Pressure of work resulted in delay in the publication of *Sussex Industrial History* and only one issue, fourteen dated 1984/85 appeared in the time of his editorship. This was however the first issue to display an improved cover layout and feature a fine line drawing by Ron Martin of the terminal at Shoreham Airport. Each issue since has displayed the virtuosity of Ron Martin's pen. The present Editor was responsible for seeing issue fourteen through the press and took over subsequent issues. Modern technology came to the aid of the society enabling better type faces to be employed as progressively electric typewriters which could justify lines and then word processors were used. Issue sixteen was a joint venture with Gatwick Airport Ltd. and issue eighteen was produced in conjunction with the Lewis Cohen Urban Studies Centre of the then Brighton Polytechnic. Both of these special issues had non-standard covers. From issue fourteen shorter items were omitted, these being included exclusively in the *Newsletter*.

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1. Winter 1970/71

The Ashburnham Brickworks 1840-1968

The Upper Ouse Navigation 1790-1869

Notes and News

Tollhouse and Milestone Survey; Park Mill, Batemans, Burwash;

Benjamin Ware's Tile Works; Two Windmill Restoration Appeals;

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Kim C. Leslie

D.F. Gibbs & J.H. Farrant

2. Summer 1971
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 Water Pump; Estate Sawmill, Brightling Park; Water Pump, Sutton Hall; Cobb's Mill;
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Sussex Industrial Archaeology: A Field Guide (1985) £5.95 post free

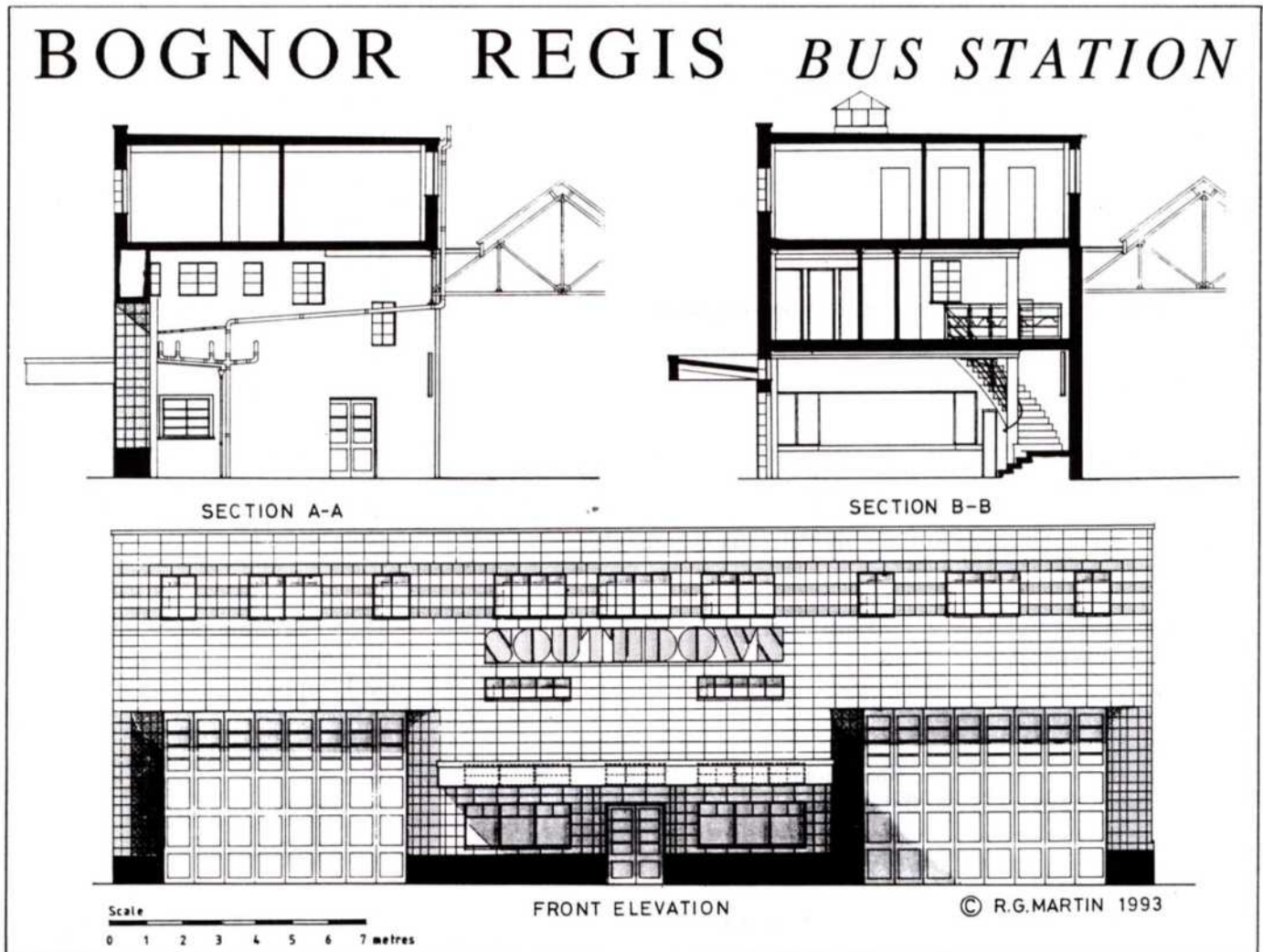
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Ron Martin



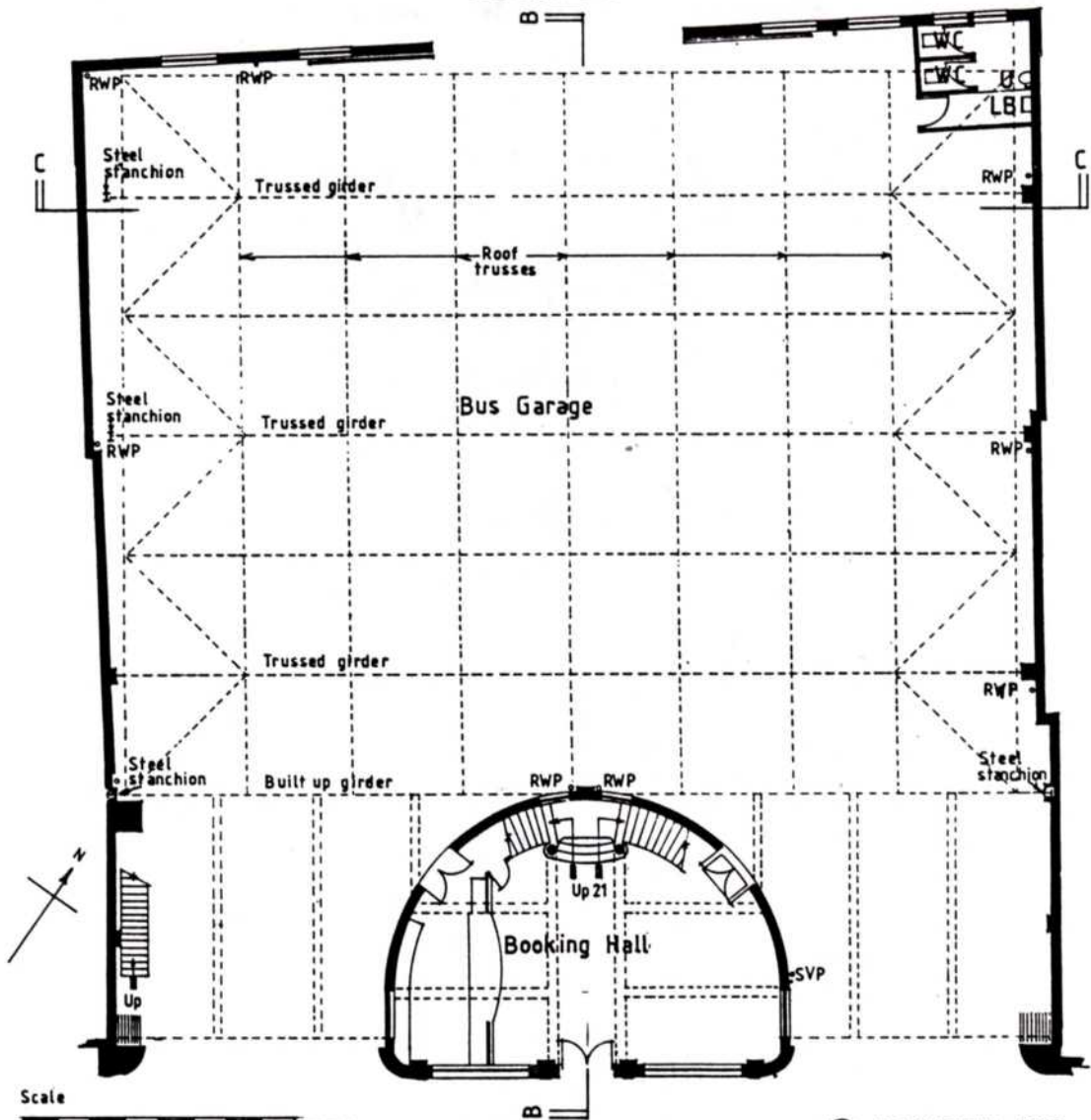
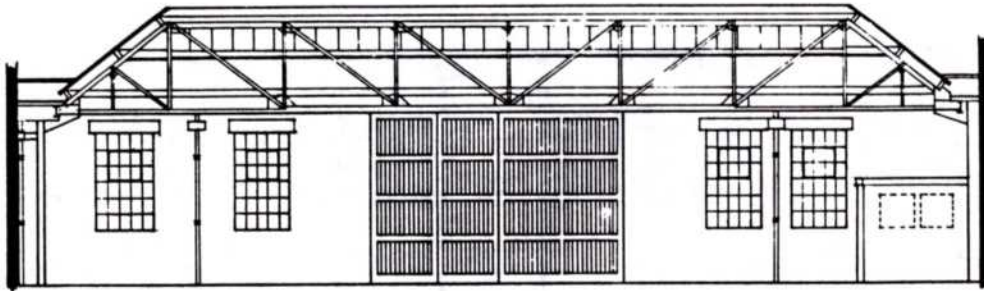
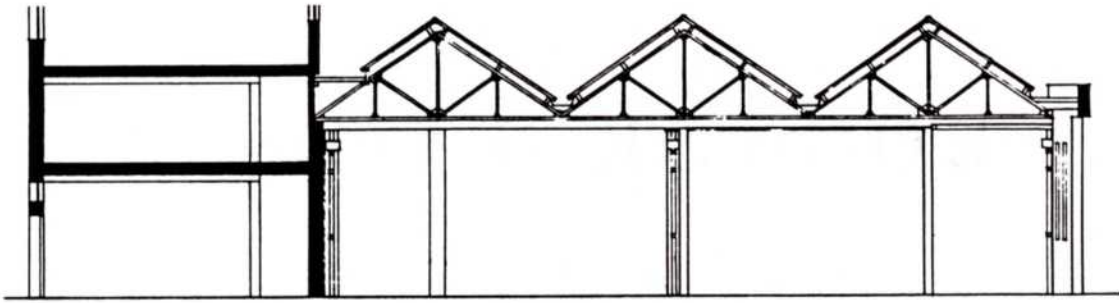
The bus station in High Street, Bognor was built in the 1930s to the designs of Clayton and Black, the Brighton architects for the Southdown Bus Company. It was the last remaining Southdown Bus Station dating from the 1930s and was demolished in June 1993 after a number of years being used as a market.

The three storey front elevation of the building faced southwards on to the High Street with the large bus garage behind. The front building comprised at ground and first floor levels an enlarged semicircle on plan containing at ground level the Booking Hall, with toilets at first floor level. They were connected with a bifurcated staircase which continued on upwards at one side to the second floor. This floor was used for office accommodation and for the staff canteen and kitchen and extended across the whole of the front of the building spanning the bus entrances at each side of the Booking Hall.

The front elevation was faced with faience tiles mainly cream with green courses and a black plinth. The bus entrances had curved corners and across the centre of the frontage was the word "SOUTHDOWN" in very stylised art deco style.

The rear bus garage was of conventional steel framed construction and carried corrugated asbestos-cement sheeting with patent glazing. The large double doors at the rear were damaged a number of years ago when a bus was being moved into the garage for the overnight parking and got out of control.

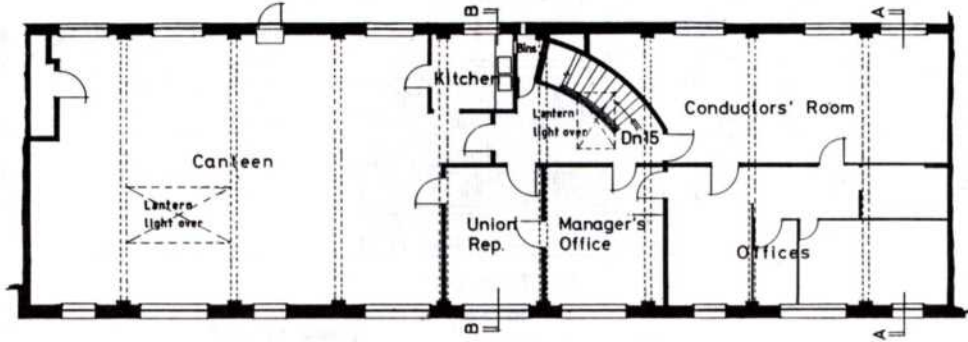
There was much local pressure to get this interesting example of art deco preserved but without success. The site is now a supermarket car park.



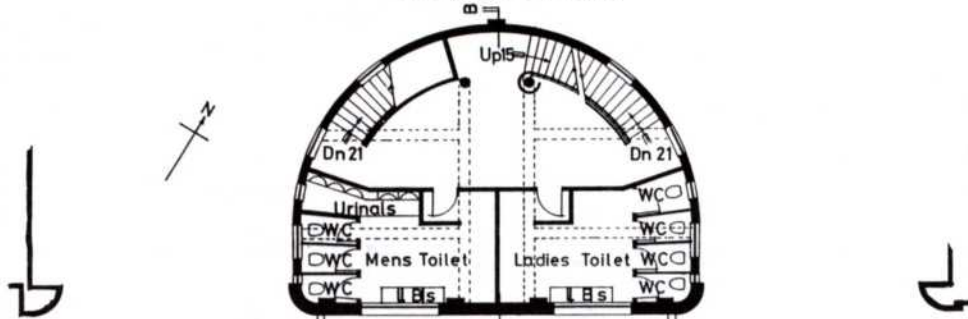
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BOGNOR REGIS

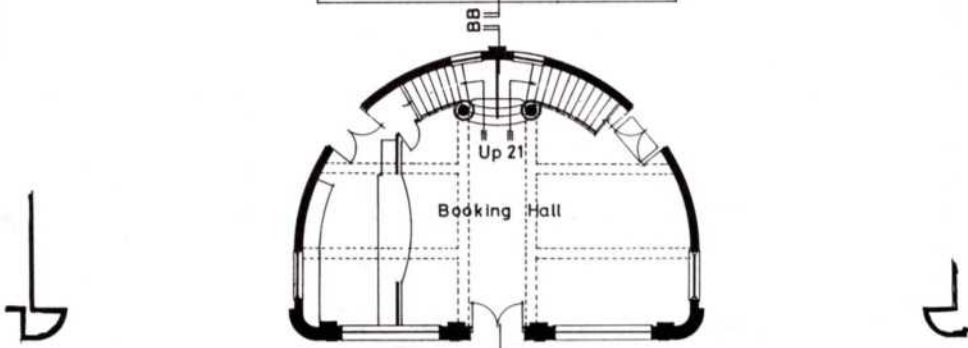
BUS STATION



SECOND FLOOR PLAN



FIRST FLOOR PLAN



GROUND FLOOR PLAN

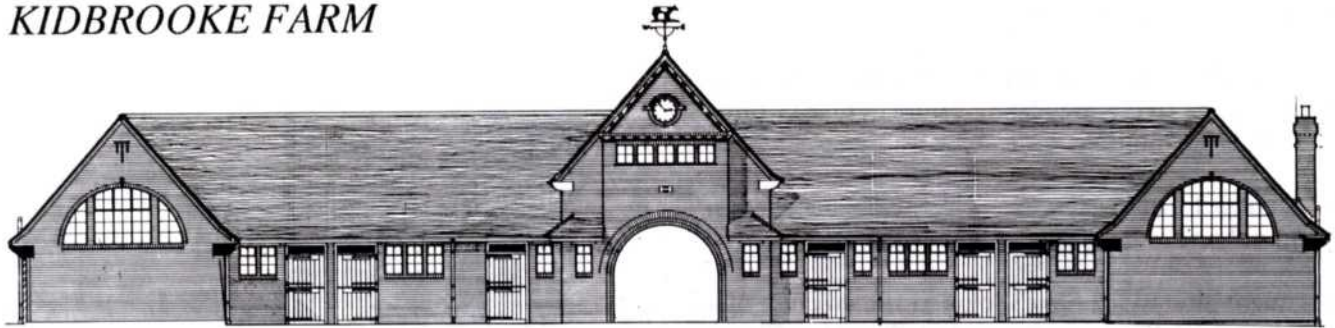


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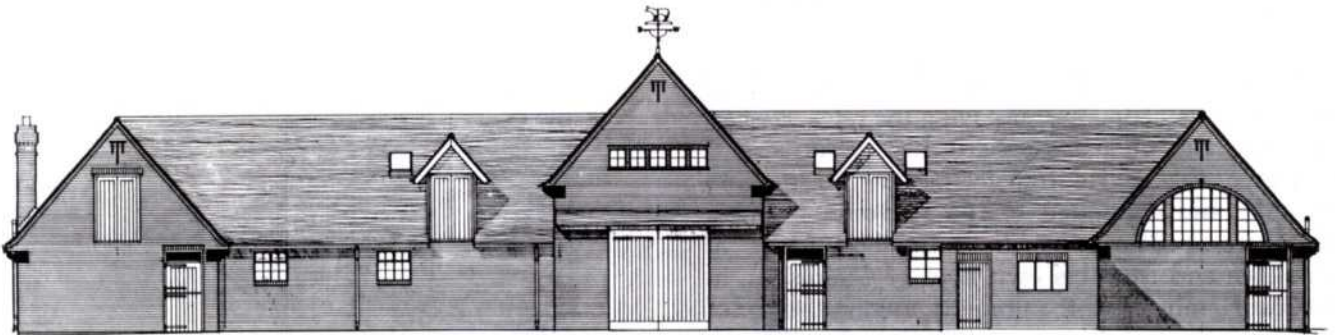
KIDBROOKE HOME FARM

Eric C. Byford & Ron Martin

FOREST ROW KIDBROOKE FARM



SOUTH ELEVATION



NORTH ELEVATION

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Originally Kidbrooke Home Farm was situated in the grounds of Kidbrooke Park estate, on the east side of Priory Road and immediately north of the former farm entrance to the estate. The still existing eighteenth century barn and reconstructed milking parlour, beside the road, indicate the location of the complex as it was before 1927. (TQ 418345)

In 1921 Ronald Olaf Hambro of Hambro's Bank, bought the Kidbrooke Park estate and soon after he purchased the Brambletye estate. Subsequently he began, as was his wont, to restore or alter various parts of his estate. One of these objectives was to remove the farm buildings from their position in the Kidbrooke grounds and to build a "Model Farm" and farm house some 150 metres to the north west on the west side of Priory Road. (TQ 416347)

In 1927 he engaged Messrs. James Waters, builders, of Hartfield Road, Forest Row to carry out this work. It comprised a range of buildings arranged around three sides of a yard, the west wing containing the cow

house with 12 tyings, a concrete standing, feeding trough with back feeding walk and tubular halters and divisions; the east wing contained a stable with three stalls, a loose box, a fodder room and harness room; the north side of the yard comprised a row of rooms in the centre of which was a two storey tower with access staircase and an arched entrance to the rear yard. The range of rooms to the east and west of the central unit has a continuous corridor along the north side and includes a washing and bottling room and three loose boxes. At 1st floor level there was a loft comprising hay and chaff loft and a granary with three corn bins. There were three loading doors at the north side. There was probably some change in the original planning for the structure as built contains a two-stall stable and only three loose boxes in total.

Along the rear corridor and both sides of the Cow House is a 1 foot 6 inch wide gauge railway track with turntables at intersections and the track running out of the north door of the cow shed. The construction generally is of solid red brick walls one brick (215 mm)

thick in Flemish bond. All the ground floors are covered with brick paving, except in the east wing which are of 215 x 215 mm tiles. The first floor is softwood boarding on 3" x 7" softwood joists. The roof is covered with clay plain tiles on softwood rafters. The roof over the Cow House is supported on timber trusses with iron king rods. In the central tower is an eight day clock, "weight operated, and the roof is surmounted by a cow weathervane."¹

All the windows are standard steel casements, those at the ends of the two wings being semi-circular in three light with brick mullions.

The contract allowed for electrical installation throughout and water points where needed.

Subsequent alterations have included the erection of a boiler house at the rear, the installation of a Churn sterilization bay in the Cow House and a refrigerator in the bottling room. Otherwise the building is virtually as built.

The farm was let to Henry Pillinger in 1936 at an annual rent of £70, the tenant paying the rates. He had previously run the dairy herd at Luxfords and Brambletye Farms. He transferred the business to Kidbrooke and continued to run the milk business from there, procuring milk from the farmer at Brambletye and from his own herd of Guernseys. In 1938 Olaf Hambro sold the property to John Proctor of Court-in-Holms, and Henry Pillinger bought the property in August 1939. His widow and daughter still run the farm and live in the house.²

REFERENCES

1. Sale catalogue of 1938 (vendor unknown)
2. Mrs. H.B. Pillinger and Miss C. Pullinger

FOREST ROW

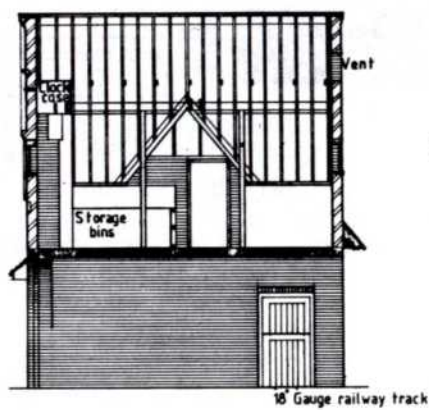
KIDBROOKE FARM



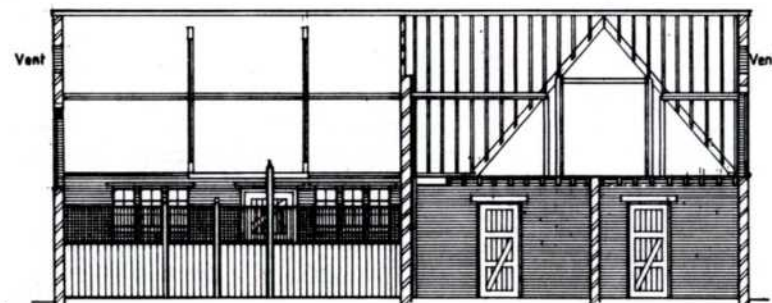
SECTION A-A



SECTION B-B



SECTION C-C

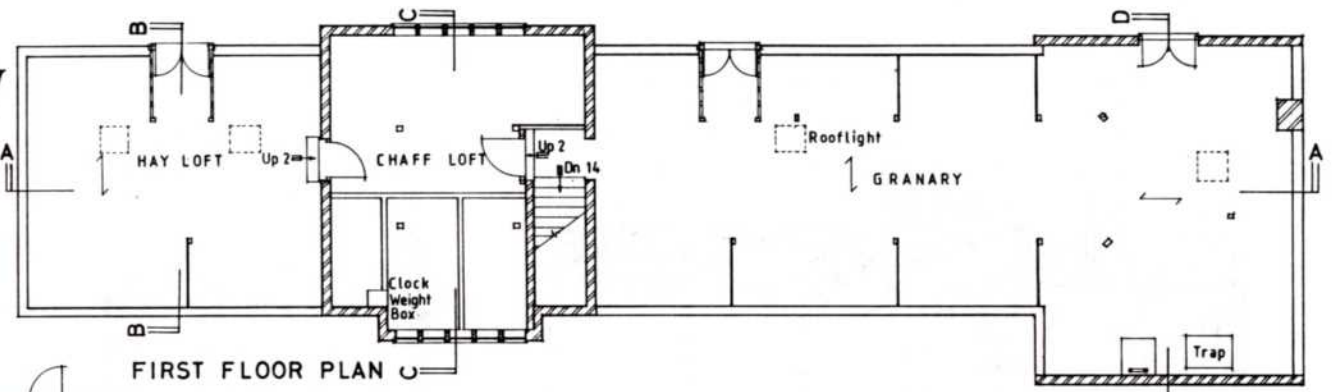


SECTION D-D

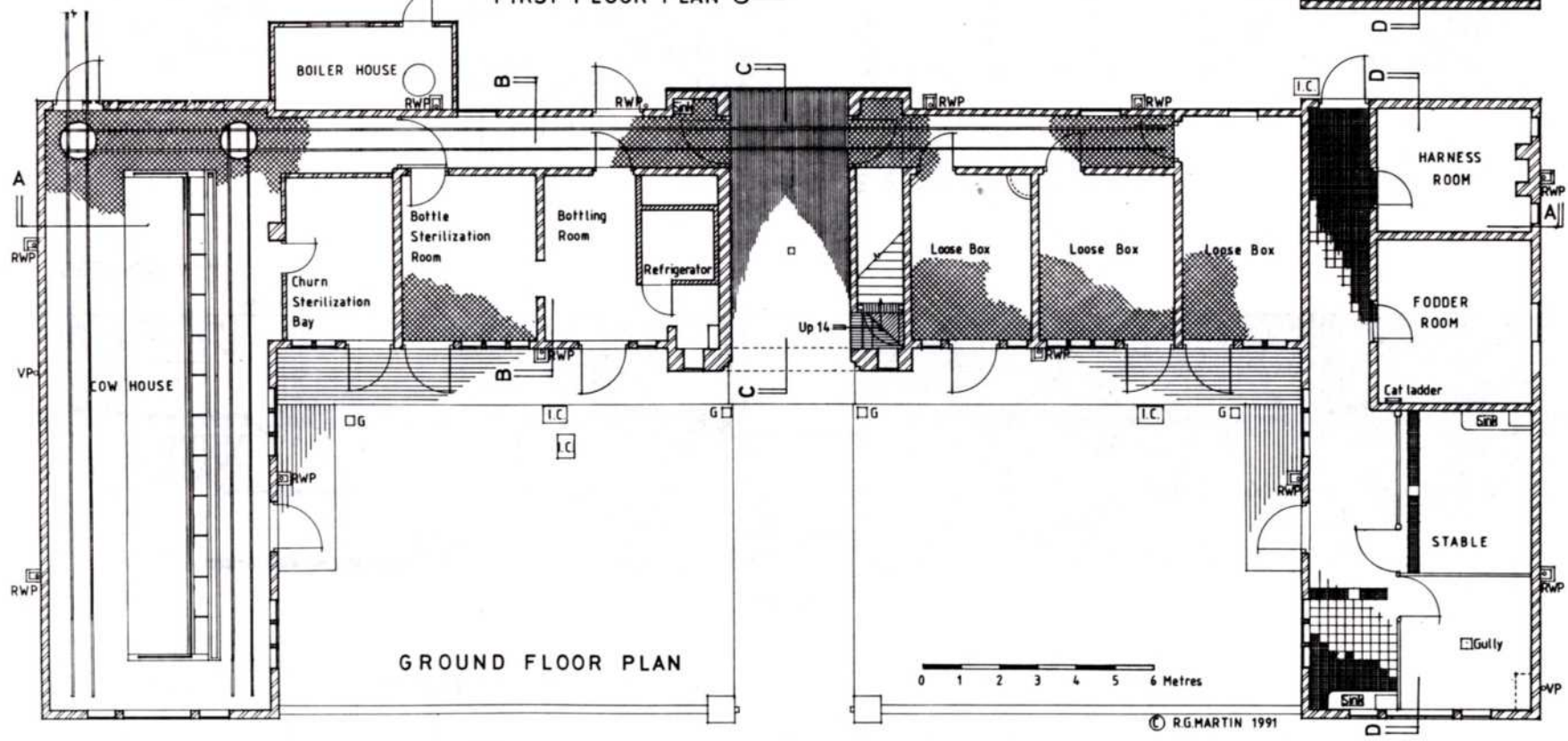
0 1 2 3 4 5 6 Metres

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FOREST ROW KIDBROOKE FARM



FIRST FLOOR PLAN



GROUND FLOOR PLAN

0 1 2 3 4 5 6 Metres

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