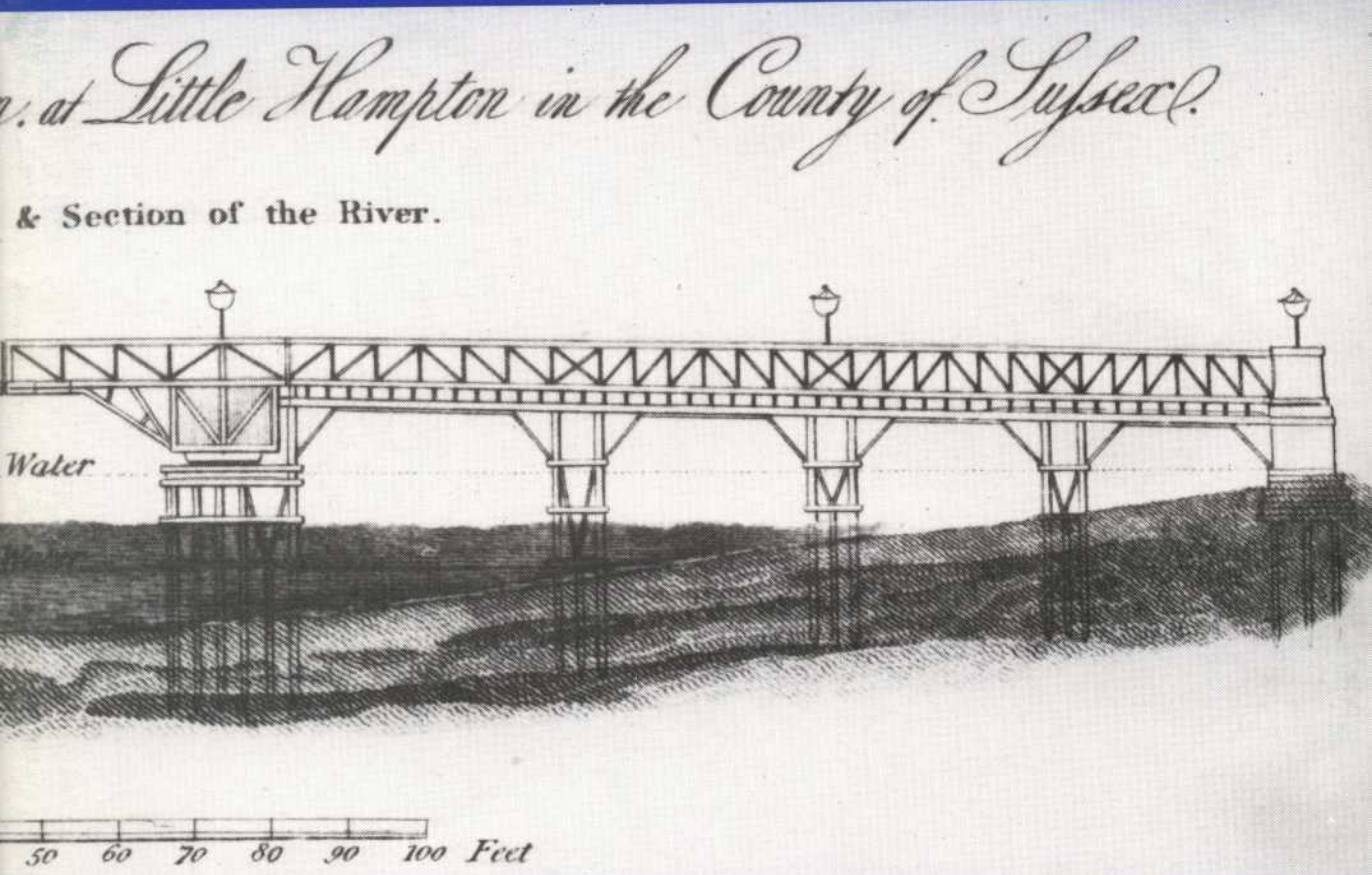
SUSSEX INDUSTRIAL HISTORY

Summer 1971



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SUSSEX INDUSTRIAL HISTORY

Journal of the Sussex Industrial Archaeology Study Group

TWO SUMMER 1971

The cover shows the design of the proposed (but never built) bridge at Littlehampton, 1821-2, from West Sussex Record Office, Add. MS. 12231, by courtesy of the County Archivist.

Edited by John Farrant, Arts Building, University of Sussex, Falmer, Brighton, BN1 9QN. *Sussex Industrial History* has as a principal objective the publication of the results of recording, surveying and preservation of industrial monuments and processes done under the aegis of the Sussex Industrial Archaeology Study Group. But its field is not narrowly defined, for it aims to integrate the findings of industrial archaeology into general historical thinking and writing, by studying the impact of industrial change, principally during the past two centuries, on a rural county. The Editor is very interested to hear from prospective contributors. Future issues will include short articles; and the 'Notes and News' section will include work in progress, recent publications, conferences and similar information.

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Published for the

Sussex Industrial Archaeology Study Group

by PHILLIMORE

MICHAEL WORTHINGTON-WILLIAMS

Dolphin Motors of Shoreham

'IN ACCORDANCE WITH your instructions I yesterday visited your Works at The Old Shipyard, Shoreham, in order to examine your manufacture and methods of production.

The engine you are producing, so far as I was able to judge, is decidedly efficient, and without doubt a very cheap article to produce.

The other branches of your business are all running on satisfactory lines, and I have no doubt will pay very well in the future, when a sufficient market is obtained for their products.

Your methods of workshop management are exceedingly good and there is nothing to criticise in the class of material you are using.

Taking the whole circumstances into consideration, I am of the opinion that, given sufficient capital to get your products on the market, there is no reason why your business should not be a decided commercial success.'

Thus ran the optimistic report dated 5 October 1909 from H.W. Bamber, M.I.M.E., consulting engineer, and commissioned by Michael Sassoon of the Two Stroke Engine Co. Ltd. Within a few weeks the company was moribund. To understand this apparently paradoxical state of affairs, it is necessary to examine both the history of the firm and those concerned with it, and the general atmosphere of motor manufacturing into which it was precipitated, perhaps prematurely, by its enthusiastic young sponsors.

THE MOTOR INDUSTRY AROUND 1907

The anatomy of failure is complex, especially when one is thinking of motor manufacture, and throughout the history of the industry there is perhaps no single common factor (save the ultimate absence of finance) which can be said to have provided a formula for bankruptcy. Even in the Depression of the early 1930s, there were very individual reasons why certain companies succumbed almost immediately, while others managed to struggle on, only to collapse when competitors were recovering in a healthier economic climate, and others, with neither technical nor aesthetic merit, nor apparently adequate finance, did survive and are still with us today.

Sometimes failure can be attributed to one single act of monumental stupidity as in the case of the Argyll company of Scotland, which literally squandered some £200,000 of excess capital on the marble halls of Alexandria, its palatial factory, in 1905, at a time when it had no intention whatever of mass-producing motor cars. Such a factory could only have been justified by an output approaching 5,000 units a year, a figure which the company never came near to achieving.[1] Elsewhere it was lack of direction or a cohesive policy which led to decline, as in the case of Crossley of Manchester, which weakened its bank balance and its reputation by a succession of uneconomic and bizarre experiments and alliances with other 'lost causes'. Clyno could have been the largest motor manufacturer in Britain today. It was, however, over ambitious and undercapitalised, a combination which blended ill with its decision to embark on a disastrous price war with W.R. Morris (the later Lord Nuffield) and which forced down not only its prices and profit margins but also the quality of the cars, upon which its reputation had been built. The Depression finally finished the company off.[2]

The period in which the Dolphin motor car (Dolphin being the trade name adopted by the Two Stroke Engine Company) was conceived heralded an earlier slump in the industry which was by no means confined to Great Britain. In the United States, the empire of Colonel Pope which embraced some five different makes of car built in autonomous factories collapsed in insolvency – only one example of what was happening throughout the continent.[3] Even Henry Ford did not emerge unscathed; having endeavoured to market a luxury car – the six-cylinder model K – he burned his fingers badly and did not build another six-cylinder Ford until 1941.[4] In Europe, Spyker, Holland's largest motor manufacturer, was saved from bankruptcy only by a drastic reorganisation,[5] and in Britain, Argyll, which had been the fifth largest producer, went into liquidation. It too was subsequently reconstructed and managed to maintain production.[6]

Table I: *Number of Firms making Motor Cars in Britain to 1914*

	Number founded	Still existing 1914	Failed before 1900	Failed 1901-1905	Failed 1906-1910	Failed 1911-1914	Total firms existing at end of period
to 1900	59	21	6	18	12	2	53
1901-05	221	22	–	59	112	28	197
1906-10	49	24	–	–	13	12	109
1911-14	64	46	–	–	–	18	113
Total	393	113	6	77	137	60	

Source: S.B. Saul, 'The Motor Industry in Britain to 1914', *Business History*, v (1962), based on G.R. Doyle, *The World's Automobiles* (1953). It is clear that a number of firms are omitted, but they are unlikely to have been any but the very smallest.

Table I reflects the high mortality among firms in the 1906-10 period, and shows that of those established in that period half had failed by 1914 and a quarter by 1910: it was hardly a promising time in which to launch a new company. Certainly money was being invested in the industry, but most of it was being raised for the largest firms by the issue of shares through the established business houses and the Stock Exchange, none of which would have been available to (or interested in) an enterprise as small as the Shoreham-based Two Stroke Engine Company.[7]

'From 1885 to 1895 men struggled to make the car go; from 1896 to 1905 they contrived to make it go properly; between 1907 and 1915 they succeeded in making it go beautifully', wrote Laurence Pomeroy.[8] Certainly there is no evidence to suggest that Dolphin cars went anything but beautifully but what Pomeroy also infers is that by the time the Dolphin made its appearance, the overall concept of the motor car had, to a large degree, been standardised. Whilst such an inference is indeed true to an extent, it requires qualification.

The motor industry in 1909 was, as Pomeroy implies, by no means in its infancy. It had been established for over twenty years on the Continent and (effectively) since 1896 in Britain. Its ramifications were if anything more complicated then than they are today, and both design and use of the motor vehicle had reached a reasonable level of sophistication.[9] The layout of the average medium/large family motor car in 1909 followed the established pattern of a rigid chassis on soft springs (pioneered by Frederick Lancaster), and of an in-line petrol engine frontally mounted and driven through a clutch and gearbox via a propeller shaft to a 'live' rear axle; and, despite its unorthodoxies, the Dolphin followed contemporary practice in all these particulars. Though such a layout was to represent the basic concept for automobile design for over fifty years, that was by no means recognised by all designers of the period: some firms adhered to chain final drive as late as 1910 and steam still attracted a reasonably large following.

Even among the larger producers of petrol-engined motor cars there was a fairly wide diversity of opinion within the broad framework of the standardised concept as to *how* the motor car should be made 'to go beautifully'. 1910 saw Daimler eschewing poppet valves in favour of Charles Yale Knight's double sleeve valve engine, whilst Argyll on the other hand, in 1912, wedded itself, unprofitably as it turned out, to the Burt-McCollum single sleeve valve design. Napier was committed to the six-cylinder engine, whilst Henry Ford was to build nothing but the four-cylinder model T under the Ford name from 1909 until 1927. Lancaster was offering horizontally-opposed engined cars with its own design of epicycle gearbox, and there were of course divers other variants available from manufacturers large and small.

In such an environment, therefore, the makers of a car with so unorthodox a power unit as the Dolphin could put it on the market with a reasonable degree of optimism in competition with a host of other, and equally odd, designs.

THE MEN AND THE PROTOTYPE ENGINE

The Dolphin engine venture was born of the design work of Harry Ricardo, the enthusiasm and commercial drive of his cousin Ralph Ricardo, the money and production skill of his Cambridge contemporary Michael Sassoon, and the draughtmanship (and again money) of another Cambridge friend, Harry Hetherington.

At the time when the Two Stroke Engine Company was conceived, in 1905, Harry Ricardo was an undergraduate at Trinity College, Cambridge. Born in 1885, the eldest child of Halsey Ricardo, 'an architect by profession but an artist by instinct and inclination',[10] Harry developed an intense interest in things mechanical at a very early age. At the age of twelve, he constructed a working model steam engine, at the age of seventeen, in 1902, he designed a steam engine which he mounted on his bicycle, and sold the design to the Liverpool Casting Company. In the same year, his father began to design himself a house at Graffham in Sussex and commissioned Harry to design and build a petrol engine to drive the Hayward Tyler pump which would ensure an adequate water supply. In the design Harry incorporated practical application of the theories which he had heard expounded the previous Christmas in lectures by Dugald Clerk at the Royal Institution.

Clerk, the leading authority on internal combustion engines,[11] talked of the possible advantages which might be obtained by operating a petrol engine with a stratified mixture as opposed to throttling a homogeneous mixture, but admitted that he had not conducted any practical experiments. The intention behind the idea was to eliminate the thermo-dynamically wasteful process of throttling, and to control the engine wholly by varying the quality of the petrol/air mixture within the cylinder. Harry's engine for Graffham ran beautifully within the limits of its intended purpose and he was converted to enthusiastic advocacy of stratified charge operation.

At Cambridge he started to read for an honours degree, concentrating on civil

PLATE I The Engine's Designer & the Car's Mascot.
Left Harry Ricardo and his fiancee Beatrice Hale (whom he married in June 1911) take a roadside picnic, c. 1910.
Above The mascot designed by Halsey Ricardo and fitted to the radiators of all Dolphin cars.

engineering, as his grandfather looked to him to join his firm of consulting civil engineers, Rendel & Robertson. But Ricardo's interest lay in mechanical engineering, and his construction of a 900 c.c. motor cycle engine brought him to the attention of Bertram Hopkinson who had been elected professor of mechanism and applied mechanics in 1903 at the early age of 29.[12] In the summer of Ricardo's first year, 1904, Hopkinson invited him to become his assistant on a programme of research into the internal combustion engine, though at the cost of Harry abandoning the pursuit of an honours degree for that of a pass degree in mechanical engineering. He was thus enabled to benefit to the full from Hopkinson's brilliance and versatility as an imaginative research leader. The research was principally concerned with the design and development of a really light and efficient petrol engine for aircraft, but Ricardo had every facility and encouragement to continue his own work on stratification.

Having read Clerk's classic book, *The Gas and Oil Engine*, probably in 1903, he was considering the possibilities of the two-cycle engine using a separate pumping cylinder. One of the difficulties encountered with engines at this time was their inability to idle, and he set out to overcome this failing. By employing end-to-end 'scavenging' of the cylinder, and by the use of a 'bulb' in the cylinder head through which the ingoing mixture from the pumping cylinder would pass, and which incorporated an atmospheric or 'automatic' inlet valve, through which a charge of air would immediately afterwards be drawn by the downward stroke of the piston, he hoped to obtain sufficient stratification to provide good idling.

A Vee-formation was decided upon for the cylinders of the engine, and the project was discussed, and a prototype embarked upon, with two young men. The first was Michael Thornycroft Sassoon, the son of Alfred Ezra Sassoon of the banking family and Theresa Georgina Thornycroft, whose brother John was a naval architect and founder of the shipyards. Alfred was the first of the family to marry outside Jewry, and was consequently cut off from the bulk of the Sassoon wealth, but on his death in 1895 was able to leave each of his three sons £600 a year and to provide for their education; Michael was thus a gentleman of leisure. He was the eldest son, the second was Siegfried, the poet, the youngest Hamo. Michael and Hamo inherited the strong technical bent of the Thornycrofts, which was quite untraceable in their Sassoon blood. Michael, who in later years said, 'I was born with a spanner in my mouth', was mainly interested in workshop practice, and being a skilled mechanic, indulged this interest to the full in the University workshops and in his own well-equipped workshop at home, Weirleigh in Kent.[13]

The other man was Harry Hetherington, who although reading law was a talented self-taught mechanical draughtsman. He assisted Ricardo in preparing such drawings as were necessary, and since most of the latter's time was spent in research with Hopkinson, Sassoon did all the pattern-making and most of the machining. In a very short time the prototype engine was ready and, after some adjustments, was made to run quite well. It was purchased by Cavendish Brown, an Irishman who lived on an island in Lough Erne, and was installed in a hull of his own design. As a marine engine it functioned perfectly well for several years within the limited speed range required of it.

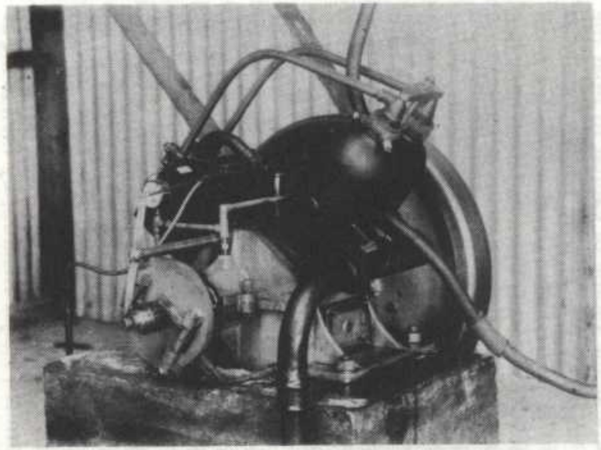
THE COMPANY

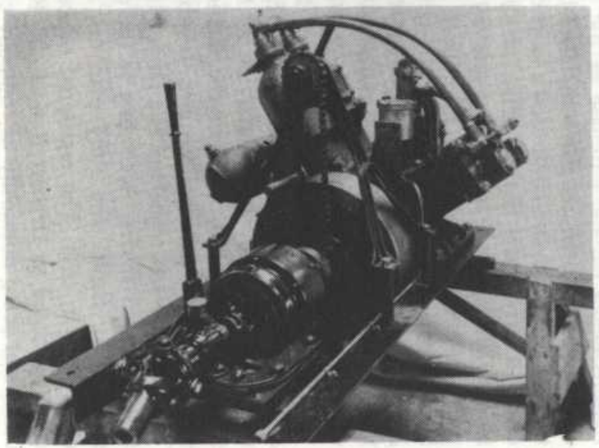
The proposal to go into commercial production came from Ralph Ricardo. Ralph was the son of Halsey's brother, Percy, who had emigrated to Australia in his youth. Ralph had thus experienced in his early years the life of a colonial pioneer, which no doubt contributed to his talent for improvisation and enhanced his commercial instinct. The same age as Harry, Ralph was sent to England for his formal education when he was twelve and lived with the Ricardo household in London. Hence many of Harry's early mechanical ventures were in collaboration with Ralph, until 1902 when Ralph joined the North Eastern Railway as a premium apprentice.[14] But, as Ralph later admitted in India, 'God made me a motorwalla, while man entirely failed to make me a railway engineer',[15] and at the age of 21, he left the railway and joined Arrol-Johnston, the Scottish motor manufacturer, at Paisley, as a driver.[16] He became head tester after a short while, competing in many English and Scottish motor trials, then assistant works manager and finally manager of the Glasgow salesroom where his natural aptitude for the commercial aspects of automobile engineering was put to good effect. He remained there until February 1907.[17]

Having virtually lost contact with Harry since 1902, Ralph appeared in Cambridge in the summer of 1905, and was introduced to Sassoon who showed him the prototype engine on test. Always the optimist, he saw unlimited commercial possibilities in the venture and not long after confided to Harry that he intended to form a company with Sassoon to manufacture the engine and assemble motor cars if Harry would agree to act as honorary consulting engineer and designer. An apprentice draughtsman named Fielding Thornton, whom Ralph had brought from Arrol-Johnston, was to be in charge of the drawing office and act as general secretary, whilst Sassoon was to be production engineer and Ralph managing director and salesman.

Both Ralph and Harry knew the Shoreham area well, having spent much of their school holidays there, and on the strength of this it was decided to place the centre of operations there. A small shipyard in Shoreham High Street, next to the Bridge Hotel and just east of the Norfolk Bridge, was located (TQ 213050), and negotiations began for the purchase of the site and the raising of capital to float the company. The premises (now replaced by an office block) were known locally as the Old Shipyard and comprised a large corrugated-iron shed (built c.1904), a small office, a jetty and a slipway. The last sizeable vessel built there had been launched in the 1880s, the barque *Britannia* by Messrs. Dyer & Co.[18] The immediately previous occupiers seem to have been Messrs. Beebe, Courtney & Scott, yacht builders; they were in possession as late as November 1906, when the motor boat *Lady Ada* was launched from the yard.[19] The firm was presumably connected with Messrs. Courtney & Birkett, boat builders and marine engineers of Southwick, a firm which had been installing marine engines at least since 1902.[20]

The negotiations took longer than anticipated and Ralph stayed with Arrol-Johnston until February 1907[21] and the Two Stroke Engine Company was not registered until over a year later, on 27 March 1908.[22] The intervening period was spent on development work on the engine and in endeavouring to persuade wealthy members of the partners' families to subscribe capital and to place orders for cars. The company was registered as a private limited company, with a nominal capital of £10,000 in £1 shares. According to the only return made, on 19 July 1909, 6,227 shares were issued and fully paid up, £6,077 being received in cash and £150 other than in cash. The registered office is shown as the Old Shipyard and the directors listed as Herbert Rendel, 25 Russell Square, London, who was Harry's uncle and acted nominally as company chairman; Ralph Ricardo, by then living at 22 Victoria Road, Shoreham, an address which he shared with Fielding Thornton, also a director; Michael Sassoon of Homeleigh, Kingston-by-Sea, and Norman Thornton, Fielding's father.[23]





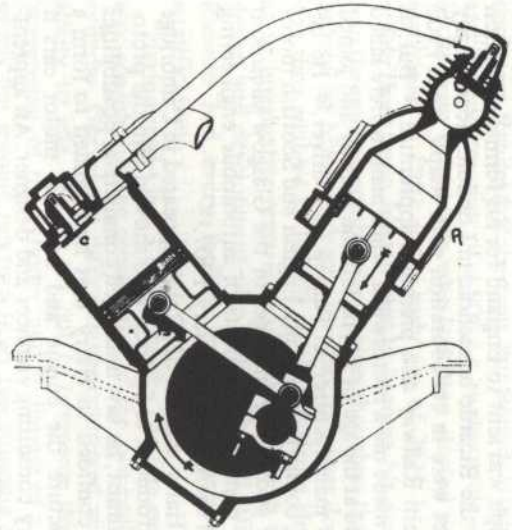


PLATE II

Above left The second or third Dolphin engine built, being one of the two manufactured by Lloyd & Plaister in 1906. It developed 10 h.p. to power the machinery in the Shoreham workshop.

Left A two-cylinder Dolphin marine engine,as used by the Shoreham fishing fleet. Note the modification to raise the starting handle clear of the bottom of the boat. The lever operated the two-speed gear.

Above Section (from *The Motor Car Journal*) through the four-cylinder Dolphin engine showing the pumping (left) and working cylinders.

Some years earlier, during rambles through London, Harry had discovered the firm of Lloyd & Plaister in the Finchley Road, and found that Lloyd and he shared an interest in tackling difficult engineering jobs and in making experimental or prototype machines of all types. They became firm friends, and it was natural that Ricardo should tell Lloyd of Ralph's plans. He was enthusiastic about the project and immediately offered assistance and advice – an offer which was accepted and which was to prove most valuable.

Whilst the legal formalities were proceeding, it was decided to build two engines incorporating various improvements which Harry and Hetherington had suggested following their test of the Sassoon-built prototype. One of these was intended to power the plant in the projected machine shop at Shoreham, the other to be used for testing and demonstration purposes, and both were built by Lloyd & Plaister. A considerable improvement in output over the original engine was obtained, between 15 and 16 h.p. being given at 1,000 to 1,500 r.p.m., and Harry was able to persuade Herbert Rendel, an enthusiastic motorist, to utilize an engine of his design in a car being built for him by Lloyd & Plaister, in place of the originally specified M.M.C. (Motor Manufacturing Company) unit. As the Shoreham works were not yet ready to start production, Lloyd & Plaister undertook to build it also.

Rendel, however, had decided views of his own on how a motor car should be built, and it soon became obvious that with the heavy five-seater body which a Croydon coachbuilder was constructing for him, the two-cylinder Ricardo engine would be hopelessly underpowered (the M.M.C. unit originally specified was rated at 30 h.p.). A four-cylinder version was therefore designed by Harry and Hetherington and built by Lloyd, and the complete car was road-tested in July 1906. It was a great success, and as a result Harry's grandfather, his uncle Arthur Rendel, and his cousin Felix Wedgwood, all placed orders for vehicles, similarly powered, to be built at Shoreham.

By February 1907 limited production of two-cylinder engines intended for a car weighing about 12 cwt. had begun at the Old Shipyard, with the intention to use a four-speed gearbox with direct drive in third and an overdrive in top to provide a speed of some 40 m.p.h. on those few roads which were suitable. The first complete vehicle to emerge from the Shoreham works took some time to construct, due mainly to the restricted manufacturing facilities available, undercapitalisation (the wealthy members of the families, whilst generous with their verbal encouragement to the young partners, were uniform in their reluctance to express their confidence in more practical form) and a diversion into marine engines. This last was by no means illogical, for at that time Shoreham boasted a sizeable fishing fleet.

THE MARINE ENGINES

The prototype engine had already proved that it was capable of marine work, and Ralph brought with him from Scotland a chargehand named Angus whose main hobby was fishing and who in his spare time had often worked with the Clyde herring fishery fleet. It was not long before he had established contact with the local Shoreham fleet and had persuaded many of them to fit two-cylinder 9 h.p. engines to their boats. The stratification technique employed by Ricardo in his design enabled the engine to run at 'tick-over' speed only, for hours on end, and this was ideal for the handling of drift nets. In addition boats fitted with the engine (which had a forward speed of 6 knots) need not wait for the flood tide to carry them through the narrow harbour entrance, which effectively precludes any reliance on sail to contend with the ebbing tide. Many a master must have missed the market with his catch through waiting for the tide to turn.

It says something for Angus's powers of persuasion that he was able to convert the fishermen, 'at first sight a rather forbidding lot',[24] to the idea of petrol propulsion. Engine power for small coastal craft was by no means generally accepted, and the internal combustion engine was only just beginning to replace steam in those which had any engines at all. Fire at sea was, and still is, a very real danger, and even in 1912 when the first petrol engine, a Kelvin four-cycle type of 13 h.p., was introduced to the Hastings fishing fleet, considerable pressure had to be exerted by its advocates to overcome the scepticism of the fishermen concerning its ability to perform as required and any tendencies it might display towards self-ignition. In the event, its detractors were almost proved correct on the second count on its maiden voyage, but the conflagration was averted and the engine vindicated itself to such a degree that by 1914 about thirty Hastings boats were motor powered.[25]

Because steam had been the accepted marine motive power for nearly a century, the published returns from the statutory register of fishing vessels even in 1913 made no distinction between steam and petrol engines. So far as small boats are concerned, however, steam is totally unsuitable other than for pleasure craft, and it can reasonably be assumed that the figures under the heading '2nd class steam' in table II do in fact relate to petrol-engined boats.

Table II: *Fishing Boats Registered at Shoreham 1905-1913*

As at 31 Dec.	1905	1906	1907	1908	1909	1910	1911	1912	1913
1st class sailing									
Number	7	9	13	13	12	11	12	12	13
Tonnage	139	198	290	290	275	259	283	302	283
1st class steam									
Number								1	1
Tonnage								37	37
2nd class sailing									
Number	63	57	52	49	40	37	36	34	32
Tonnage	492	427	400	372	337	326	314	300	285
2nd class steam									
Number	1	2	4	6	10	9	10	12	13
Tonnage	7	3	8	14	24	26	31	33	30
3rd class sailing									
Number	107	115	134	139	138	140	135	131	128
Tonnage	144	163	195	199	204	212	206	201	200

1st class: over 15 tons burden. 2nd class: 15 tons or under, but over 18 foot keel length. 3rd class: under 18 foot keel length.
Source: British Parliamentary Papers, *Annual Statements of the Navigation and Shipping of the United Kingdom.*

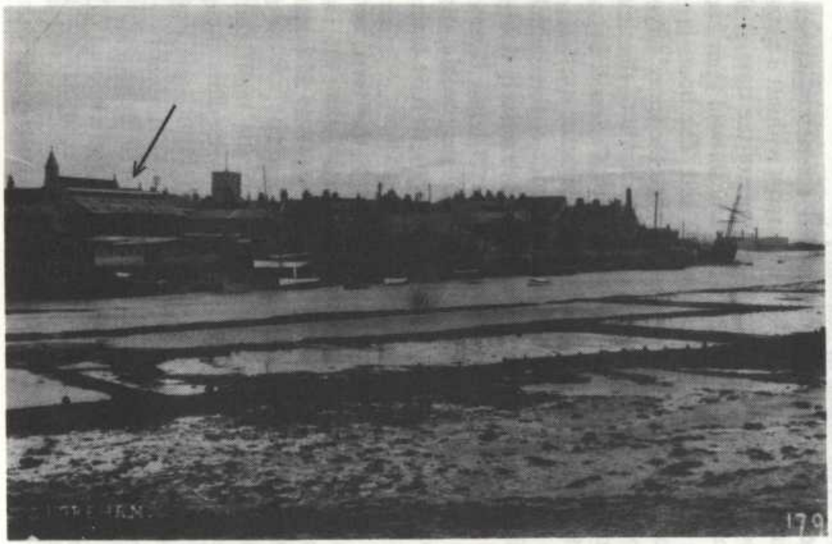
The table shows that during the period 1905-13 the number of 1st class vessels almost doubled whilst 2nd class boats of the type which would have favoured the Dolphin engine were almost halved. Petrol-engined vessels of this class show a steady increase with the largest rise between 1907 and 1909 when the Dolphin made its appearance. In the latter year powered boats represented 20 percent of the 2nd class vessels, though the figure should be viewed with regard to the decline in sailing vessels irrespective of those fitted with engines. Harry Ricardo states that when he revisited Shoreham in 1919 the fleet had been entirely dispersed and the town became a popular holiday resort with the fishermen finding it more profitable to cater for the needs of the holidaymakers than to fish. The steady increase in small sailing boats in the table gives perhaps a preview of the trend away from serious fishing and towards pleasure craft. Ricardo also says that almost all the fishing boats in which engines were installed were of similar size and design, 30 to 38 feet long with a beam of 8 or 9 feet, which would indeed place them in the 2nd class.[26]

Competition in the marine engine market was becoming very fierce by 1908, although engines had scarcely begun to penetrate the small boat market, and well over 50 manufacturers were offering a variety of designs in Britain. To combat this, and in an endeavour to retain the foothold it had secured in Shoreham, the Two Stroke Engine Co. maintained a steady stream of advertisements in the marine press throughout 1908 and 1909, and indicated that its engines were suitable for powering not only fishing boats, but also racing boats, yachts, hydroplanes, barges, and for use in factories and garages.[27] Whilst racing may appear to have been beyond the capabilities of the Dolphin engine, which owed its success to the ability to idle slowly, it only competed within its own class and there is no evidence to suggest that it was not evenly matched. Ralph was a member of the Sussex Motor Yacht Club and entered his small boat *Dolphin,* fitted with a Dolphin engine, in the 6½ metre race during the annual regatta in July 1909.[28] Whilst it did not distinguish itself against its four-cycle rivals, a 12 h.p. Dolphin-engined vessel delivered to a Mr. Rolf of Brighton in the previous month and tested by the staff of *The Motor Boat* was 'found equal to the four cycle engine in flexibility'.[29]

Suitably encouraged, the company commenced a series of rather flamboyant advertisements containing lines such as: '. . . nine races without a spanner' and 'it's done in Shoreham and Shoreham only'. In the manner of the time, it also endulged in poetic plays on words: '. . . were Dolphin-like and showed their backs to all the boats that raced with them' (Shakespeare, revised) and 'The boats are darting o'er the curly bay and sporting Dolphins race them through the spray' (Byron, revised). The plagiarism was sometimes not even original: 'The *engine* of the time shall teach me speed' (after Shakespeare) had been used by Capol, Carless & Leonard, purveyors of petroleum spirit, without the substitution of engine for spirit.

Table III indicates the whole range of Dolphin marine engines which (theoretically at least) were available in November 1909, but it is extremely doubtful whether all these models were in fact made, particularly the larger types. It was the practice for small firms to offer a very wide range in the hope that they would attract customers, and the economics of small production runs appears to have been a secondary consideration.

Four other British two-stroke designs were offered at this time, and among the lower horsepower models, only one was more expensive that the Dolphin. The 3 h.p. Ajax retailed at £40, the Boulton & Paul 2 h.p. was only £18 against the Day 2 h.p. at £44. The smallest Marmot model, 5 h.p., cost £91. Of the foreign two-strokes available, Fairbanks-Morse from America was the main competitor (its 2½/3½ h.p. model cost only £26), with all its models considerably cheaper than the Shoreham products. The same was true of the Mitcham, Primus and Regent engines. It should be remembered that these competitors utilised the simpler two-stroke principle of crankcase compression (which was eschewed at Shoreham and replaced by the separate pumping cylinder) and at least one (the Regent) could offer only hot bulb ignition. It is probably fair to say that the Shoreham customer got what he paid for by way of quality and enhanced flexibility.



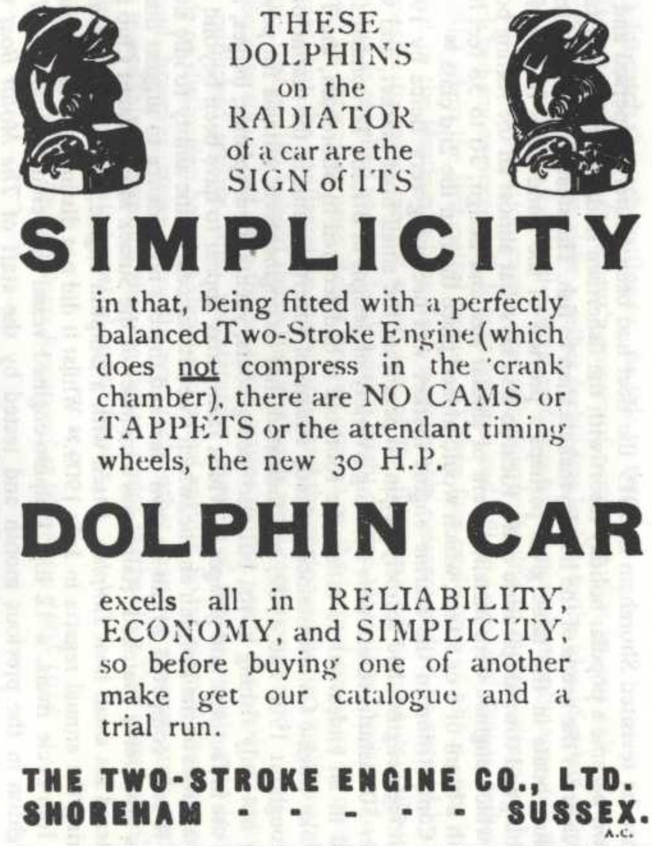


PLATE III
Above View of Shoreham across the harbour from the west end of the Norfolk bridge, c. 1909. The corrugated iron shed, with THE TWO STROKE ENGINE CO. LTD., MOTOR CARS MOTOR BOATS on its roof is arrowed.

Right One of the few advertisements for the Dolphin car to appear.

Table III: *Dolphin Marine Engines Advertised in November 1909*

Horsepower	Number of cylinders	Bore and stroke	Speed (r.p.m.)	Price
3	1	3½ in. x 4 in.	800	£62.10.0
4½	1	4 in. x 4 in.	800	£65
6	1	4½ in. x 5 in.	800	£68
9	2	4 in. x 4 in.	800	£103
12	2	4½ in. x 5 in.	700	£135
24	4	4 in. x 4 in.	800	£196.15.0
36	4	4½ in. x 5 in.	800	£214.15.0
30	2	6 in. x 8 in.	400	£198
60	4	6 in. x 8 in.	400	£304

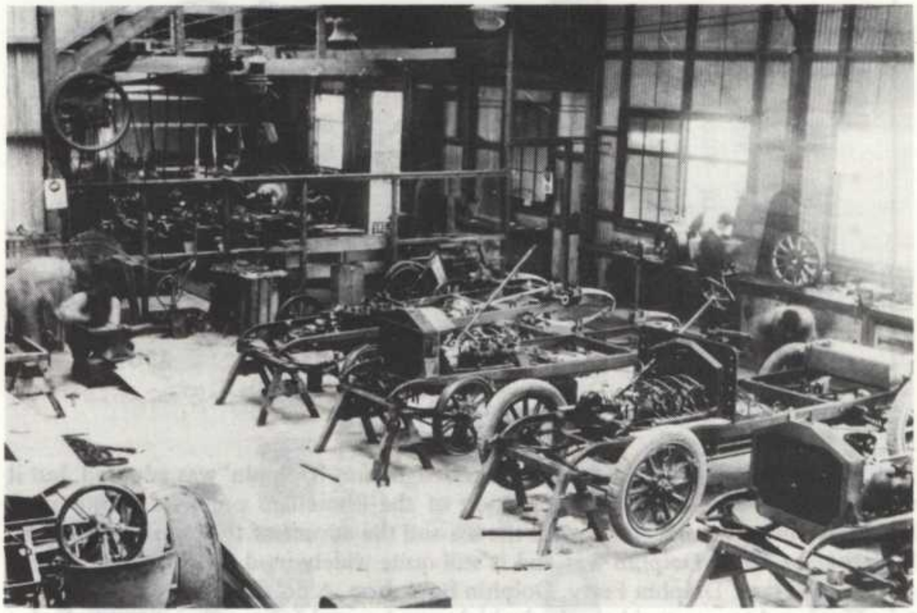
Source: *The Motor Boat*, 11 November 1909

It is difficult to say when exactly the designation 'Dolphin' was adopted, but it was probably only after the occupation of the Shoreham premises. Quite apart from the obvious connections with the sea and the advent of the marine side of the business, the name Dolphin was and is still quite widely used in the Shoreham area – Dolphin Hard, Dolphin Ferry, Dolphin Bookshop. A dolphin is also a name given to a buoy and to a quayside bollard which may be used for warping ships through a harbour's mouth against the tide. An explanation of the name's adoption by the firm is given by Ralph Ricardo's daughter. In her possession is a photograph of an ornate carved wooden panel over a mantel, below which were painted a series of leaping dolphins.[30] She recounts that Ralph visited the house in Shoreham where the mantel stood and was inspired by the painting. Certainly the dolphins which are illustrated in the marine advertisements follow exactly the shape of those on the mantel, whereas those used in the motor car advertisements are the more stylised version designed and cast in bronze by Halsey Ricardo for the radiator mascot,[31] which was the only identifying emblem the cars carried.

PRODUCTION DETAILS AND PRICES

Unfortunately the firm's penetration of the local market for marine engines was limited – perhaps few fishermen could find the requisite £100 for engine and installation – and the firm was not in a position to compete with the larger manufacturers when it came to spares and servicing. Hence attention gradually returned to motor cars. It had been the original intention to market a car of only 12 cwt., but the cars ordered by relatives all followed the specification of the successful car constructed for Herbert Rendel, and two other orders, from a local butcher and a Brighton jeweller, also required the use of the larger four-cylinder engine which was rated by the R.A.C. at 25.8 h.p. No one seemed to want the 15 h.p. two-cylinder model and so apart from the prototype, which Harry Ricardo used as personal transport for ten years, no other cars of this type were constructed.

About this time, Ricardo replaced the spring-loaded poppet valves of the original design with a thin sheet metal 'reed' valve of copper alloy supplied by the Metallic Valve Co. of Liverpool, and this allowed the output of the two-cylinder engine to be increased to 19/20 h.p. with an increased engine speed of nearly 1,800 r.p.m. The new valves were less susceptible to fatigue and corrosion, imposed less restriction on the flow of air and were markedly quieter in operation. Possibly more than any other single improvement they contributed to the viability of the Dolphin engine as



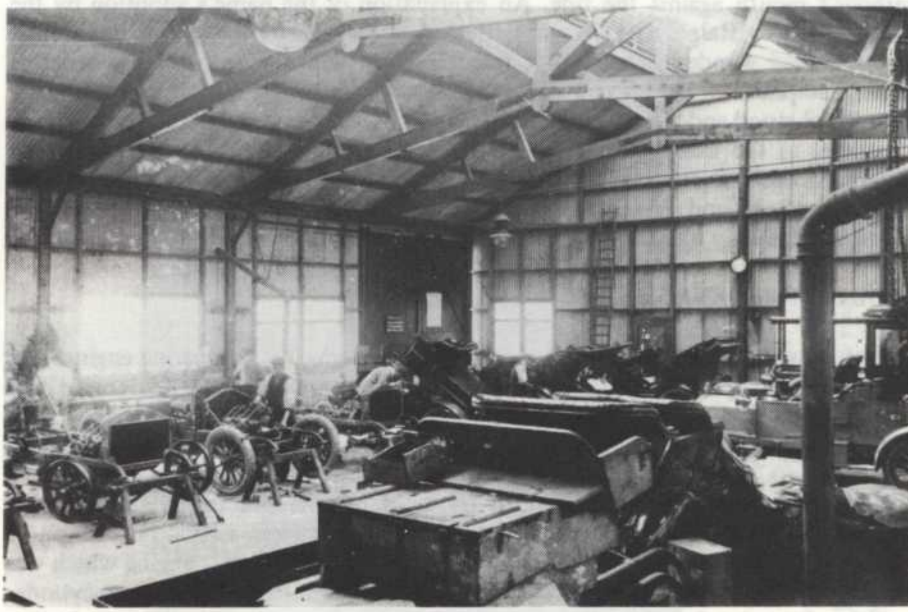


PLATE IV Two views of the interior of the Shoreham works, c. 1909.

Above On the bench by the window is a small single-cylinder Dolphin engine, and leaning against the partition is an early motor cycle. The car in the left foreground is probably the 15 h.p. prototype.

Below The car on the right seems to be complete; the closed car behind it is not a Dolphin. Note that the two radiators and mountings on the trestles are different.

the prime mover for a competitive, commercially produced motor car.

In his autobiography, Ricardo expressed the opinion that eight four-cylinder cars were constructed in all, of which Sassoon had one, a friend of Hetherington's another, the eighth being kept as a work 'hack'. The two photographs of the works (Plate IV), both taken on the same occasion, as the chassis are at the same stage of construction in each, suggest that this figure is perhaps on the low side. Five chassis (supplied by Thornycroft, which had been building vehicles since 1903 at Basingstoke)[32] are shown laid down on wooden trestles, four of them fitted with four-cylinder engines. Two other chassis frames are stacked awaiting use: three cars are in the process of being bodied, and there is one complete car. In addition there is a further chassis of apparently lighter construction (possibly the works car or the 15 h.p. prototype) fitted with less elaborate front wings, steering gear and 'test' seat. Assuming that Herbert Rendel's car was not on the premises, it is quite possible that twelve cars with the larger engine were built, plus the two-cylinder model.

1908 saw the first Dolphin advertisements in the national motoring press and a four-cylinder chassis of 28 h.p. was exhibited at Olympia in the October. The principle employed was identical to that of the earlier engines and the design was reported in detail in the *Automotor Journal, Autocar* and other publications.[33] Priced at £500, the 1908 five-seat model boasted dual high-tension ignition, a multi-plate clutch ('of the type used in cranes and disappearing guns' said *Motor Car Journal*, and incorrectly described by *The Motor* as being of single-plate type) driving through a four-speed and reverse gate-change gearbox. The combined radius and torque rods were built up in lattice style to allow a 'whip' when the wheels travelled over uneven ground, and removal of a panel at the rear of the differential casing permitted the withdrawal of the axle sections on each side. A glass sight feed on the radiator permitted the circulation of the water to be seen quite clearly when the engine was running. Lancaster is generally credited with this idea, and it was a hall-mark of Lancaster motor cars for many years; the writer knows of no manufacturers other than Dolphin and Lancaster which used it. The carburettor was fitted with two mixing chambers, both with a common float feed supply, and each jet supplied fuel to a pair of pumping cylinders. The water pump, magneto and distributor were all driven by Skew gear from the four-throw crankshaft.

The 1909 Olympia show saw the Dolphin exhibited once again in four-cylinder guise, although an announcement was made that the 15 h.p. model fitted with two-cylinder engine was about to be introduced (in fact it never was). A price of £400 was quoted for the smaller model and the 28 h.p. car could still be obtained for £500. Only minor changes in the latter were reported, including a steering column with adjustable rake (within limits), a ball-bearing gearbox and a twin rear-wheel braking system comprising pedal-operated internal expanding and hand-operated external contracting bands.

It was also reported that experiments were being carried out in connection with the construction of a special two-stroke design for use in aircraft.[34] Ricardo confirms that this work was largely the result of Hopkinson's enthusiasm for flying, but the power-to-weight ratio problems could not be overcome, and following this initial press release nothing appears to have come of it, though he and Hetherington worked on designs during their spare time.

The 1909 show was the last attended and indeed coincided with Bamber's report which was quoted at the beginning of this article and which, as will be seen, heralded the cessation of production. But technically at least Dolphin cars were available in 1910, for they appear in the buyer's guides, though there is some difference in the prices quoted. *Car Illustrated* gave a figure of £400 for the 15 h.p. chassis whereas

Stone & Cox and the *Red Book* gave £230; the majority of journals consulted priced the 28/30 h.p. car at £500 (as did the company's advertisements) whilst the *Red Book* stated £445. The *Red Book* also included Dolphin in its 1911 edition. It is not uncommon to find defunct motor manufacturers living on in the pages of contemporary buyer's guides; this can make difficult the historian's task of ascertaining production years.

Although the formal dissolution of the company was not until August 1911, the end of production was marked by the following pathetic little announcement in *The Motor Boat* for 18 November 1909:

> MARINE MOTOR BUSINESS FOR SALE AS A GOING CONCERN; ON RIVER FRONTAGE. GRAND OPPORTUNITY FOR GENTLEMAN WITH CAPITAL OR A COMPANY. GOOD CONNECTIONS AND PROSPECTS. PRESENT WORKING STAFF WOULD REMAIN WITH PURCHASERS. APPLY TO BOX 263 THE MOTOR BOAT.

THE FAILURE OF THE ENTERPRISE

A variety of factors can be seen to have contributed to the demise of the Two Stroke Engine Company, and these will be discussed under five heads.

1. *Methods of Manufacture*

Ricardo states that the last few cars built were perhaps the most tedious and difficult, mainly due to troubles with outside suppliers. The tiny works was unable to manufacture the cars *in toto* and did rely to a considerable extent on 'bought out' parts of proprietary manufacture. The suppliers of these were also supplying larger and more influential concerns with similar items and were constantly making modifications to suit the requirements of those larger customers. This situation naturally resulted in design and production difficulties for the Shoreham directors who were having to re-design their own chassis to cope with the modifications, a costly business. In addition, each car was hand built, no attempt being made to achieve interchangeability of parts, and therefore all spares had to be made individually.

Whilst it was by no means unusual in 1909 for small motor car firms to buy in their major components (chassis, engines, gearboxes, back axles and steering gear, etc), it was not as widespread as in, say, 1919-20. A concern as small as Dolphin was indeed able to undertake the production of its own, relatively complicated, design of engine, and in fact in the period up to the First World War any small engineering firm with access to foundry facilities could manufacture rather than assemble cars; hence small manufacturers proliferated.

On the other hand, larger manufacturers were taking steps to ensure interchangeability of parts, and in America in 1902 Oldsmobile had achieved a degree of mass-production and standardisation which allowed production of 2,100 units, rising to the then incredible figure of 5,000 in 1904.

The problem of spares applied equally to the marine engine side of the firm. The marine engine industry for larger vessels was at a similar level of sophistication as the motor car industry, and firms like Kelvin, Thornycroft and Parsons operated through a countrywide network of dealers and agents, which was being developed to provide service and spares for the small engines suitable for coastal craft.

2. *Lack of Local Support*

One aspect of the Dolphin story is unusual. Whilst other regional manufacturers were often successful in building up an enthusiastic local following, which would keep them in business for longer than would have been the case in areas of keen competition (i.e. Coventry, Wolverhampton, London), the Dolphin cars appear to have attracted little or no attention in the area in which they were built. The marine engine did, it is true, enter what was effectively a captive market, but it was strictly limited in extent and could not be relied upon to sustain the business.

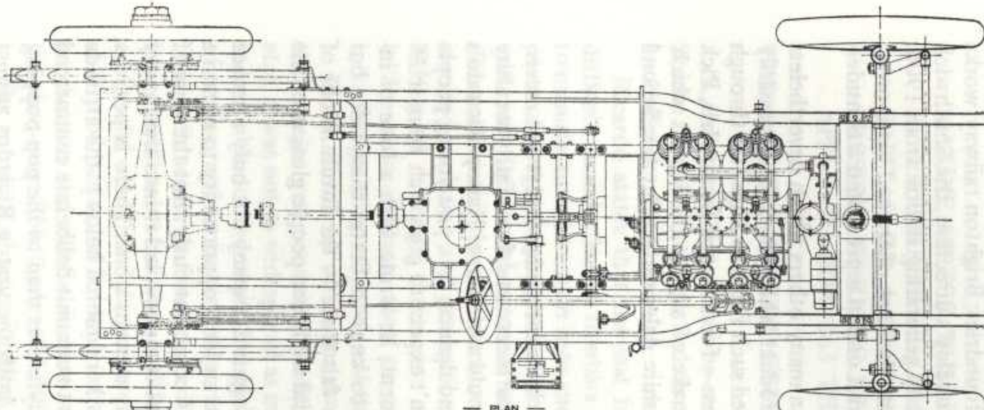
None of the directors had a locally known name nor had had any business connections with Shoreham before the Dolphin venture, and the choice of site seems to have been dictated by sentiment on the part of Ralph and Harry. On the other hand the choice may have been as good as any could have been. Shoreham, Brighton and district had a fair number of engineering works and foundries; Brighton railway works had reached very high standards of work under Stroudley's direction, the Southwick gas-works dated from 1870 and the adjacent electricity generating station from 1906. If the firm had expanded, there would have been no shortage of trained manpower. Brighton as a fashionable resort only an hour from London represented a considerable market for a quality motor car.

The site at Shoreham was thus more suited than many others which nevertheless managed to foster a local enthusiasm for their product which was not necessarily supported by economic arguments and which enabled such firms to linger on through the 1920s offering thinly-veiled Edwardian designs – for instance Scout, Iris, Pick and Clyde.[35] Perhaps the most famous regional make of all was the Jowett which probably never lost its affiliation with the Yorkshire dales until after the Second World War.

3. *The Lack of Family Support*

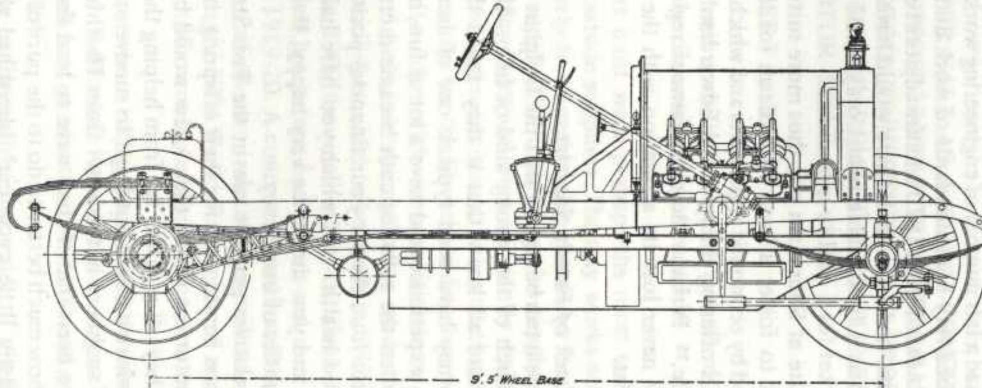
Perhaps it can be argued that the Dolphin would have succeeded had it not received too much of the wrong kind of help. All the partners came from fairly wealthy families and all knew that if they failed they would not starve. Halsey Ricardo's attitude may have been typical: one of amused indulgence: '. . . you young people will gain experience and have a lot of fun, but don't expect to grow rich from it'.[36] Later, when the calls for cash became more frequent, he wrote with a tone of indifference: '. . . As for your financial position, you know it better than I do, but given good health – of which you have had your fair share – the future is one of promise and you should be very happy'.[37] Thus did well-bred people gloss over the harsh realities of insolvency.

The relatives perhaps saw in the Two Stroke Engine Company not only a source of harmless amusement for their offspring, but also an ideal opportunity to obtain a cheap motor car which they knew would be built conscientiously. But the type of vehicle they all wanted, far from helping the infant company, led it into the luxury market where it could not hope to survive on family custom alone. There is perhaps a hint of snobbery in the letter from Thornton's father (quoted below): the attitude may have been that if they were to lead the boys to commit deliberate commercial suicide, how much better to do to the purr of four cylinders than to the pop-popping of a 'beastly little cycle car'. Lloyd had warned both the young Ricardos against entering the luxury market, and he should have known for he was making bespoke motor cars from 1900 to 1911 under the names of Hurst & Lloyd and Lloyd & Plaister–and it was he who adapted the Dolphin principle successfully to the cycle car. The tragedy was that the design was sound but no one took the young engineers really seriously and the whole episode was looked upon as being merely a stepping stone, a transitional period, in their careers, and so indeed did the participants view it in later life.



— PLAN —

26 H.P. R.A.C. DOLPHIN CHASSIS.



— SIDE ELEVATION —

26 H.P. R.A.C. DOLPHIN CHASSIS.

PLATE V Plan and elevation of the four-cylinder Dolphin chassis. Note the massive separate gearbox and the flexible latticework allowing the transmission to negotiate uneven ground without undue stress on the propellor shaft.

4. *The Lack of National Support*

Whilst the conventional four-stroke engine proved itself capable of considerable development, by 1911 the Dolphin engine had been improved as far as *then* seemed possible and did not appear to offer much scope in competition with its rivals. It also suffered from an inherited British prejudice against two-stroke engines which can, in part, be attributed to the pre-motor car era.

The two-cycle principle was first employed in Britain during the late nineteenth century by stationary engine manufacturers at a time when ignition systems (largely by hot tube) were crude and unreliable. By the time the Dolphin design appeared, these early problems had been largely overcome, but it was a question of 'give a dog a bad name' and the British public in fact did not accept the two-stroke engine in any appreciable measure until the advent of the Trojan – developed by Leslie Hounsfield in 1913-14 but not marketed commercially by Leyland until 1922.

In sharp contrast, American two-stroke engines outnumbered four-stroke by twenty to one, in the stationary and marine field, if not that of the motor car, during the Dolphin period, and this for a simple reason.[38] Two-stroke development in the U.S.A. was relatively late, and by the time it was introduced, ignition systems were reliable. It therefore did not suffer the maladies which attended its earlier European counterparts and inherited no prejudice from dissatisfied operators of an earlier era.

Whilst eccentric designs of motor cars continued to appear after the first war, they were far more common in the 'veteran' period up to 1918. It is significant however that British two-strokes were distinguished by their absence before 1922, and apart from the Dolphin and its derivatives and the prototype Trojan, very little is documented (the Hampton & Weston cycle cars of 1914 employed similar two-cylinder engines, but were built in very small quantities).[39] The survival rate is very low indeed, and the only other car known to the writer is a Cooper, built by the Cooper Steam Digger Company of King's Lynn in 1909-10 and now owned by a member of the Veteran Car Club.

5. *Undercapitalisation*

By the time Bamber's report was prepared, the directors were thoroughly disillusioned and even the ebullient Ralph was beginning to lose interest. Their feelings are perhaps summarised in the following letter which Thornton's father (one of the directors) wrote to Ralph after receiving a copy of Bamber's report:

'Brookside',
Seaton Farm,
Dudley R.S.O.,
Northumberland.

6.10.09

Dear Ralph,

Fielding read me part of the contents of your letter of yesterday's date. You say Sassoon had an *expert* to see the works and that he is constrained to pass an opinion that 'we are fools' not to go on. Perhaps we are, and *bigger* fools if we go on, and I would think more of this expert's opinion if he had advised us to close down *at once* under the circumstances.

If money can be found before Saturday, we go on – if it *can't*, then we close down *for certain.* I for one shall be extremely sorry to see the show bust up, but I cannot allow things to go on under our rotten financial position.

Fielding and myself hold practically half the shares, and Mr. Rendel will also stick to what he said about closing down and therefore this point will be carried at the meeting.

If a sufficient sum can be got together, F. and myself will be prepared to put in something like £1,500 altogether. As this sum is of course inadequate in itself for the successful carrying on of the concern, it – or rather the promise of it – will be withdrawn by Saturday unless the other (or new) shareholders are prepared to come forward.

I have requested F.W. to take immediate steps for closing down and selling off on his return to Shoreham. No! we are not fools to close down if things don't immediately take a better turn.

Our assets will about pay our debts and we will fail honourably if we have to fail. Every day we go on we get further into debt. To be quite candid with you I am not satisfied that you are doing right in wishing to go on – unless you are prepared to increase your own holding.

Naturally you have your salary to think of, but that is a matter for the shareholders to decide, and I am determined that we shall carry out what I have written.

My advice to you is to approach your relatives without delay and see what can be done if you want the company to carry on. £5,000 is wanted and to this F. and self will add £1,500 between us.

F. has himself to look after and it is against his own interests to waste further time with a company which is under-capitalised. This is the advice I give to you if you care to take it; I have thought things over very carefully and I have come to no other conclusion but that we will be 'big fools' to go on unless this £6,500 can be found, and found at once.

If I had money of my own I would not be frightened to invest it with the company for I have an idea something good can be made of the engine.

I am exceedingly sorry I am obliged to write to you in this strain and you must believe me when I say that this course will be taken in the best interests of all concerned – including yourself.

The engine will be ready for her trial trip tomorrow.

With regards, etc.

Norman M. Thornton.

P.S. Show this to Sassoon.

DEMISE, REBIRTH AND VINDICATION OF A DESIGN

In the event, manufacturing ceased as it was no longer, perhaps had never been, an economic proposition to continue, but the Dolphin design did not die. Ricardo was able to enter into a licensing agreement with the Britannia Company of Colchester which built a range of stationary and marine engines of 4 to 30 h.p. and also with Browett Lindley of Manchester which concentrated on small electricity generating plants of 2 to 10 kw. Both companies did well with these until the 1914 war.

On the motor car side, Lloyd & Plaister adapted the principle to a smaller 72 x 95 mm engine (the 15 h.p. Dolphin was 102 x 102 mm) which was installed in a cycle car of the firm's own manufacture called the Vox. This enjoyed a certain popularity during the 'New Motoring' or 'Cyclecar Craze' of 1912-14, and some fifty or so were built.

In June 1909 Ralph had married Doris Colbourne Baber, daughter of a Brighton merchant (a Dolphin was used for the wedding and the honeymoon),[40] and the need for him to secure a more regular income no doubt contributed to the crisis in the firm's affairs coming when it did. Late in 1909 he joined the London General Omnibus Company, soon moved to W. White & Co., consulting engineers of Westminster, through which he emigrated to India in 1910 to become workshop superintendent of the Morvi State Railway. In the workshops, and with Indian labour, he built a motor car called the Morvi, and later became managing director of the Automobile Company of Bombay, a founder member of the Western India Automobile Association and chairman of the Motor Traders' Association of Western

India. He returned to England in 1932 and settled near East Hoathly; in the remaining years before his death in 1939, he pioneered a battery chicken farm and housebuilding in pre-cast concrete.

Harry Ricardo had been with his grandfather's firm, Rendel & Robertson, since the summer of 1907 but retained his interest in internal combustion, maintaining his own programme of research, initially in a garden workshop at Walton-on-Thames and later in his research laboratory at Shoreham which still flourishes. He was elected a Fellow of the Royal Society in 1929 and was knighted in 1948.

Michael Sassoon died in 1969. After the failure of the Dolphin enterprise he had moved to Thornycroft as an apprentice and then emigrated to Canada;[41] on his return to Britain he founded a successful agricultural machinery business. His son was for a time curator of the Tank Museum at Bovington Camp: during the First World War Harry Ricardo worked on the development of the engine for the first tanks.

The working principles of the Dolphin engine are sufficiently unique to warrant recording here.[42] Assuming that there is an explosion charge already in one of the working cylinders, upon this being fired, the piston is driven down, and at the same time the pump piston is drawn downwards. The latter action draws in a further charge from the carburettor through a valve. When the pump piston is at the bottom of its stroke it then rises and compresses the gas in the pump cylinder, causing the valve to shut and driving the compressed mixture through the crosspipe to a valve in the working cylinder. When the piston in the latter reaches the end of its power stroke it uncovers ports in the cylinder walls, allowing burnt gas to escape, and as soon as the pressure due to exhaust gases is removed, the inlet valve opens, admitting a fresh charge to the top of the working cylinder. The setting of the engine is such, that the pump piston starts its return stroke before the working piston has finished its outward stroke, and consequently it begins to deliver its charge of mixture whilst the exhaust ports are still uncovered by the working piston. Thus the incoming charge forces the exhaust gases out of the exhaust ports and ensures complete scavenging of the latter. This continues until the pump piston reaches the top of its stroke, this coinciding with the coverage of the exhaust ports by the working piston. The working piston then compresses the new charge, is fired in the normal way and the cycle commences again.

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Research on the Two Stroke Engine Company began in 1967 when I was gathering material for an article 'Sidelights on Sussex Motor History' which appeared in *Sussex Life*, iii (November 1967). An earlier version of the present article appeared in three parts in *Veteran Car*, spring, summer and autumn 1969. Sir Harry Ricardo's autobiography, *Memories and Machines: the Pattern of My Life* was published in 1968 and contains a chapter 'The Dolphin Venture'; inevitably some of the material in this article appears therein. I have, however, used independent sources of information to check the facts which I present, and in some cases my conclusions do not agree with those in Ricardo's book. I have been fortunate in having had made available to me Ralph Ricardo's papers and photographs, and since I have been intimately concerned with the history of the motor car for the past sixteen years, I have at some points drawn conclusions based on general knowledge acquired during that period. The following references are for statements of fact not covered by the sources mentioned above.

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ACKNOWLEDGEMENTS

I wish to express my gratitude to the following, who have shown infinite patience despite my endless barrage of questions and queries: Sir Harry Ricardo, F.R.S., the late Michael Sassoon and his son, Kenneth Boulter (grandson of Ralph Ricardo) and his mother, Dennis and Mary Field of the Veteran Car Club of G.B., Miss Mary Wilkes of Southwick Public Library, and Michael Norman, curator of the Marlipins Museum, Shoreham; help in locating newspaper material has come from the staffs of the *Shoreham Herald* and the British Museum Newspaper Library.

MARGARET HOLT

Lime Kilns in Central Sussex

THE DOWNLAND ESCARPMENT from Washington to Glynde contains an almost continuous line of chalk pits; some of them are still worked commercially, some were so worked during the nineteenth century, and many tiny sites were used exclusively by the farmers who owned or leased the adjoining land. Chalk is a form of the mineral calcite, consisting of calcium carbonate which, when burnt in a kiln, parts with its carbon dioxide and becomes quicklime (calcium dioxide); if water is then added it converts to slaked lime (calcium hydroxide), and it is this resultant product which is used in making mortar and cement, and as a fertilizer to restore calcium to the soil. Lime burning was carried on in conjunction with these chalk pits, and the kilns were usually set back into the sides of the Downs in order that the raw material could be easily and economically handled. Unfortunately, a great number of these kilns has been filled in, but there are, nevertheless, some which are still intact, and traces of many others. This short survey of pits and kilns has been undertaken to discover in what way, if any, the Downland kilns differ from those within the Weald, to which chalk was transported for burning. The area surveyed was chosen simply for ease of access, and the sites were initially located from the first edition of the 25 inch Ordnance Survey maps of 1875.

The process of burning lime is of great antiquity and originated in the Near East, probably at Jericho, at least as early as the sixth millenium B.C.[1] It then spread around the shores of the Mediterranean and was diffused through the Roman empire, reaching Britain in the first century A.D.

In classical times gypsum was used in preference to limestone, firstly because of the much lower temperature required for calcination, a mere 400°C. compared with the 900°C. required for limestone, and secondly because of the scarcity of suitable fuel in the Near East, as a great quantity of timber is necessary to reach and maintain the higher temperature.[2] The only deposits of gypsum in Sussex occur at Brightling and Mountfield, just north of Battle, where the Purbeck beds outcrop, and seams some 300 feet deep are now worked commercially.

At first lime was probably only used for building purposes and it is not readily apparent when its use for agriculture became general. Cato, in *De Agricultura,* describes the building of a lime kiln in great detail, giving the measurements as twenty feet in height, ten feet deep, narrowing to three feet at the top, and from the context it is obvious that the lime was used as fertilizer.[3]

Remains of Roman buildings still exist in Sussex, notably at Pevensey and Chichester, and Roman mortar was well known for its lasting qualities. On the Continent additional materials such as Pozzolonas, volcanic ash and pumice fragments were often added to give extra strength, but as such natural materials were not available in Britain, crushed brick, tile and pottery had to be used instead. This method of construction is shown to perfection in the walls of Pevensey castle where Roman brick has been used as a bonding course between the flint, and the mortar is pink in colour due to the fragments of brick and tile which can be clearly seen.

References to lime and mortar in Saxon times occur in the chronicles of the period and are concerned with ecclesiastical buildings as domestic structures were mainly in timber. William of Malmesbury, writing in the twelfth century of St. Wilfred's work on the church at York in 690, described the white-washing of the masonry with 'shining lime'. There do not appear to be any such Sussex references during Saxon times, and the first national documents which describe lime kilns are of the thirteenth century, and concerned only with building. An early mention of lime in Sussex occurs in the Cellarers' accounts for Battle Abbey in 1278, when it is listed under domestic expenses; the construction of a kiln is recorded in 1373-4, but the context is not perfectly clear and in all probability also refers to the erection of a building.[4]

From very early times farmers and land owners had been fully cognisant of the necessity to maintain and improve the fertility of their land, and the thirteenth and fourteenth century custumals of Laughton, Bishopstone, Amberley and other Sussex manors give careful regulations for the use of dung and marl as fertilizers,[5] but no mention of lime is made; even Walter of Henley, in his meticulous description of medieval farming procedure does not specify lime. Marl, a calcarious clay, is found at the base of the Lower Chalk and also in small pockets throughout the Weald, so that it had always been easily accessible and traditional as a fertilizer within the area.

It is impossible to give an exact date for the first agricultural use of lime in Sussex; the survey of the manor of Alciston in 1433 refers to 'the Furling called Lymepits' in the Middle Laine of the Common Field,[6] and in view of its position it is not unreasonable to suppose that it was for use on the land. The faint beginnings of 'improvement' in agriculture by land owners of the late sixteenth and early seventeenth centuries were paralleled by the 'Great Rebuilding' of the same period, which required lime both for wall infillings and plaster and for mortar as brick and stone were more extensively used; it was even exported to Calais and other French ports as shown by entries in the Rye Port Book for 1583.[7] Sir John Norden pinpointed the efforts made by farmers when he wrote in 1614 that 'in some parts of Sussex . . . the poore husbandmen and Farmers doe buy and digge and fetch limestone, 2, 3, and 4 miles off, and in their fields build lime kilns, burn it and cart it on their fields to their great advantage'; the Parliamentary Surveyors of Ashdown Forest in 1650 recommended that new ground which was put to tillage should be manured with lime, and the same idea had already been suggested by Leonard Mascall of Plumpton in the late sixteenth century.[8] In the seventeenth and eighteenth centuries such agricultural procedure was confirmed in turn by Pelham of Laughton, Fuller of Brightling and Ellman of Glynde, and acted upon by numbers of smaller farmers, as shown by the inventories of the period, and as the use of lime became more general marl lost its position in farming practice.

Fuel for the firing of the kiln was invariably wood, at least until the end of the thirteenth century when coal was first considered as an alternative fuel, but it was only used in very small quantities to begin with, and the availability of suitable transport was a dominant factor in its use.[9] It only came to Sussex in the sixteenth century, brought into Sussex ports from the north of England, in particular from Newcastle, and carried up the Adur, Arun and Ouse for distribution; but billets, peat or furze persisted as the traditional materials used throughout the Weald, and coal was never considered to give such a good end product. In fact it was not until the nineteenth century, when production became commercialised, that coal became the primary fuel.

Complaints concerning the despoilation of the forest by uncontrolled cutting were persistent from the earliest times, and in the Hundred Rolls of 1275 it was stated that five hundred oaks had been felled in order to supply the king's two lime kilns in the forest of Wellington (Hunts.);[10] and when it is realized that it required an oak tree of 18 inches diameter and some 30 feet in height, or its equivalent in other timber, to produce one ton of lime, it will be readily appreciated how great the problem was to become.[11]

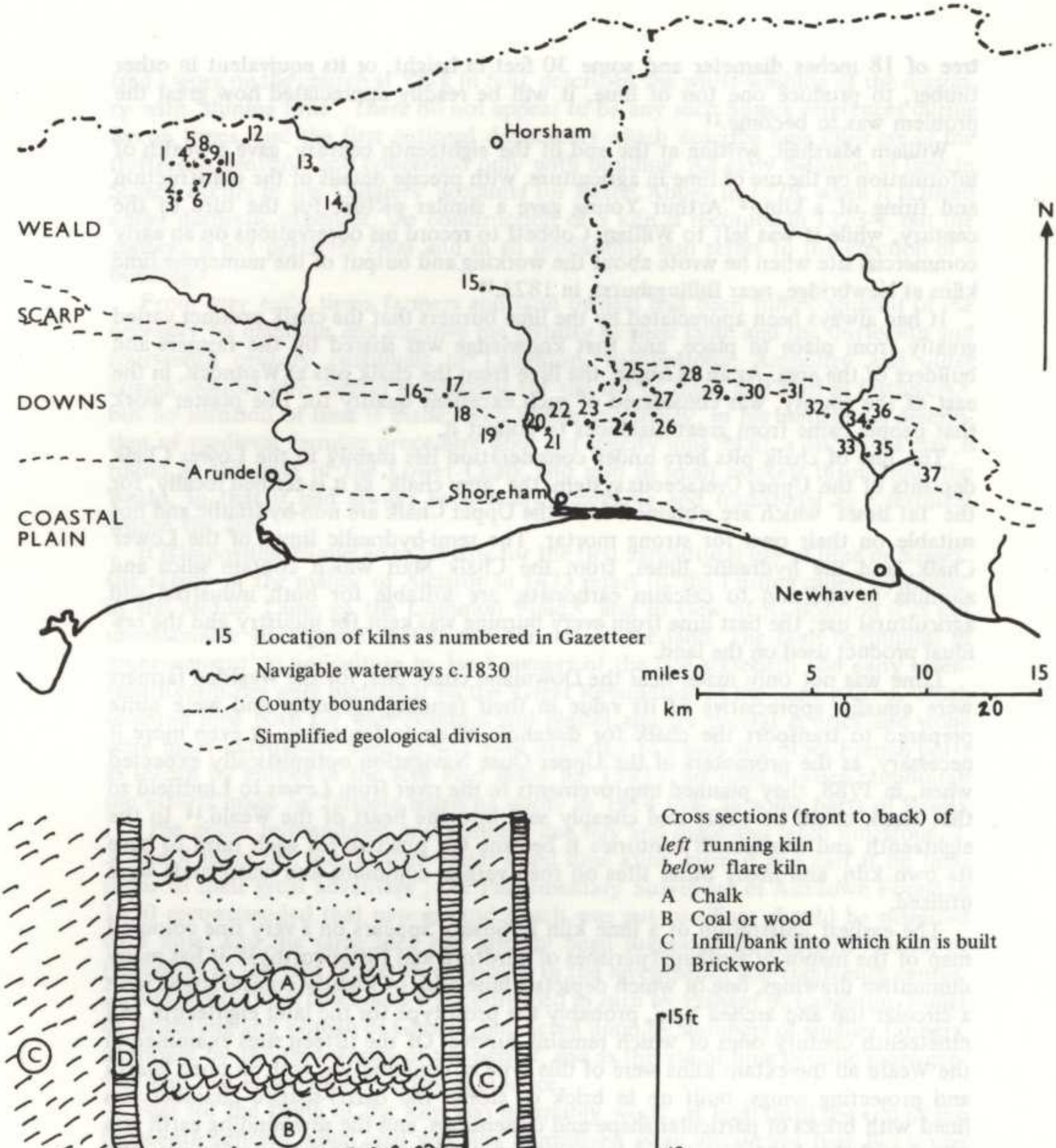
William Marshall, writing at the end of the eighteenth century, gave a wealth of information on the use of lime in agriculture, with precise details of the construction and firing of a kiln;[12] Arthur Young gave a similar picture for the turn of the century, while it was left to William Cobbett to record his observations on an early commercial site when he wrote about the working and output of the numerous lime kilns at Newbridge, near Billingshurst, in 1823.[13]

It had always been appreciated by the lime burners that the chalk product varied greatly from place to place, and that knowledge was shared by the farmers and builders of the area. As an example, the lime from the chalk pits at Wannock, in the east of the county, was considered of such excellent quality for fine plaster work that people came from great distances to collect it.

The line of chalk pits here under consideration lies mainly in the Lower Chalk deposits of the Upper Cretaceous system, the 'grey chalk' as it is termed locally, for the 'fat limes' which are obtained from the Upper Chalk are non-hydraulic and not suitable on their own for strong mortar. The semi-hydraulic limes of the Lower Chalk, and the hydraulic limes, from the Chalk Marl which contain silica and alumina in addition to calcium carbonate, are suitable for both industrial and agricultural use; the best lime from every burning was kept for industry and the residual product used on the land.

Lime was not only made near the Downland chalk pits, for the Wealden farmers were equally appreciative of its value in their farming economy and were quite prepared to transport the chalk for distances of up to ten miles, or even more if necessary, as the promoters of the Upper Ouse Navigation optimistically expected when, in 1788, they planned improvements to the river from Lewes to Lindfield so that chalk could be easily and cheaply sent into the heart of the Weald.[14] In the eighteenth and nineteenth centuries it became the practice for each farm to have its own kiln, and many other sites on road verges, commons and wastelands were utilized.

The earliest illustration of a lime kiln in Sussex appears on a very fine coloured map of the manor of Bedham (parishes of Kirdford and Fittleworth);[15] it has many diminutive drawings, one of which depicts a lime kiln, of slightly conical shape with a circular top and arched 'eye', probably the prototype for the later eighteenth and nineteenth century ones of which remains survive. Of the fifteen sites examined in the Weald all the extant kilns were of this type of construction with an open hearth and projecting wings, built up in brick or stone: the barrel-shaped chamber was lined with bricks of particular shape and dimensions, and the surrounding earth was raised up behind the face into a large mound of about 30 feet circumference. The chalk was first set in an arch above the hearth and when this was firm enough to stand the load the rest was carefully fitted into the centre of the kiln, and gradually built up into a slight dome over which the largest blocks of chalk were arranged to close it completely. This was a 'flare' or 'periodic' kiln with the burning completed in one operation. It took four loads of chalk to fill each kiln, a task completed by a man and a boy in one day, and then a thousand faggots were used for the firing, a process which required the continuous efforts of two men to maintain the necessary high temperature for twenty-four hours; the kiln was then allowed to cool naturally for several days before the lime was removed. The building or 'setting' of a kiln and its correct burning needed a very high degree of technical ability, and limeburning became the monopoly of certain families who travelled the county



LIME KILNS IN CENTRAL SUSSEX

working the kilns, jealously guarding from outsiders the science and mystery of their craft which they hand down from generation to generation.[16]

It is unfortunate that no trace remains of the kilns at the two known Wealden commercial sites at Newbridge and Baybridge, and it is therefore impossible to discover how they were constructed. But it is highly probable that they were of the 'draw tunnel' or 'running kiln' type as used at similar sites in the Downland area, and with the proximity of a river to each site it is most likely that coal was used for fuel, brought up by barge from Littlehampton and Shoreham respectively.

This second type of kiln differed from the 'flare' kiln in design and method, and probably appeared in Sussex in the last quarter of the eighteenth century. It was considerably larger with a tall square face, often built up of chalk blocks, or flint and rubble, the arch and quoins in brick, and with an extensive working area beneath the arch. In the kiln alternate layers of chalk and fuel were built up over a grille, and then heated together, the process taking roughly a week for the material to pass from the top to the bottom of the chamber, and the burnt chalk falling through the grid as it was calcinated; as the kiln emptied so more chalk and fuel were added and the working period extended for many weeks.

The survey of the twenty-two Downland sites presents a rather complicated picture; of these eleven are fully documented as commercial, seven are obviously for farm use only, at Chanctonbury Ring there is too little evidence to indicate to which category it belonged, and at Saddlescombe, Ditchling Beacon and Novington the sites, although commercial, are smaller than the first group, with only two kilns apiece, but the pits are fairly large and it may well be that they supplied the needs of the immediate farms, with a surplus for sale within the Weald. It may seem strange that Downland farmers should require lime for their own use, but it must be remembered that many of the farms ran from north to south in depth, and although each comprised a large area of Downland pasture they also traversed the geological range of Upper Greensand, Gault Clay, Lower Greensand and in some cases even penetrated the perimeter of the Weald clay as well, and it is because of this particular geological feature that lime was as necessary to the Downland farmer as it was to those who lived within the Weald proper.

GAZETTEER OF SITES

The gazetteer is arranged in two parts, Wealden sites (1-15) and Downland sites (16-37); within each part, the sites are listed from west to east and the numbers correspond to those on the map.

WEALDEN SITES

1 **Northchapel** SU 951293

The kiln is at the far end of the tiny Pound Green with an area of stone deeply hidden in the hedge.

2 **Colhook Corner** SU 957273

3 **Colhook Corner** SU 957272

There are two kilns here, only a slight distance apart. Both have a clear trackway entrance to the kiln, the deep depression and the projecting wings of which are discernible although covered with ivy. A few bricks remain beneath the ivy.

4 **near Garlands Farm** SU 963294

5 **near Frith Hill** SU 965294

Both these sites are marked on the 1875 O.S. map, but no signs now remain.

6 **Spring kiln, Colhook Common** SU 967275
The kiln had been infilled but a few scattered bricks remain to indicate the site.
7 **Ebernoe** SU 968279
Good remains of the stone face, with a brick arch, can be seen built into the bank at the side of the common, and the circular chamber is exposed in the field behind.
8 **Mitchellpark** SU 971298
The kiln is situated at the side of the road near the end of the old hammer pond, just above a small gulley. There are remains of an archway and part of the kiln below.
9 **Hammer Bridge** SU 975296
A kiln is set into the bank near the stream with some brickwork still in position.
10 **Roundwick** SU 983291
The remains of a very decorative brick face, with projecting wings, is built into the bank by the roadside, and a large mound can be seen in the field behind.
11 **Little Frithfold** SU 984296
A slight mound against the hedge indicates the site which lies down the lane past the farm.
12 **Plaistow** TQ 003308
Typical position for a kiln but no definite sign of one due to dense thorn.
13 **Roundstreet Common** TQ 049288
The thick undergrowth makes it impossible to determine the site exactly, but the trackway indicates where it must have been, set back at the edge of the common.
14 **Newbridge** TQ 069261
This important commercial site beside the Arun has been completely filled in and there are no traces of bricks or kilns.
15 **Bay Bridge, West Grinstead** TQ 163206
There were three kilns here but all have disappeared with the diversion of the stream and the construction of the dual carriageway.

DOWNLAND SITES

16 **Duncton Quarry, Washington** TQ 123128
Lime is still made here but the old kilns have been filled in.
17 **Lower Chancton** TQ 138132
'Lime-kiln wood' lies in from the scarp face and two 'flare' kilns can be seen near the bank of the stream.
18 **Chanctonbury Ring** TQ 143126
The chalk pit lies just off the Bostel but there is no sign of the kiln. Lime-covered bricks were found scattered over the area.
19 **Steyning** TQ 176112
This was a large commercial site and lies some 300 yards along the road leading over the Downs to Lancing. There are three kilns set next to each other, all in fairly good condition, the circular chamber of a fourth one is exposed, and the bricked-in arches of two others can be seen against the bank. The working floors beneath the arches are 16 feet high, 14 feet wide and 16 feet deep. The openings at the top of the bank for filling the kilns are now filled in. The trackway down to the kilns has high brick walls with shallow buttresses.
20 **Beeding** TQ 202008
This was also a commercial site set into Beeding Hill, close to the river Adur: there were originally two old kilns but these have recently been filled in. Chalk is still excavated, and lime and cement are made.

21 **Golding Barn** TQ 208107

The position of the kilns appears to be indicated by a sunken road leading to the chalk pit, but impenetrable scrub makes it impossible to detect the kilns.

22 **Trulegh Manor** TQ 223113

There is a small chalk pit and traces of a kiln with scattered bricks.

23 **Perching Manor** TQ 239113

One kiln is set back into the hill below the chalk pit. The face is square, some 12 feet high above the arch which spans 16 feet. Brick quoins with courses of flint and random rubble for the walls; the working floor is only 10 feet square and the opening at the top of the kiln has been filled in.

24 **Poynings** TQ 266119

There is no sign of the kiln but many typical bricks are scattered.

25 **Wolstonbury** TQ 275141

The entrance to the old kiln is just discernible through the undergrowth, some 100 yards along the Bostel next to Star House, and many typical bricks are scattered.

26 **Saddlescombe** TQ 279119

Two large kilns just above the chalk pit; in one the arch spans 14 feet, and the kiln, although now nearly filled with earth, extends about 12 feet into the bank. The mound behind is circular and the top opening can still be seen. The face is built of brick and flint.

27 **Newtimber** TQ 279136

This is a very old site as documentary evidence records; it was working early in the nineteenth century, probably even earlier, and belonged to Newtimber Place. Two kilns remain from the last years of the same century, set back into the hill. The site is still worked commercially as chalk is excavated but no lime is now made.

28 **Clayton** TQ 298139

There were extensive works here in 1875 and a complete kiln can be found some yards within the gate at the bottom of the hill. There must have been several others and the whole area gives evidence of a busy industrial site. A little farther up the hill can be seen the building which was once the works office.

29 **Ditchling Beacon** TQ 329133

'Lime Kiln Cottages' still stand a short way up the road to the Beacon, and the chalk pit lies above them. The kilns are now filled in but their position can be seen some 200 yards up the track just below the pit. There are many scattered bricks.

30 **Westmeston** TQ 339132

The kiln lies beside the track which leads off from the Bostel, well below the chalk pit; it is very overgrown and the kiln arches are well hidden against the bank. The top above the arch is rounded, but so completely covered with grass that it is impossible to determine what materials, apart from the bricks which show here and there beneath the turf, have been used. At the rear of the working floor the drawhole still contains pieces of calcinated chalk.

31 **Novington** TQ 369129

Two kilns are here but only fragments remain as the greater part has been infilled. The site lies well below the pit where a track leads off to the woods on the left. Many lime-covered bricks are scattered.

32 **Offham** TQ 399118

This is quite the best site with four kilns still remaining. They stand just in front of the chalk pit; three are of the round type and one, probably later, has a tall square face. This latter is built of brick, flint and chalk blocks, the drawhole and ashpit are complete, and the inside is thickly coated with burnt lime. An incline plane railway carried the lime to a wharf on the river.

33 **Cliffe** TQ 422103

Cliffe was the oldest of the Lewes sites but was disused by 1800. There are two almost complete kilns built into the rock face, and traces of four others.

34 **Malling Hill, New Pit** TQ 426113

The four kilns at New Pit are built into the side of the chalk pit. One brick face remains but the other kilns have been infilled and are now covered with thick grass.

35 **Southerham** TQ 427093

A series of four kilns set within a very tall cement face were in use until 1930, and the chalk was carried to the top by a small overhead rail-track. About 60 yards to the south are the remains of an earlier kiln now partly filled and very overgrown with ivy.

36 **Malling Hill, Bridgewick Pit** TQ 428114

At Bridgewick Pit the entry track is clearly visible but the kiln's site is heavily overgrown and no traces can be seen.

37 **Glynde** TQ 458086

The oldest kilns, now filled in, were set back into the hill below Mount Caburn, and the present quarry and lime-works were started by the Newington family in 1834 and have been worked continuously since that date. At the entrance to the works a large square kiln, now disused, still stands above the waterway, while the modern kilns are situated behind. A mill for crushing burnt lime has the steam engine *in situ*. All lime and chalk was transported to Newhaven by water and the firm built its own barges and boats. Full records of this interesting company have been preserved from its inception.

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15 West Sussex Record Office, Mitford MSS.

16 Marshall, p.75.

Notes and News

THE PROGRAMME OF VISITS AND TALKS FOR 1971

As a reminder for members and for the enticement of non-members, the following is the Sussex Industrial Archaeology Study Group's programme for the year. All dates are Saturdays.

20 March	Croford Coach Builders, Ashford, wheelwrights, and Wye College Agricultural Museum.
17 April	Dungeness Power Station.
15 May	Kew Pumping Station (mid-nineteenth century beam engines).
5 June	Tower Bridge, London. *It is hoped to arrange a visit to another i.a. monument in London on either 15 May or 5 June.*
17 July	Industrial relics in and near Rye: organised by Mr. Hugh Gordon.
18 September	Brede Pumping Station (two 1904 Tangye triple expansion engines) and industrial relics in Hastings (Fishing Museum, cliff railway, net huts, etc.): organised by Mr. A.J. Haselfoot.
23 October	Annual General Meeting in Brighton, followed by a talk on 'Sussex Ports around 1800' by John Farrant.
20 November	Brighton Railway Station.

WEALDEN IRON: INTRODUCTION TO THE SURVEY

This survey is one of the most difficult as much of the evidence has been destroyed or lies buried in the ground. The small early bloomery sites in particular are very hard to locate; they were not water powered as were the later furnaces and forges, and their presence is not indicated by the remains of ponds, bays and spillways.

Surface evidence which may indicate the location of a bloomery site are pieces of slag, charcoal, roasted ore, and natural ore. A site once occupied by a bloomery may show as a black area in a ploughed field, and often a small stream runs nearby.

Bloomery slag is usually heavy, blue black or blue grey in colour, and almost always shows signs of porosity. Part of its surface may be globular, or it may have vermiform striations. The slag is a complex silicate, a product of smelting, which has trickled from the hottest zone of the furnace as a free flowing viscous liquid.

Cinder is a more refractory furnace product, consisting of material which has not attained a molten condition. It is generally intermingled with slag, and may contain pieces of charcoal and burnt ore. Normally it would be removed with the bloom. The burnt ore is a deep red purple colour.

Pieces of burnt clay with a vitrified green glassy surface are likely to be part of the lining of the furnace.

Water power may have been used to work the bellows and forge hammers of the later cloomeries, but as regards the Weald, definite evidence of this has yet to be found.

The advent of the blast furnace was certainly associated with the use of water power, and the remains of ponds, bays and spillways may indicate a blast furnace or a forge site. The forges were sometimes powered with water from the same pond as the blast furnace, but more often the forge was situated away from the furnace, although the same stream may have supplied both forge and furnace ponds.

One of the main purposes of the forge was to convert the brittle cast iron into malleable wrought iron. Water power would have been required for the tilt hammers used to consolidate the malleable iron product of the finery hearth, and also for the bellows which supplied the air blast to the finery and the chafery hearths. In the process of converting cast iron to malleable iron a slag was formed in the finery hearth. This slag closely resembles bloomery slag.

The slag from the blast furnace is normally lighter in weight than bloomery slag, and often has a glassy appearance. The colour varies from black to dark green. Any slag which is a light grey colour, and has a powdery appearance, is of special interest as it possibly contains a higher percentage of lime than normal. Such samples could provide the answer to the question, was lime used as a flux in Wealden blast furnaces? Also associated with blast furnace working are remains known as bears. These are massive pieces (some weigh a ton or more) of semi-fused material, formed in the blast furnace by the attack of molten iron on the refractory material of the lining and hearth.

The above notes are very brief, but may assist in the location of iron making sites, and the collection of samples of slag cinder etc. A brief bibliography is below.

The object of the survey is to collect a reference library of information concerning iron making in Sussex. Data is required on the location of iron making sites, the type of site, what surface features remain, danger of destruction, access, and ownership. Samples of slag, cinder, ore, charcoal, and pieces of iron are needed. It is from such samples that information regarding the technique of early iron making can be obtained by analysis and microstructure examination.

The products of the industry must not be neglected, details of fire backs, cannon, cannonballs, sows, pigs, anvils, hursts, etc., are required, especially those artifacts in private hands. Photographs and detailed measurements are of particular value. Documents and records concerning the industry also need to be found and assessed.

Members of S.I.A.S.G. and anyone else interested in the survey are invited to send information, queries and suggestions to me, as the co-ordinator (63 Mackie Avenue, Hassocks, Sussex; Hassocks 3896). Offers of help regarding the examination and analysis of samples of slag, cinder, iron, etc., are gratefully received. Also welcome are offers of help with the search for documentary evidence, and the surveying of sites and artifacts found. It is hoped to publish reports of findings in future issues of *Sussex Industrial History*. For those interested in active excavations, the Wealden Iron Research Group will be digging on several sites during the summer (notes on some of last year's excavations appear below). Volunteers are most welcome and should contact me for details.

The following are basic reading on the Wealden iron industry:

Ernest Straker, *Wealden Iron* (1931, reprinted 1967 and 1969).

H.R. Schubert, *History of the Iron and Steel Industry c.450 B.C. – A.D. 1775* (1957). Publisher's remainders may still be available from the Iron & Steel Institute, 39 Victoria Street, London, S.W.1., 75p plus postage.

H.F. Cleere, *Iron Smelting Experiments in a Reconstructed Roman Furnace* (1970). Available from the Iron & Steel Institute, 25p plus postage.

H.F. Cleere, *The Romano-British Industrial Site at Bardown, Wadhurst.* Sussex Archaeological Society Occasional Paper 1 (1970).

Herbert Blackman, 'Gunfounding at Heathfield in the Eighteenth Century', *Sussex Archaeo-*

logical Collections, lxvii (1926).
M.C. Delany, *Historical Geography of the Wealden Iron Industry* (*c.* 1923).
Donald Maxwell, *Unknown Sussex* (1923) and *A Detective in Sussex* (1932).

D.S. BUTLER

WEALDEN IRON: WORK IN PROGRESS

Turners Green

The bloomery site found by Mr. W.R. Beswick and reported in *Newsletter* No. 5 has been given a Carbon 14 dating by the British Museum of A.D. 567 ± 45 years, thus placing it in the early Saxon period. During the 1970 excavation some substantial timbers and wattle were found underlying the furnaces. After Carbon 14 dating of this timber, another season of digging will take place to determine the nature of this structure. During the winter a piece of pottery of Saxon type has been found, as well as what appears to be an arrow head with shaft.

Holbeanwood

Bulletin of the Historical Metallurgy Group, v, no. 1 (1971), carries a report of the excavations in progress in Ticehurst (TQ 664305) under the direction of H.F. Cleere, for the Wealden Iron Research Group. The hearths of two iron-smelting shaft furnaces were found in 1970, bringing the total for the site to eight. Conclusive evidence for the Roman dating of the site was given by a piece of samian pottery.

In the report on Bardown (see bibliography above), the theory was advanced that 'satellite workplaces' were established as supplies of iron ore and timber became exhausted in the immediate vicinity of that site. It received further support from the location of four new sites producing bloomery slag, all to the south and within a half and one and a half miles of Bardown. The total of such sites (including Holbeanwood) is now seven.

Chingley Forge and Furnace

The same issue of the *Bulletin* contains a report on D.W. Crossley's excavations. At Chingley Furnace (TQ 684327), the main structure of the sixteenth century furnace has been cleared. It is a square stone structure with solid walls on the north and west sides. The lining is in position, badly caked with slag. The bellows seem to have been to the east; the casting floor was probably to the south. The wheel-pit area is fairly clearly established, to the south east. At Chingley Forge (TQ 682336), remains were found of wheels earlier than the seventeenth/eighteenth century structures hitherto recorded; their date is possibly medieval.

Upper basin of the eastern Rother

Charles Cattell spoke to the Sussex Archaeological Society in February on his research on the sources of materials for the furnaces and forges, particularly in the Heathfield area, in the eighteenth century. Ironmasters leased blocks of woodland, which theymaintained, and cut the coppice wood systematically, in a cycle of about 18 years; the wood was then converted to charcoal. As demand for iron rose, so the distance from which charcoal came increased, up to as far as eight miles. But shortage of timber does not seem to have contributed to the decline of the industry; shortage of iron ore however was more significant. Ore tended to be bought by the load from farmers who found it on their land; mining was by means of bell pits. As furnaces closed those remaining can be seen taking over their sources of supply.

JOHN FARRANT

TOLLHOUSE AND MILESTONE SURVEY

Bow-Bells Milestone Preserved

Arrangements are being made to place on permanent exhibition in the Gun Garden, Barbican, Lewes, one of the famous Bow-Bells milestones where it will be in the care of the Sussex Archaeological Society. The East Sussex County Council are at present engaged on a programme of restoration, and where missing the replacement with replicas, of these attractive milestones which are a feature of the London–Eastbourne road. The Barbican example will be an original and includes the Pelham Buckle on its ornamentation.

1830s Flyover Demolished

The photograph shows the bridge which was built to carry the Flimwell - Hastings turnpike over the Silverhill–Sedlescombe and Whatlington turnpike (TQ 79811325). The road was authorised by an Act of 1836. The bus illustrates how narrow the arch was – the reason for its destruction in February. A similar bridge still survives to carry the Whatlington–Rye road over the Sedlescombe–Hawkhurst road.

Lectures in Battle

On 26 February 1971, Mr. John Upton, the General Secretary, gave to the Battle and District Historical Society a most comprehensive and detailed talk, illustrated with colour slides, entitled 'Turnpike, Tolls and Tollgates In and Around Battle'. Much of the data was drawn from the Battle Society's own archives on toll roads. The talk was very well received by an audience of more than 80 members.

This followed an illustrated talk given by Mr. Brian Austen, Survey Co-ordinator, at the Society's previous meeting, which outlined the growth of the turnpike system in the whole of Sussex.

H.A.G.

CAST IRON GUNS

Those interested in Sussex cast iron guns will find a fine example of a small John Fuller gun on permanent display at the Tunbridge Wells Museum and Art Gallery. It is 2 feet 9 inches long and of 2 inch calibre, giving a shot weight of one pound. On the barrel is an ornate coronet encircling the letter D, but of more interest for Sussex are the initials JF cast on the trunions showing that it is a product of the Fuller family of Heathfield who made guns up to about the year 1760. Two large 24-pounders by the same makers and with the same JF initials may be seen at the Tower of London.

Cast iron guns were first made in Sussex. The earliest examples of circa 1543 were simple mortars but very soon the famous bronze gunfounders from the Tower came down to Sussex to help in the production of well made ordnance, in the newly developed metal of cast iron, produced by the skilled ironmaster, Ralph Hogge. Prior to this mid-sixteenth century time the only alternative to bronze cast guns were the so called bobbin guns fabricated by blacksmiths from strips of hand-forged iron and reinforced along their lengths with circular forged iron bands. A good example can be seen in Colchester Castle Museum, and there is a bobbin gun made from a single rolled sheet instead of longitudinal strips at the Southsea Castle Museum, Portsmouth.

W.R. BESWICK

PARK MILL, BATEMANS, BURWASH

A contract for the renovation of the building was placed in January 1971, and this work is well under way. Attention has been concentrated first on the ground floor and the north west corner where much of the brickwork has had to be rebuilt and various oak beams and uprights renewed.

A volunteer working party has also started on the job of cleaning out the tail-race channel, which is blocked with up to 2 feet of silt and rubbish heavily overgrown in places. It is proposed that this shall continue every second and fourth Saturday in each month until the channel is clear. Any members willing to undertake hard and dirty work will be warmly welcomed. Please contact Mr. W.R. Beswick (Rushlake Green 350) or Mr. A.J. Haselfoot (Hastings 260).

A.J. HASELFOOT

CROSS-IN-HAND WINDMILL

As reported in *Newsletter* No. 4 the windmill at Cross-in-Hand is in need of repair. Local organisations have since been engaged in the collection of funds for this purpose and now our corporate members the Heathfield & Waldron Rotary Club are taking an active part in the work. Our Natural Power Co-ordinator, Mr. Frank Gregory together with the Hon. Secretary for East Sussex met members of the club during the winter to discuss the matter and to give advice.

W.R.B.

RARE PROVENDER MILL SAVED

In March 1971, an unusual small provender mill at North Stoke was dismantled by volunteers under the supervision of Frank Gregory and removed to storage pending permanent exhibition at the Weald and Downland Open Air Museum, Singleton. The motive power was provided by a steam traction engine positioned outside the building, a piggery, and drove a single pair of 3-foot stones on a simple hersting. It is believed to date from about 1900 and may have been manufactured locally since no maker's name appears. The hersting is 5 feet by 5 feet, with an overall height of 8 feet. Very few mills of this type are known in Sussex, the example under review being in what was formerly a fine range of flint buildings housing the mill and pulley for stone-dressing, a large copper and continuous fresh water reservoir.

P. WEST

WEALD AND DOWNLAND OPEN AIR MUSEUM

A visit to the Museum, which is at Singleton, near Chichester, was one item on the Group's summer 1970 programme. The Museum was open experimentally for six weekends during September and October, with great success, for despite only limited publicity there were 7,198 paying visitors.

Two of the buildings already erected qualify as 'industrial archaeology': the donkey wheel (c.1600) from Catherington, Hants., and the toll house (1807) from Upper Beeding. One of the buildings under erection is a late eighteenth century wagon shed from near Petworth, which will be used to house the wagons already on display. there are tentative plans for an industrial archaeology section proper, and the Muesum is interested to hear of relics which could be considered for preservation.

An illustrated guide book is now available, price 25p, post free, from Phillimore.

In 1971, the Museum will be open on Wednesday, Thursday, Saturday and Sunday in each week from Whitsun to 31 October.

THE UPPER OUSE NAVIGATION 1790-1868: AN ADDENDUM

When the article by David Gibbs and myself in the last issue went to press, we knew of eighteen locks on the navigation, the number, indeed, given by other writers. Our list, as represented by the sketch map (page 25), was compiled by matching up what was found on the ground and on the first edition of the six-inch Ordnance Survey maps with the names which appeared in the company's records. We had no contemporary list of the locks.

Such a list has now come to light. It is among the Sussex Archaeological Trust muniments, CO/c 227, in the form of a report on the state of the works, with an estimate of the cost of repairs, by John Cowper (whose principal employment was as Surveyor of County Buildings and Bridges for the eastern division of the county); it is dated August 1821. Its main significance lies in the naming of a nineteenth lock, at the northern end of the navigation. Our final, eighteenth, lock is placed just above Lower Ryelands bridge and called Riverswood. It now appears that this lock was called Ryelands and that the final, Riverswood, lock was about three quarters of a mile upstream, at TQ 332284. It is marked on the 1841 tithe map for Ardingly (East Sussex Record Office, TD/E32), immediately west of the bridge which now carries the public footpath over the river. It has been taken out completely.

On page 29 we state that the canal planned in 1810 to link the Ouse navigation with the Grand Southern Canal would have left the Ouse 'just west of Riverswood lock'; this remains correct – the junction would have been at TQ 332284.

The tithe map also marks what we have called the terminal basin, at Upper Ryelands bridge (page 36). It looks as if the river was widened to allow barges to be swung, and a slipway provided for landing barges.

JOHN FARRANT

'SNIPPETS'

Mr. Andrew Fayle reports an ice house at 'Ades', Chailey, (TQ 401194) on the road from the *Five Bells* public house to Newick via Cinder Hill.

The Group's Chairman, Mr. G.P. Burstow, has compiled an index to the five published numbers of the *Newsletter,* and a copy has been lodged in Brighton Reference Library.

Industrial archaeology has featured regularly on the weekly B.B.C. Radio Brighton programme, 'The Countryside Hereabouts'. In February, Charlie Yates and Walter Gorton recalled the Stanmer donkey wheel and horse gin in earlier days; in April, Deans Mill was heard at work grinding wheat, and in the same month John Farrant talked about the Upper Ouse Navigation. Members who can suggest topics which might be covered in the programme may like to contact him.

The *Brighton & Hove Herald,* 18 February, published a photograph of 'an ancient piece of machinery' found while the Black Lion Brewery, Brighton, was being demolished. It has been broken up, but appears to have been some kind of winding gear, probably no more than a hundred years old.

The clock from the 'Brighton side' of Victoria station, installed by the L.B. & S.C.R. in 1860, has been exported to San Francisco, where it will hang in a restaurant called 'Victoria Station' (*The Times,* 10 February).

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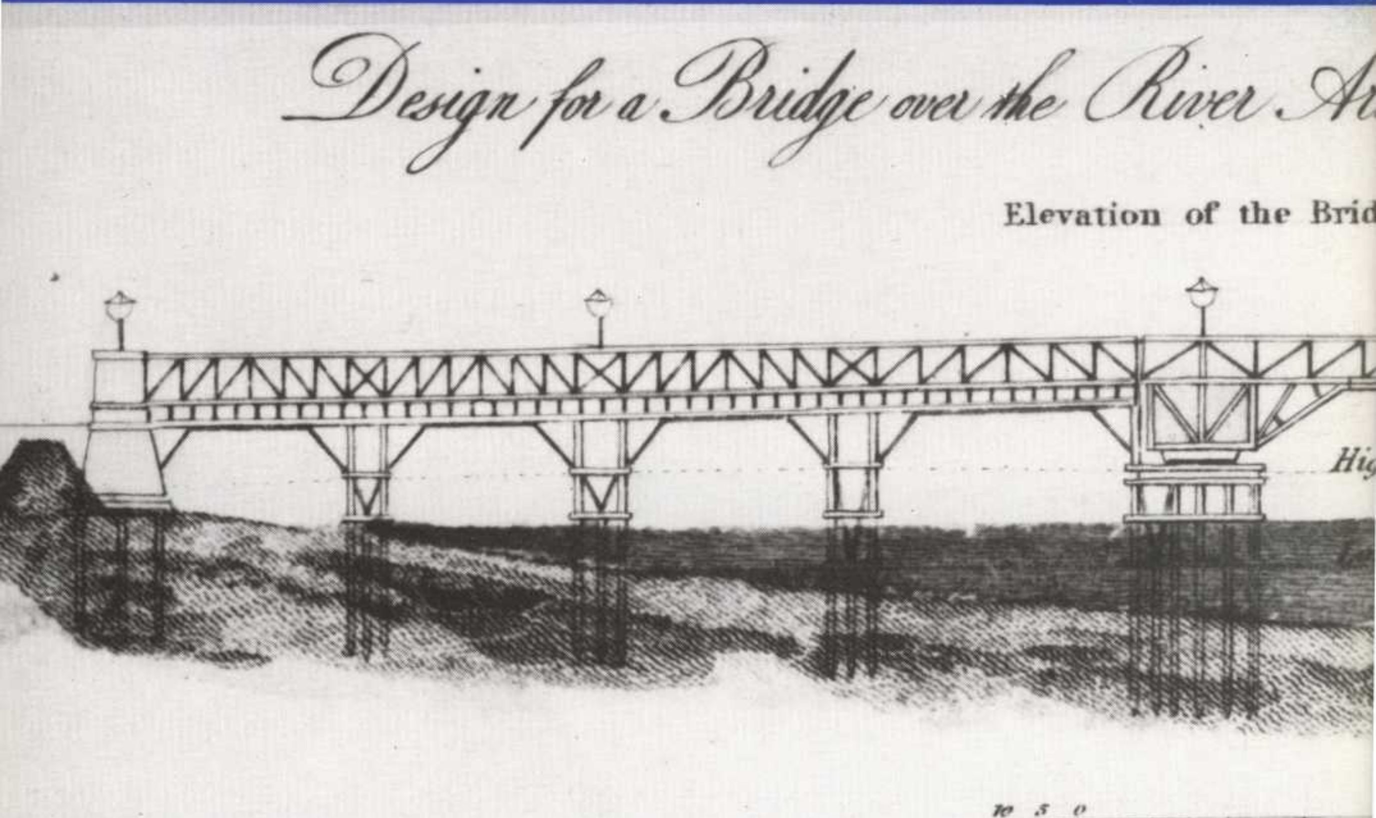
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