A Seven-Day Journal

The Society of Technical Engineers.

REVIEWING the work and policy of the Society of Technical Engineers at last week's opening meeting of the London Central Branch, Mr. C. T. Inman, the chairman, affirmed the Society's decision to keep itself independent of all combinations of employers or manual workers. This, the "third party," policy was, he said, being adopted by other associations designed for the protection of salaried workers. Their Society was registered as a trade union, but while they were willing to co-operate with the manual workers' movement to promote the efficiency and prosperity of industry, they were bound to resist the claim of the Trades Union Congress to exercise dictatorship over them. Dealing with the professional aspects of the Society's work, Mr. Inman described the efforts it was making to improve the status of engineers. The Engineers' Bill, now before Parliament, was, he said, the outcome of the Society's decision to promote a comprehensive measure for the registration of engineers. Some difficulty was being encountered in securing general agreement among the scientific institutions whose position would be affected by the passage of the Bill into law. Registration of engineers was, however, the law of the land in several countries, including Italy, the United States and New Zealand, and, he said, would sooner or later come into force here.

The Institution of Electrical Engineers' Wiring Regulations.

FOR the last two years the Wiring Rules Committee of the Institution of Electrical Engineers has been considering the comments and criticisms which were put forward as a result of the issue in July, 1924, of the English edition of the Wiring Regulations, and it has recently been decided to publish a revised edition of the regulations, embodying various alterations, with a view to bringing the regulations up to date, removing certain difficulties that have arisen in complying with the regulations, and amending the wording of some of the regulations so as to render their meaning clearer. A few amendments, particularly one affecting the revised current-carrying capacities of flexible cords and cables, were considered by the Committee to be of such importance as to warrant their immediate publication, and the Committee has therefore issued a revised alterations and additions pamphlet, a copy of which has been forwarded to us. Copies of this pamphlet can be obtained free of charge on application to the secretary of the Institution of Electrical Engineers.

Spanish-American Air Service.

A CONFERENCE is to be held in Madrid in a few days' time at which will be present delegates from nearly all the States in Central and South America. Its object is to prepare the basis of a Convention which will control air services between Spain and those countries. Diplomatic and technical representatives will attend, and while it is hoped to make regulations which will facilitate Transatlantic air services, the Spanish Government aims at securing a practical monopoly for the home industry. The object of the conference is clearly to enable the syndicate to complete its organisation for the Seville and Buenos Aires service, and its eventual extension all over Central and South America. The Seville service will be connected up with Berlin, so that Germany will have practical control over all the South American air routes. A German representative will be present at the conference. The whole of the enterprise was initiated, and is being carried through, by German firms in association with the Spanish Government, which hopes, in this way, to create a vast national aircraft industry under the direction of German engineers, while it may be presumed that no small part of the business of constructing the necessary machines will fall to German manufacturers. They are now building a large airship and seaplanes that are to be used in the preliminary service between Spain and Argentina which it is hoped to open next year.

Domestic Supplies of Electricity and Methods of Charge.

FROM a close observation of the trend of electrical development in recent years the Electricity Commissioners have been impressed by the marked increase which has taken place in the utilisation of electricity for domestic purposes, the great scope for the extension of electricity supply in that direction, and the large number and diverse character of the tariffs and methods of charge which have already been adopted or proposed with the object of encouraging the wider use of electricity for such purposes. It appeared to the Commissioners that an investigation of this aspect of electrical development, in the light of steps hitherto taken by authorised undertakers, might result in practical proposals which would assist the efforts of the electrical industry to bring about an increased consumption of electricity for domestic purposes and lead to simplification and greater uniformity in tariffs and methods of charges. Accordingly, the Commissioners appointed an Advisory Committee under the powers conferred on them in 1924 to consider and report on the matter. The various conclusions and recommendations contained in the report by the Advisory Committee have not yet been fully considered by the Commissioners, but the Commissioners decided to publish the report forthwith, as it was felt that it was likely to prove informative and of interest to the different sections of the industry and also to a wider public, including existing and potential consumers of electricity for domestic purposes. Copies of the report are now available at H.M. Stationery Office.

Local Taxation Burdens on Industry.

THE effects of the present industrial situation on local taxation and the serious results exercised by high rates on industry are causing many people much concern just now. It will therefore be welcome news that the Federation of British Industries has approached the Government in the matter, and in a letter sent this week to the Minister of Health has urged the institution of a full inquiry into the subject with a view to relieving industry of some part of the burden it is now bearing, particularly in the "necessitous areas." It is pointed out that distress and the rates imposed to relieve it are greatest in those areas where the industrial depression is most acute, and therefore that the high rates have to be met at a time when the local industries are least able to bear them. It is farther pointed out that high local taxation affects limited liability companies frequently in a more directly deleterious way than high national taxation, in that it is based on "annual value" without relation to a firm's capacity to pay. Moreover, as a limited company a firm has no vote governing the spending of the money which it has to find, while those who receive the benefit of the expenditure are the very people by whose votes the spending authorities are elected. The Federation argues that many of the services for which industry pays through the rates benefit a much wider area than that of any circumscribed local authority, and that in certain districts the abnormal distress prevailing at present arises from national or even international causes. It is therefore maintained that it is unjust that a distressed locality which from the nature of the case is least able to bear the cost of relieving the distress, should have to carry the whole of the burden.

A New Generating Set for the Barton Power Station.

FOR the Barton power station of the Manchester Corporation the Metropolitan-Vickers Electrical Company is about to construct a new 41,000-kilowatt turbo-generator set which will bring the total capacity of the plant at the station up to 119,000 kilowatts. The turbine will have two cylinders, and under the existing steam conditions, viz., 350 lb. pressure, 700 deg. Fah. total temperature, and a vacuum of 29in., the economic rating of the set will be 32,800 kilowatts at a speed of 1500 revolutions per minute. The main alternator, which will be capable of developing 50,000 kilovolt-ampères, and will weigh 161 tons, is claimed to be the largest alternator that has been ordered in this country. The rotor will consist of a single forging, 31ft. 6in. long, and will weigh 61 tons. The alternator will be directly coupled to the turbine and will generate 50-cycle current at a pressure of 6600 volts. Air for ventilating the machine, on the makers' patented closed circuit system, will be provided partly by fans mounted on the rotor and partly by a separately driven fan. An auxiliary house service alternator, giving an output of 1250 kilovolt-ampères, at a pressure of 420 volts, is to be directly coupled to the main alternator, together with two exciters for the main and auxiliary alternators. The existing equipment of the Barton power station includes three 25,000-kilowatt turbo-alternator sets, built by the Metropolitan-Vickers Electrical Company. The new machine will conform with the existing scheme of permanently connecting the alternators to 33,000-volt step-up transformers, and all switching will be carried out on the high-tension side.

The Institution of Fuel Economy Engineers.

THE Institution of Fuel Economy Engineers, one of the two societies devoted to the study of fuel and its economic use, was formed about a year ago, and has so far held only one business meeting. On Wednesday of this week its activities may be said to have been fairly launched, when Sir Robert Horne addressed about seventy members and guests at a luncheon held under the chairmanship of Sir Hugo Hirst at the Connaught Rooms, London. Sir Robert, in the course of his remarks, pointed to the fact that of the 184 million tons of coal consumed in this country in 1924, the amount consumed in the raw state was 147 million tons. Some 3 millions of the coal consumed each year was, he said, discharged into the atmosphere as soot, and as a result industrial centres suffered on the average a loss of 20 per cent. of the sunlight that otherwise would come to them. Our present methods of using coal were both wasteful and very costly, and if the aims for which the Society stood could be realised, something like a revolution would be produced in the country's industrial life. In spite of the progress registered in the laboratory with the Bergius process for the hydrogenation of coal, and with the low-temperature carbonisation process, the progress being made towards improved methods of utilising our fuel resources was very slow. The trouble lay in the fact that it was not sufficient to achieve success in the laboratory; it was necessary to convert the laboratory success into a full-scale commercial success. After the Napoleonic wars the ills and troubles which this country experienced were as great as those from which we were now suffering. The country was saved a hundred years ago by the era of new inventions which dawned soon after peace was restored. In searching for a kindred influence that would save the country to-day, Sir Robert concluded, he looked hopefully towards the results to be achieved from the present activity in fuel research. Progress and success in that direction, he held, could change our condition of depression into one of happiness and prosperity, just as certainly as did the era of invention in the early part of the nineteenth century.

The Coal Dispute.

IT is a little difficult at the moment of writing justly to appreciate what will be the effect of the Miners' Executive's new policy for the intensification of the coal dispute. Strenuous efforts are being made in the Midland areas to induce the miners who have resumed work to cease their activity again, but while a small measure of success is attending these efforts on the part of the leaders, it is widely held that the effect will only be temporary. On Monday of this week there were some 219,000 men at work in the pits producing coal, or nearly 18,000 fewer than on Friday, October 15th; on Tuesday the decrease had been very nearly made good, but on Wednesday the progress was not maintained, the falling off being confined almost entirely to the Nottingham, Derby and Leicestershire districts on which the Executive has been concentrating its oratorical efforts. With no active steps, official or otherwise, now being made to bring about a settlement, the country is looking to the drift back of the miners to the pits on the strength of local agreements as the effective means of ending the stoppage. The leaders' campaign may delay that end, but it is not now likely to render it unattainable. Among the men, the Federation's new policy is widely regarded as a last desperate throw, while by the nation generally it is clearly seen to be a policy of anarchy, which, if it were allowed to succeed, would be fatal to the whole of industry. Rumours are in circulation that the Government is considering what fresh steps it can take to end the dispute. Confirmation of these rumours cannot be obtained. It is quite possible that they have been circulated with the object of inducing the men to resist a little longer. In any event, in the opinion of many observers, the position would be best served by the Government's maintenance of an impassive attitude.

Aircraft in Warships.

A MESSAGE from Washington reveals the interesting fact that American war vessels of every type are now equipped with aeroplanes. Each of the eighteen battleships carries, or eventually will carry, three machines and two launching catapaults. Two aeroplanes have been supplied to each of the ten scout cruisers of the "Omaha" class, and eighteen destroyers have so far been provided with a single machine. Aircraft are now carried by nine submarines and other boats are to be supplied with them in due course. For submarine use a special type of seaplane with limited dimensions but high speed has been evolved. When not in use it is housed in a cylindrical compartment on deck, abaft the conning-tower, the wings being collapsible. It can be brought out and prepared for flight in a few minutes. The stern of the submarine is then depressed by flooding the after tanks until the seaplane is afloat, when the engine is started up and the machine takes off from the water. Destroyers launch their seaplanes by hoisting them over the side, but it is hoped in time to produce a catapult sufficiently compact to permit of its being used by these vessels. Finally, several fleet auxiliary ships have been equipped with one or more aeroplanes. American policy aims at providing the navy with a large number of aircraft, irrespective of those accommodated in the aircraft-carriers proper, so that the sinking or disabling of the latter ships in action would not deprive the fleet of aerial co-operation. When the two large carriers, Lexington and Saratoga, are commissioned next year, each with its complement of seventy-two aeroplanes, the total number of aircraft borne in sea-going ships of the U.S. Navy will be 290.

Some Notes on Engineering Photography.

By A. W. SWAN, B.A.Sc.

Photography as a valuable adjunct to engineering work of all descriptions has received much attention during recent years, particularly in connection with publicity. While, however, photography is certainly most useful to engineering publicity, that is only one of a great many services which it can render. For record purposes it is an ideal complement to the drawing, and its advantages in this connection need hardly be stressed, particularly in relation to special work, the record of progress in the erection of a machine or building, and so on. In regard to instruction, too, the importance of photography is even greater; a series of photographs showing the sequence of operations in the assembly of a machine which is shipped in sections and erected on site, or the manipulation of a complex instrument, will tell more, and more clearly than many pages of typescript. Fig. 1—illustrating a stage in the changing of a chart



FIG. 1—PHOTOGRAPHIC INSTRUCTION

This photograph illustrates the first stage in changing the chart roll on a special recorder.

roll on a special recorder—illustrates this point. The instrument shown was shipped to New Zealand, and it will be realised that the instructions had not only to be extremely clear, but free from any possible ambiguity.

In the same category as photographic instruction is the photographic part list—greatly appreciated by the engineer away from the works, and by foreign correspondents. Other uses of photography which are valuable both for record and instruction include such important work as copying special documents, oscillograph charts, and the like for transmission to branch offices, or correspondents.

Enough has been said to indicate that the field of photography in connection with engineering is remarkably wide, and that photography does, in fact, warrant very careful consideration on the part of an engineering firm.

It is a curious fact, however, that while the problems involved in engineering photography are special, little has been published on this important matter, as the services of a competent professional photographer are not always readily available, and as it is both economical and sound practice to have this branch of the work attended to by a member of one's own organisation, the following notes based on the writer's personal experience may be of some value to firms preferring to deal with their own photographic work but doubtful as to the methods to be employed. The photographs used as illustrations are reproduced by the kind permission of Evershed and Vignoles, Ltd.

Equipment.

Camera.—As the majority of exposures in engineering work are lengthy, from a few seconds upwards, a stand camera is essential. It will be found that a very suitable size is the "half-plate," which provides sufficient detail and is not too bulky for expeditions away from the works. This size has the additional advantage that it can be purchased at a very reasonable figure, largely because it is not in great demand either by the professional photographer, who demands a "whole-plate" camera, or the amateur, who prefers a smaller size. A good half-plate camera can generally be secured second-hand with full equipment for between £12 and £20, and it may be said here that a camera is one of the few things which can safely be bought second-hand.

The camera must have a sound and stable tripod; it must have a "triple extension," which is essential when lenses of different focal length are to be used and for copying full size. It must have a good "rising front," with swing back and swing front for taking photographs above or below horizontal without the "pyramidal" distortion one so often sees on amateur photographs of tall buildings.

Lenses.—While a good camera can safely be bought second-hand, the lens sold as part of the equipment may not be of the best, and an exchange may be necessary. The essential qualities in a lens for engineering work are "definition" and "covering power," but not what is termed "speed." In other words, high-grade anastigmatic lenses must be used, but there is absolutely no point in buying very expensive "fast" lenses, such as are essential for press photographers. Such lenses have the virtue that they permit short exposures in dull light, but the engineering photographer is not interested in $^{1}/_{1000}$ second photography, and can contentedly buy slower lenses (F6·3 or F8) at a very much lower figure.

Many photographers employ three or more lenses with different focal lengths, using, for instance, lenses of 5in., 7in. and 10in. focal length for a half-plate camera. There is an advantage in this practice, especially in the provision of at least one lens with a focal length considerably longer than that usually employed, as it gives a "tele-photo" effect that is very valuable when one is in a machine shop and the subject of the photograph is not directly accessible. A simple and inexpensive way of securing this type of lens equipment is to use a convertible anastigmatic lens, for which, by the way, there is no need to go to Germany. In a 7in. convertible lens of this type the front or back half may be unscrewed, the remaining half being a perfect lens of 14in. focus. This arrangement avoids the necessity for carrying an additional lens in a separate mount. One addition is really necessary, a "wide angle" lens. The angle covered by an ordinary lens is about 45 deg., while a good wide angle lens covers from 90 deg. to 100 deg. without distortion, and proves very serviceable in cramped quarters. In the purchase of a wide angle lens care in selection is necessary, and too much economy may well be false.

Shutter.—The majority of stand cameras are fitted with shutters of rather elementary type, and one is supposed to use the cap for all time exposures. This is somewhat inconvenient, and as a good shutter with automatic settings for 1/100, 1/50, 1/25, &c., "time" and "bulb" can be obtained at a relatively small expense, it is worth while to invest in a shutter of that kind. While the majority of engineering photography is done indoors, there are occasions for work outside, and guessing fractions of a second is not easy.

Plates and Films.—While there is a great variety of very excellent photographic plates on the market, the writer has been converted to the use of cut film. The photographer with memories of curling roll film instinctively wonders if cut film really can lie flat in the camera, and the writer's test photographs on cut film were made principally with a view to settling this point. Fig. 2—taken as a test—conclusively proves that cut film does lie flat; no distortion due to buckling can be detected on this or any of the other illustrations, all of which were taken on cut film. The film lies flat when in the camera because it is gripped tightly in metal sheaths or in special dark slides.

Cut film has several advantages in comparison with plates, especially for engineering work. It is far less subject to glare or halation than ordinary plates, a point which will be noticed in Fig. 2, where the windows are quite free from glare. It is not breakable and it is much lighter than a plate, and hence is more suitable for expeditions. Finally, it is more easily stored. Cut film is supplied by several makers in a number of different "speeds" and with different emulsions.

This matter of the speed of the film or plate is important. The higher the speed the shorter can be the exposure under given conditions, but high-speed plates and films have a very thin emulsion and are more difficult to handle in the dark room for that reason. Slow speed plates and films are excellent for another reason, in that they have, as a rule, a very fine grain and are therefore suitable for reproducing very fine detail. For these reasons the engineering photographer need not concern himself with very high-speed plates and films which can be obtained up to a speed of 700 "H and D," and should be content with medium speeds between 150 and 300 "H and D," bearing in mind, of course, that exposures must be calculated accordingly. Panchromatic plates form a class by themselves, and are used where correctness in colour rendering is required. Another special class is the "Process" film or plate. This is extremely "slow" and calls for very long exposures, but is ideal for copying work.

Focussing.

All photographers who have progressed beyond the very elements are aware that when a lens is focussed on a definite plane it is also in sharp focus for a certain distance on both sides of that plane. For instance, when the hand camera is set for "infinity," it is in focus for all distances beyond, say, 20ft. The problem that affects the engineering photographer is the exact distance on both sides of this plane of greatest sharpness which can be counted on to provide real definition, the problem being, for instance, to take a photograph of a machine shop 90ft. deep, and have sharp detail from all points 5ft. distant from the camera to the end of the shop. It is evident that any rules which are made to assist in solving this problem must be based on some arbitrary assumption as to what is "sharp," and it will be found that the rule for definition stating that the "circle of confusion," point sharpness, should not be less than $^{1}/_{100}$in., is quite satisfactory, although theorists may and do press for a much higher degree of definition. Taking this rule for granted, one can calculate the distance of the plane on which the camera must be focussed to give the maximum effective depth, known as the "hyperfocal distance." The engineering photographer is, however, not so much interested in a plane which will give him sharp focus from a certain number of feet to infinity as to know the proper stop to give sharp definition, as in the machine shop mentioned above. The table given below provides this information for a 7in. lens. The figures at the head of the columns are taken as the plane of maximum sharpness suitable for various classes of subject, the table providing information as to the distance "fore" and "aft" on the plane of principal focus which will be in sharp focus at various stops. For example, if the camera is focussed on a plane 3ft. distant, and the aperture is F 6·3, it will be in focus from 2ft. 10·4in. to 3ft. 1·8in., giving a total depth of 3·4in. only. On the other hand, if the lens is stopped down to F 45, there would be sharp focus from

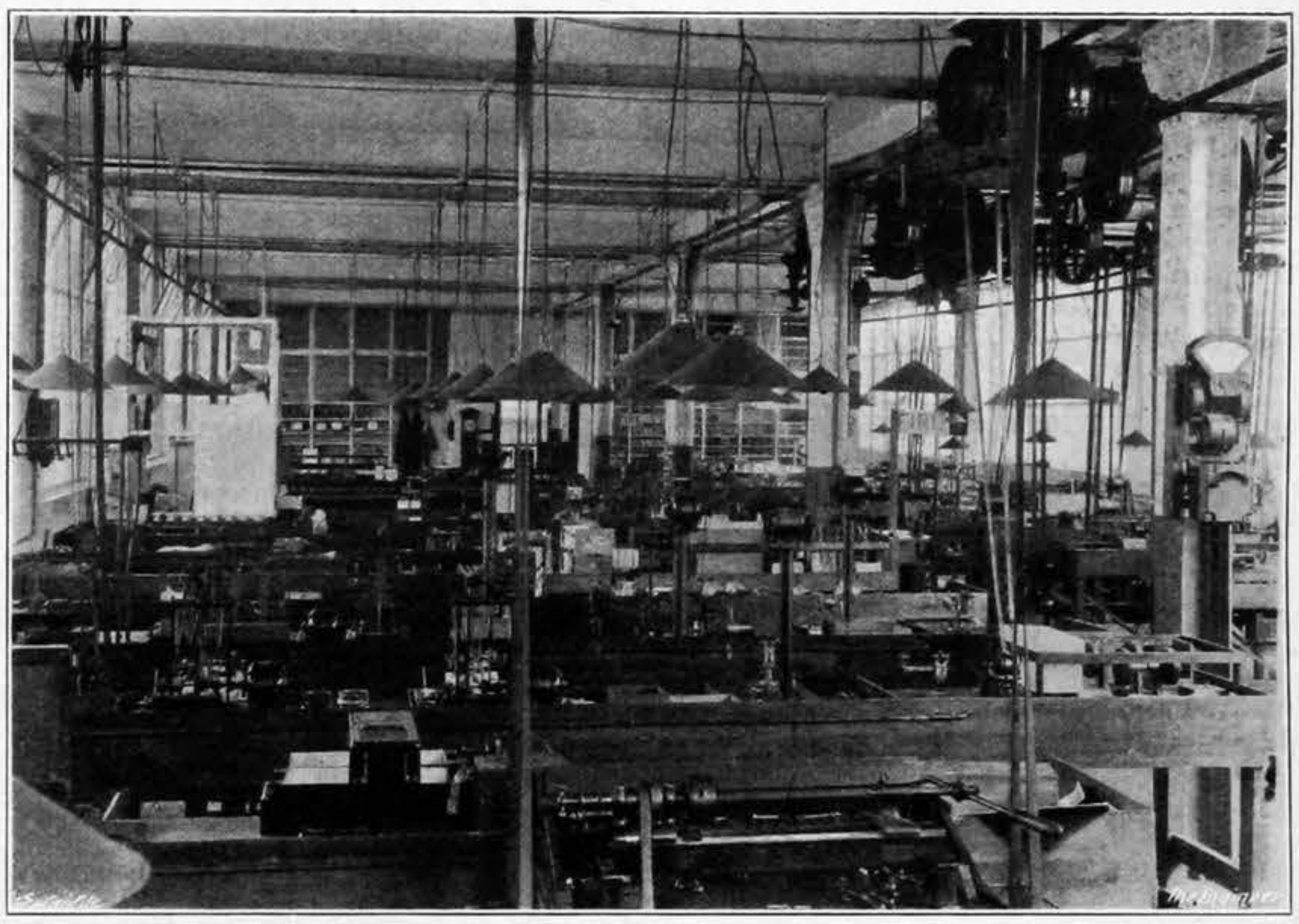


FIG. 2—TEST PHOTOGRAPH ON CUT FILM

The complete absence of blurring which would be caused by buckling of the film may be noted, also the lack of glare from the windows.

2ft. 3·1in. to 4ft. 6·1in., giving a total depth of 2ft. 3in. —a remarkable difference, by the way. Supposing, then, that one is taking a photograph of the machine shop mentioned above, 90ft. long, and that one wishes to have the maximum depth in sharp focus. It appears from the table that the best procedure would be to focus on a plane 10ft. from the camera and use the stop F 45, thus giving a sharp focus from 5ft. to infinity. Suppose, again, that one has to photograph an instrument of box-like form, 20in. wide, high and deep. In order to secure an effective depth of 20in., it is evident from the table that the plane of focus must be at least 3ft. from the lens, and even then one must stop down to F 45. If one is compelled to give a short exposure, and hence to use a larger aperture, such as F 16, the machine will have to be placed further away, say, at 5ft., to have the necessary depth. In this case, the resulting photograph will only occupy a small proportion of the plate, but it will be sharp from the front to the back, and can always be enlarged.

As the table applies only to the 7in. lens used for the half-plate camera, it may be well to show how it is derived, so that a similar table may be worked out for any other lens. If, as stated above, the "circle of confusion" is taken as $^1/_{100}$in., L, the hyperfocal length for any stop $= \frac{100 f^2}{F}$, where f = the focal length and F = the stop. The distance in sharp focus can be thus calculated from a simple formula d^1 (distance before or behind the plane of principal focus) $= \frac{d\,L}{d \pm L}$ (d = distance of plane of principal focus).

Depth of Focus Table for 7in. Lens.

Camera focussed on object at		2ft.	3ft.	5ft.	7ft. 6in.	10ft.	15ft.	20ft.
		ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
F = 6·3	Minimum	1 11·3	2 10·4	4 7·6	6 8·6	8 8·0	12 3	15 4
	Maximum	2 0·8	3 1·8	5 5·6	8 6·0	11 10	20 10	29 2
	Total depth	1·5	3·4	10	1 9·4	3 2	8 7	13 10
F = 8	Minimum	1 11·1	2 10	4 6·4	6 6·5	8 4	11 6	14 4
	Maximum	2 1·0	3 2·2	5 6·0	8 9	12 5	21 2	32 9
	Total depth	1·9	4·2	11·6	2 2·5	4 1	9 8	17 5
F = 11	Minimum	1 10·8	2 9·5	4 5·0	6 2·8	7 10·5	10 8	13 0
	Maximum	2 1·3	3 4·7	5 9·4	9 2	13 8	25 1	43 4
	Total depth	2·5	7·2	1 4·4	2 11·2	5 9·5	14 5	30 4
F = 16	Minimum	1 10·3	2 8·4	4 2·8	5 9·5	7 2·5	9 4	12 1
	Maximum	2 2·0	3 5	6 3·5	10 7	16 6	36 9	93 4
	Total depth	4·7	8·6	2 0·7	4 9·5	9 3·5	27 3	81 3
F = 23	Minimum	1 9·3	2 6·8	3 11	5 3·4	6 8	8 2	9 6
	Maximum	2 3	3 7·3	7 0	12 11	23 10	95 0	Infinity
	Total depth	5·7	12·5	3 1	7 7·6	16 2	86 10	
F = 32	Minimum	1 8·9	2 5·2	3 7·0	4 8·6	5 7·4	6 11	
	Maximum	2 4·4	3 11·2	8 3·0	18 2	46 2	Infinity	
	Total depth	7·5	1 6	4 9	13 5·4	40 6·6		
F = 45	Minimum	1 7·7	2 3·1	3 2·6	4 1·1	4 8·7		
	Maximum	2 6·9	4 6·1	11 1	42 0	Infinity		
	Total depth	10·2	2 3	6 9·4	37 10·9			

Formula to calculate a similar table for any lens :—

Circle of confusion taken at 0·01in.

$$L = \frac{100 f^2}{F}$$

$$d^1 = \frac{d\,L}{d \pm L}$$

f = focal length (inches).
F = stop.
L = hyperfocal length (inches).
d = distance of plane of principal focus (inches).
d^1 = limit of sharp definition (inches).

Various useful facts emerge from the table and from the formulæ on which it is based. It is evident, for instance, that since d^1 varies directly as L (hyperfocal length), which, in turn, varies as the square of the focal length of the lens, the shorter the focal length of the lens the greater will be the "effective depth of focus" at all apertures; hence a short focus lens is useful for work where considerable effective depth is necessary. Another point is that the plane of principal focus is never half-way between the two limits, the extreme instance being when one of the limits is infinity. The practical bearing of this is that in taking a machine shop, one does not focus on a plane half-way along the shop, but on one very considerably nearer, probably 10ft. or 15ft. from the camera.

In using the table it is well to decide definitely on the plane on which to focus and to neglect the extremes, for the simple reason that in dim interiors it is usually necessary to open the lens to full aperture to have enough light for the subject to be visible on the focussing screen, and both the front and back of the subject will appear hopelessly blurred. For instance, one may be taking an instrument 20in. across and 3ft. away from the camera, as indicated in an earlier paragraph. The table indicates F 32 as the correct stop, but it may well be necessary to open to F 6·3 when focussing, which stop it will be noted gives an effective depth of about 3in. only, so that back and front will be completely out of focus on the screen. If, however, the plane of principal focus is correctly placed at 9in. from the front of the instrument, as indicated by the table under F 45 for 3ft., one can focus sharply on that plane and care nothing about the apparently blurred front and rear.

It is decidedly an advantage to focus on printed matter, principally because the eyes are so accustomed to print that they can detect a slight blurr far sooner than on a machine detail. Printed matter, such as a calendar, has the additional advantage that when placed at the proper position—as indicated by the table—one can concentrate on that particular plane. A calendar or notice is useful for shop interiors; it should be hung upside down, so as to be readable when reversed on the screen; match-boxes serve the same purpose at close range. Where the light is so dim that printed matter cannot be read, focus may be made on an electric (incandescent) lamp or a candle flame.

Setting Up.

Setting up a stand camera for engineering work would be much simpler were it not for the fact that quite a large proportion of photographs of this class must necessarily be taken looking down on the subject. For instance, the best view of a machine shop is frequently to be obtained from the gallery or crane runway, while many forms of apparatus must be photographed showing full details as seen from above. The difficulty arises that any tilt in the camera will bring about an apparent tilt in the subject, the vertical lines appearing to converge, and it is therefore necessary to know what steps can be taken to avoid this form of distortion.

In the first place, it can be laid down definitely that the plate must be vertical in the sense that it must not tilt either forward or back. Generally speaking, the lens should also be vertical, although it can in theory be tilted. To secure photographs looking downwards or upwards, advantage is taken of the fact that the "effective field" of a lens is considerably larger than the particular size of plate used, and that the lens need not be therefore opposite the centre of the plate. For work of this kind, the front is therefore lowered, the process being, in fact, the reverse of that adopted by the amateur photographer when raising the lens in the "rising front" for photographs of high buildings. The limit of this process is the covering power of the lens, but with a good-quality anastigmatic lens it is quite possible to look "downhill" 40 deg., as shown in Fig. 3. For extreme cases a wide-angle lens can be used.



FIG. 3—TESTING THE GELLI POWER LINE

This is an extreme example of taking a photograph downhill, using an ordinary lens, without "pyramidal" distortion.

It may be well to mention that the distortion brought about by tilting a camera can be corrected by enlarging and tilting the enlarging easel in the opposite direction, but this method of using two wrongs to make a right is not to be recommended.

Exposure.

The first essential in estimating the exposure in engineering photography is to use an exposure meter, either the "tint-matching" type, such as the Wynne or Watkins, where the exposure is determined by the time taken by a piece of special sensitised paper to darken to a definite tint till it matches a tint painted on the meter, or the "extinction" type, such as the "Justaphot," where one adjusts the light falling on a semi-opaque screen until a figure on the screen is just readable. It is true that one can become quite proficient in guessing the correct exposure, but even proficient guessing is a poor substitute for the use of a scientific instrument. It is not pretended that the results with an exposure meter are absolutely accurate. It is not always easy to tell on a Wynne or Watkins when the sensitised paper has reached the particular shade of green shown on the dial, particularly in a dimly lighted shop or foundry, where the change in tint is very slow and gradual, and, on the other hand, it is not easy to judge just how bright a figure must appear on an extinction meter to be "readable"; but when one remembers that the modern plates give quite good results with exposures from half to twice the correct amount, the small margin of error with an exposure meter is entirely negligible, and certainly not to be compared with the dangers of guesswork.

Exposure meters take advantage of the latitude of modern plates, mentioned above, and are apt to give the minimum exposure which will give good results, whereas the engineering photographer will usually prefer a longer exposure under the same light conditions. An exposure meter must therefore be calibrated in the same manner as any other scientific instrument

It is perhaps hardly necessary to add that care should be taken when a change is made from a "fast" to a "slow" plate or film, or *vice versâ*.

Shop Photographs.

As mentioned in the introduction, photographs showing machines in use have a value not only for publicity, but for record purposes. Such photographs can also be important in the study of a complex tool set up, and experimenters, such as the Gilbreths, have used photography as an aid in determining, not merely the most efficient, but the easiest method of performing operations.

In all shop photographs there arises the problem of the length of exposure. Ordinary shop lighting conditions demand exposures of 15 seconds upwards with the lens fairly wide open, and for apertures such as F 16 or F 23 which are necessary for a reasonable depth of sharp focus, much longer exposures are necessary. Unfortunately, there is a limit to these longer exposures, whenever people are shown at work. Few people can keep really still for more than 20 seconds, and if therefore photographs include operators at machines, the exposure must be kept down to this period. One is therefore frequently faced with the embarrassing choice of having insufficient exposure through using the lens "stopped down," or having insufficient depth of sharp focus through using the lens wide open. An aid in solving this problem is to use "high speed" plates or films for this class of work, as they require less exposure for given conditions than the slow plates or films used under ordinary conditions. If the light is so dim that even the use of high-speed plates will not solve the difficulty, and that may well be the case in a foundry or mill room, one can have recourse to flashlight, although this last method has limitations. In the last analysis, however, it is better to have adequate exposure and lose a little depth, rather than have the depth with an under-exposed plate. When the photographer is taking a man at a machine, he is not as a rule interested in the whole shop, and there may even be an advantage in having the background slightly out of focus, so as to throw the principal subject of the photograph into stronger relief. Fig. 4, taken in a Bradford woolcombing mill, illustrates this point. It will be noticed that the machines in the background are quite out of focus, and that one's attention is instinctively drawn to the young man testing the motor.

Touching-up machines in order to improve their appearance in the photographs must be done very warily. A photograph to be valuable must be realistic, and too much beautifying will defeat its own object. Certain aids are, however, quite permissible. Machines normally painted in black are considerably improved if painted grey. A rubbing with putty is a help in toning down high polish which might cause glare, and chalk assists in accentuating outlines.

A background screen is handy, both for confining the photograph to a particular subject under consideration, and is a protection from glare. The use of screens also greatly facilitates the work of "block-

ing out" the negative for use on part lists or in publicity work. Simple portable screens can readily be made with canvas, either on rollers or folding frames, similar to the ordinary kitchen clothes-horse. They should be double-sided with material of a dull cream colour on one side for use as a background for dark objects, and green on the other side used for products with nickel or aluminium finish. Fig. 5 illustrates the use of the dark background screen against aluminium finish.

Flashlight.

Flashlight is important not only in connection with photographs taken in darkness or semi-darkness, but



FIG. 4—SHOP PHOTOGRAPH

Testing a motor in a Bradford woolcombing mill. Note that the background is out of focus.

in fairly good daylight. The first and most obvious use of flashlight is when there is not sufficient daylight for ordinary photography, as, for instance, in a mine or stokehold. The next is frequently encountered, the shop of considerable width having windows on one side only, and therefore good light on one side and semi-darkness on the other. The third occasion for flashlight is when the unfortunate photographer is compelled to look straight towards a window. In passing, it may be said that if "backed plates" or "cut film" are used, it is possible as a rule to avoid the glare from windows unless, as stated above, one is forced to look straight towards them. Fig. 6 illustrates the use of flashlight for both types mentioned—the shop was well lit on one side, the camera pointed directly to the windows. The exposure in this case was about 15 seconds of daylight followed by the flash. The bright line which will be observed round the young man's head is due to the meeting of the two forms of lighting. In this type of photograph daylight plus flash the same quantity of flash powder can be taken as for an ordinary subject in complete darkness, over-exposure being unlikely.

In engineering photography, it is distinctly advisable to use "slow" flash powders, the ignition period being about one-tenth of a second instead of one-fiftieth as with high-speed powder used for public meetings. The relative slowness of the flash is a great advantage in machine shops and mills, as the flash is not nearly so startling, and there is considerably less smoke. The result is that one can take flash photographs in crowded machine shops without anxious inquiries as to "where that fuse has blown."

Generally speaking, the flash lamp should be of the trough type with ignition by detonator cap or electric spark. It should be held over the back of the camera, thus avoiding the difficulties due to heavy shadows which will occur if it is held to one side. An exception is, however, presented when the camera faces a reflecting surface, such as a switchboard panel, and in such an event care must be taken that the reflection of the flash does not appear. When it is necessary to take more than one flash in different positions, extreme care must be taken to avoid cross shadows. One word of caution is necessary. The engineering photographer seldom uses the banquet photographer's elaborate equipment designed to give diffusion and even lighting; the ordinary flash is a bright light at one point, and the intensity of illumination will be found to shade off very rapidly towards the background. For this reason the ordinary flash equipment can be used where a principal object is to be illuminated, but not as a rule for an interior such as a long machine shop.

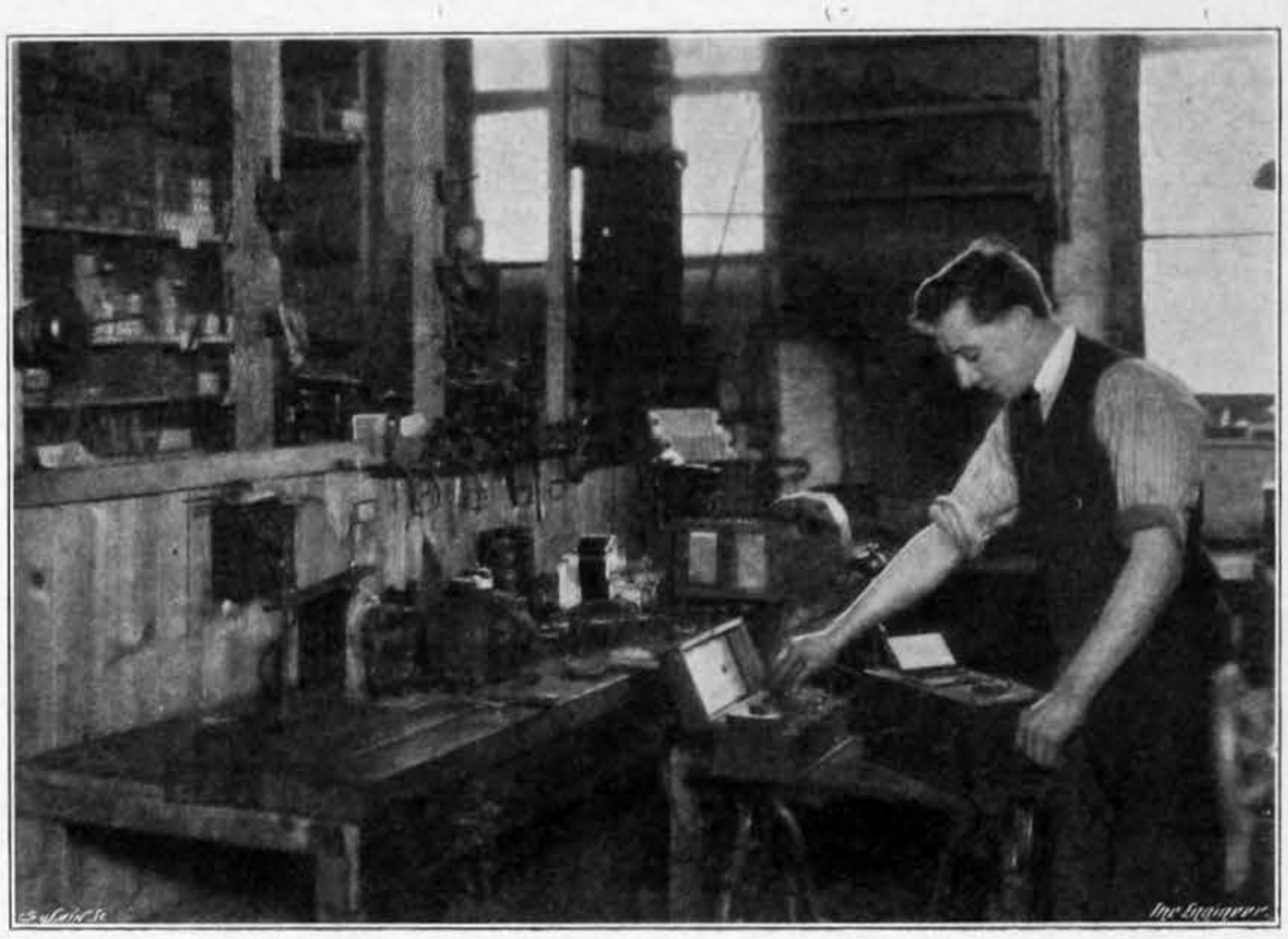


FIG. 6—INTERIOR FACING WINDOWS

The use of flashlight in daylight. This photograph was taken partly by daylight, partly by flashlight.

Flood Lamp.

While a fairly large proportion of engineering photography is done in mills and foundries where the photographer has little choice in regard to the lighting, a fair proportion of record work is done in one's own factory, and should be done under the best conditions obtainable. Good daylight is excellent, but artificial lighting is a useful accessory, particularly in the winter. While, however, artificial lighting has an advantage to the engineering photographer, there is no necessity to purchase expensive equipment, and one or two portable flood lamps will be found to answer most purposes. Various types of portable flood lamp are on the market, that in use by the writer being a 500-watt gas-filled lamp in a "spreading" bowl reflector mounted on a telescopic tripod stand. The candle power is not high according to the standards of the photo-engraver, but a lamp of this size and power has the advantage that it can easily be carried to any part of the works and can be connected to any lighting circuit, which would not be true of larger and heavier equipment. In addition to the fact that the flood lamp provides lighting of uniform intensity, it has the further advantage that it enables the photographer to look into intricate mechanism and secure photographs which are relatively free from shadow. For work of this kind the lamp should be placed immediately above the camera and as close to the camera as possible. This arrangement throws the shadows away from the camera and a practically shadowless photograph can be obtained—as in Fig. 7.

Special Work.

Copying.—Copying work has a very wide range for the photographer. It is useful for record purposes and in connection with the distribution of information to engineers away from the works, to branch houses, correspondents, and others. It is also useful in preserving a permanent record of documents on loan which must be returned to their owners, such as, for instance, assembly drawings and the like.

The rules for copying photographs or documents are simple; employ "Process" plates or films, use artificial illumination as uniform as possible, and give three-quarters the full exposure suited for this particular class of plate. It will be found that for full size copying it is difficult to find the exact position of the camera and lens giving the required result exactly true to size. If much work of this kind is to be done, as in copying sketch drawings, it is as well to mark a position on the camera for the lens and plate holder for full size copying, and to know the

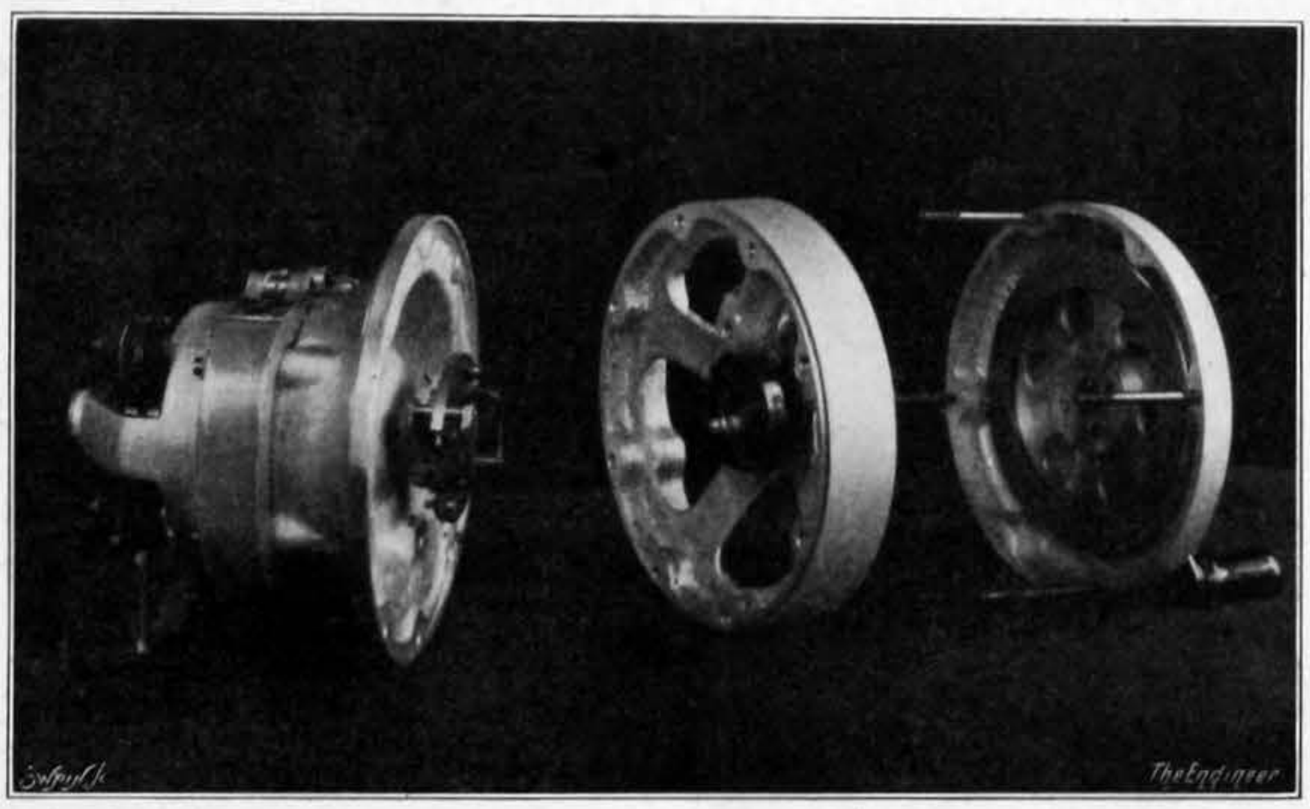


FIG. 5—ALUMINIUM PARTS

Showing the use of a dark background.

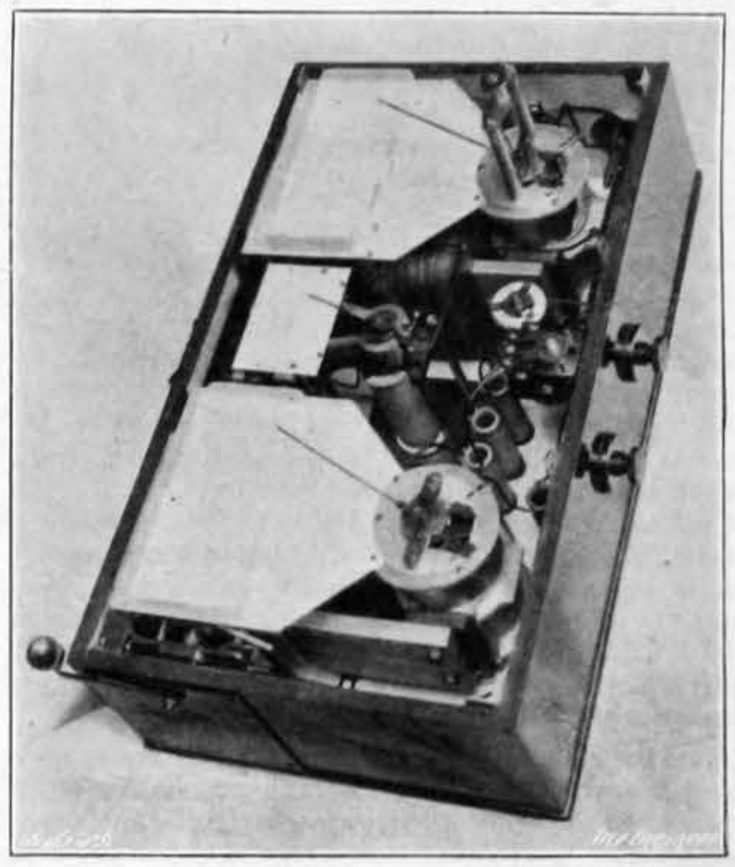


FIG. 7—INTERIOR OF AN INSTRUMENT

The use of a flood lamp to obtain a shadowless photograph.

correct distance from the lens to the subject. With this information at hand much time can be saved.

Phantom Photography.—The "phantom" or "ghost" is a very special class of photograph, difficult to take but very useful to illustrate the construction of a machine or instrument. The phantom photograph is taken in stages, two or more, the camera and subject being left in position, parts being added to the subject between successive exposures of the lens. The resulting photograph shows the internal construction of the machine or instrument with the lid or cover apparently made of glass. In the illustration—Fig. 8—the first exposure was made with the instrument having neither dial-cover nor wooden lid. The dial-cover was next placed in position, and a further exposure given. Finally, the wooden cover was placed in position and the final exposure was made on the same plate.

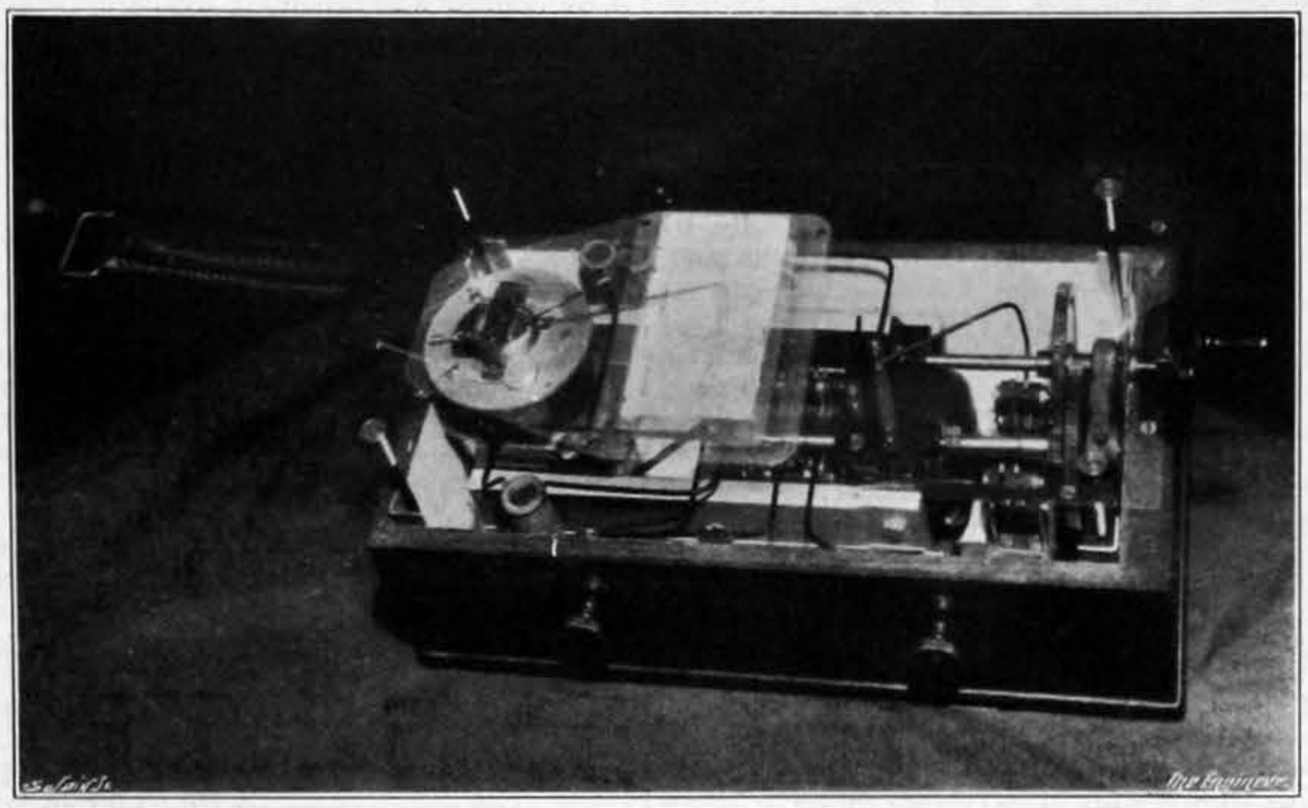


FIG. 8—GHOST PHOTOGRAPH

Woodwork.—The photography of woodwork is a special subject and does not frequently come within the scope of the engineering photographer. It depends very largely on correct rendering of colour values on a photographic plate and involves a study of film emulsions and the use of colour filters. The engineer, however, is not interested in the niceties of the photography of woodwork provided he can secure reasonably satisfactory results, and it will be found that the use of panchromatic film or plate with a "five times" light filter—Wratten screen—will be quite satisfactory. As panchromatic plates and films must be loaded and developed either in complete darkness or with a very dim green "safe" light, they are somewhat inconvenient, and it will be found that one can secure quite good results using the same filter and a good orthochromatic plate or film. For engineering work it is as well to have the filter in a mount threaded to screw into the lens front, so that there is then no question that the filter is really parallel to the lens.

Observations on the Rise and Progress of Manufacturing Industry in England.*

By RHYS JENKINS.

In addressing a society concerned with the history of technology, the rise and progress of manufacturing industry in England seems a not inappropriate subject; but with so wide a field it is not possible to give a connected story and some of its important aspects must be left untouched, so that I fear that my remarks may be found somewhat disjointed.

By manufacturing industry I mean the production of goods in quantity for the satisfaction of more than a local demand, as opposed to handicraft methods. Put in another way, the producer on the small scale works with his hands, either alone or with one or more assistants, whereas the man in the large way of business, even if possessed of the requisite skill, finds that his time is fully occupied in the work of supervision and in the commercial side of his affairs, and does not work with his hands. The two forms of production, however, merge into each other. Apart from the production of works of art, the small man usually works for a limited area; the producer on the large scale has to find a wider field for his productions.

A consideration of the manner in which our manufacturing industries have come into being shows that they fall into four groups. First, those which from the earliest times of which we have written records have been carried on as such. Second, those which within historic times have been developed from handicrafts. The third group comprises the manufactures that have been imported from the Continent, ready made so to speak; and the fourth, those which have originated in this country, such as that of Portland cement. Of this last group I do not propose to say anything, and my observations on the other groups will be confined mainly to their early history.

* Presidential address, the Newcomen Society for the Study of the History of Science and Technology, October 20th, 1926.

I. INDIGENOUS INDUSTRIES.

Production on such a scale as to supply more than a local demand is not a thing of modern times. It was carried on in the prehistoric period with flint weapons and tools, and in the Bronze and Iron Ages. In the Middle Ages the great bulk of our people lived in villages and was concerned directly with the cultivation of the land. The town population was quite small. Each village was to a large extent an independent unit. The villages produced all their own food—grain, meat, butter, &c. They made their own clothing, spun the wool from their sheep, wove it into cloth, and converted that cloth into garments. The skins of the animals slaughtered for food they tanned and dressed for boots and clothing. Their dwellings were made from local materials, wood, wattle, earth, and reeds or straw. The villagers did most of the work for themselves. As time went on they came to rely on the services of craftsmen and a blacksmith, a carpenter, a weaver would be found, not perhaps in each village, but in one of a group of villages or in the nearest town. It must be understood that I am speaking of the ordinary people. The great man of the village, the lord of the manor, would have a great many wants that could not be met locally, and when we come to the towns we find a much higher standard of living, as is shown by the number of handicratts that were carried on.

But even the villagers required a few things that the village did not produce, or at any rate only the villagers in particular districts. The important things were salt and iron. Iron was required for the farm implements and for the repair of the mill; very little was used, but it could not be dispensed with entirely. Salt was indispensable and was used to a very large extent. They were great meat eaters in those days, but had not the fodder to keep their stock alive throughout the year, so the animals had to be killed at the approach of winter, and the flesh salted. Clearly these commodities must be derived from particular districts. The salt from such parts of the sea coast where salterns could be laid out for the evaporation of sea water, or from places where brine springs were to be found; and the iron from districts in which the ore and the wood for fuel were found in convenient proximity. Accordingly we have in these commodities elements which go to give rise to manufacturing industry, an outside demand—production greater than that arising from local requirements.

Manufacture of Salt.

After agriculture and fishing, the manufacture of salt is thought to have been our chief industry in Anglo-Saxon times. It was quite widely spread. In addition to the brine pits in Cheshire and Worcestershire, which had been worked in Roman times, there were salterns at many places round the coast. The process consisted of a preliminary evaporation by solar heat; the remaining water was then driven off from the concentrated brine in lead pans placed over fires. The industry demanded capital for the construction of the large ponds in which the solar evaporation was effected, and of the boiling pans, their furnaces and the enclosing sheds, and for the provision of fuel. Probably the landowners constructed the salterns and either worked them by serfs or by paid labour, or else let them to farmers. Some of the monastic orders embarked quite extensively in industry; we find them running not only salt works, but iron forges and lead smelting works, and there is some indication that they were making glass. The production of salt from sea water was still being carried on at different points on our coast so late as a hundred years ago. There were five pans at work in South Shields in 1820. The question of transport no doubt was one of the first importance. Defoe, in 1724, tells us that very good salt was made at Lymington, in Hampshire; it was sent all over the South of England as well by water as by land carriage, and sometimes it was sent to London, but this was only when the price there was very high, in consequence of the ships which brought salt from South Shields having been kept back by contrary winds.

The first definite reference to the use of coal in salt making is of the year 1506, and it concerns works belonging to Monkwearmouth Monastery. The boiling pans at first were made of lead; we learn of iron pans at South Shields at the end of the fifteenth century. Two hundred years later, although iron pans were in use in Cheshire, the pans at Droitwich were still of lead.

Although we had a great many works making salt, the production was not equal to the demand, and a good deal was imported, so we find in the time of Elizabeth and the Stuarts efforts being made to extend the home manufacture. Of the patents granted in the reign of Elizabeth, six are for the production of salt. One of them is for making "salt upon salt"; in this process rock salt was dissolved in sea water and the brine evaporated. It was being carried on at Bideford in 1759.

In regard to iron, I have addressed you at length on previous occasions, and I do not propose to take up your time this evening; but there are two other metals which, although they do not fall within the list of commodities found essential by the villagers of the Middle Ages, do come within our first group. They are tin and lead.

Tin Smelting.

Tin, it is commonly held, was smelted in Devon and Cornwall before historic times; but, curiously enough, there seems to be no indication that the industry was carried on during the Roman occupation. There is something to suggest that it was in existence in the seventh century, but we have to come on to the middle of the twelfth century to find any definite information about the trade. At this date mining was being carried on as well as alluvial working. The miners, like those of the Peak District, the Forest of Dean, and the Mendips, were a highly privileged body. Probably in the early days the same man would carry on both the getting and the smelting of the ore on his own account, but at least as early as 1237 the capitalist with paid workmen appears in the field. In 1156 it seems that the production was 70 tons a year, fifteen years later it was 350 tons, and by 1337 it amounted to 700 tons. After this the production fell and rose again, and in the time of Elizabeth it was about 500 tons. At the beginning of the eighteenth century it is said to have been 1600 tons, and towards the end 3000 tons per year. As to the introduction of water power to work the bellows and the ore stamps we have little definite information, but it is on record that in the time of Queen Mary a German built a smelting house in Cornwall with four pairs of great bellows, a stamping mill and water wheel. Coal was tried in the time of Charles I., but it was not successfully introduced until the beginning of the eighteenth century.

During the Middle Ages a considerable amount of tin was used for the production of pewter. The trade seems to have been of native origin and at first was very prosperous. English pewter ware was in great demand on the Continent, and this induced certain London pewterers to go abroad to carry on their trade; the industry soon spread, and by 1533 the London men were complaining of foreign competition. An Act of Parliament was passed to protect them, but this did not keep out the foreigner; sixty years later the Pewterers' Company was again complaining and asking for restraints on the export of tin, and that it might be made illegal to sell beer except in standard pewter pots.

Lead Smelting.

If in the case of tin evidence of smelting in Roman times is lacking, the contrary is the case in regard to lead, and it is known that in this period that metal was produced in the Mendips, in Shropshire, and in Derbyshire. In Saxon times lead smelting was being carried on in Derbyshire and Gloucestershire, and soon after the Conquest at Alston Moor in Cumberland. In the latter half of the thirteenth century Derbyshire lead was being exported and the mines on Crown lands at Beer Alston, Devonshire, employed 700 men. From about the middle of the fourteenth century the industry seems to have declined; still towards the end of the sixteenth century we find lead being exported to France and Germany, and about this time and during the next century there was great activity in silver lead mining at Combmartin in Devonshire and in Cardiganshire.

The "boles," the earliest smelting furnaces we know of, were worked with a natural draught obtained by setting the furnace in an elevated situation facing the prevailing wind, but at an early date "foot-blasts"—hearths blown by bellows—were in use. It is said that water power was applied to work the bellows as early as 1295 in Devonshire, and in Durham in

1426, but the foot-blast was still in use in Derbyshire in 1579 and probably a good deal later. The fuel used for the boles was wood, for the foot-blasts charcoal. The reverberatory furnace with coal as the fuel came into use about the end of the seventeenth century. Water power was applied to work the ore stamps in the sixteenth century.

2. INDUSTRIES DEVELOPED FROM HANDICRAFTS.

To proceed to the industries of the second group, those developed from handicrafts. The formation of such industries, or perhaps we should say the change from production in the small way to manufacturing in quantity, is in progress to-day. Instances will readily occur to you—baking, tailoring, shoemaking.

The Woollen Industry.

The woollen industry is the great example. Spinning, weaving, and fulling too, were at first household tasks; each family produced for itself such cloth as it required. Then the task of weaving was given out to a man who made that operation his particular work; the same followed with fulling. Next the master weaver or clothier comes into the field, takes control of all the operations and supplies the finished cloth; and following this, but at a long interval, we have factory production. This is a mere sketch of the changes that took place, and it is not suggested that the industry as a whole advanced step by step in this way and that each step displaced the one before it. At any one time the industry might be at one stage at one place and at another in an adjoining district, or even in the same place two or three stages might be co-existing. The history of the woollen manufacture is indeed very complex; it is difficult to make general statements and to give a brief outline that would be of any value. Something should, however, be said as to the position in the Middle Ages. We have all heard of the Flemish weavers, who came over to this country in the time of Edward III. It has been asserted that up to that time weaving was unknown in England, or at least that such cloth as we made was of a very poor and coarse quality. Both these statements are incorrect. The art of weaving was carried on here before the coming of the Romans, and long before the time of Edward III. the weaver's craft was being practised all over the country. In the twelfth century cloth was being made for merchant purposes in a good many of our towns, and there were guilds of weavers in London, Oxford, York, Nottingham, Huntingdon, Lincoln, and Winchester. Dyers and fulling mills were at work in a great many different places. The diffusion of the fulling mills is alone sufficient to show how widespread and considerable the weaving industry was. One fulling mill could deal with the product of a number of weavers, and unless there was enough cloth produced in the locality to keep it in fairly regular employ the old plan of fulling with the feet would be retained. In 1182 scarlet cloth was bought at Lincoln for the King, and in 1236 we read of the blues of Beverley, the scarlets and greens of Lincoln, and the scarlets and blues of Stamford. No doubt cloth was being exported before this, and it is certain that by 1265 English cloth was on sale in Venice. But we were importing cloth as well, and the imported cloth was made from English wool. Probably the importation was due to the superior finish and to new colours in the foreign goods. So far as the actual weaving was concerned, and the strength and durability of the material, it would seem that all along we stood very well.

That the capitalist was well established in the industry by the fifteenth century is evident from the fact that an Act of Parliament of 1464 compels the clothier to pay his work folk in money instead of in pins, &c., and to deliver them wool according to due weight. At the beginning of the sixteenth century there are several instances of men in a big way of business; one is said to employ 500 people of all sorts, and the celebrated Jack of Newbury had in his house a hundred looms, and at each loom a man and a boy. The export of unmanufactured wool was now diminishing, while that of cloth was increasing rapidly.

3. INDUSTRIES IMPORTED FROM ABROAD.

Brewing.

Of the industries of the third group, those brought in from abroad, the first I have to mention is that of brewing. Brewing has been carried on in England from very early times, but, so far as is known, it was always in the small way until in the first half of the fifteenth century the brewing of beer, as distinguished from that of ale, was brought in by men of the Low Countries. Before the end of that century we were exporting, and by the end of the sixteenth century the average annual export was above 26,000 barrels. The reputation of English beer was now fully established on the Continent. Fynes Morison, at Oldenburgh in Germany, had a drink of English beer, the goodness whereof made his companion "speak much in honour of England and of the Queene." A German writer of the same period says that the English beer was delicious, and that the Duke of Wurtemburg relished it exceedingly. In Queen Elizabeth's time brewing was one of the most important industries of London; there were at least twenty-six breweries, but about half of them belonged to aliens.

Mining and Metallurgy.

In the reign of Elizabeth it became the policy of the State to encourage the introduction of new manufactures. One essential element for the carrying out of this policy was money, and it is at this time that the joint stock company first makes its appearance in the field of industry. The Company of the Mines Royal was established, among other things, to mine and work copper, and managers, miners, and smelters were brought over from Germany. The shareholders included Lord Burleigh, the Earl of Leicester, and other prominent men, but about half the capital, which amounted to a very large sum, was found by a firm of German merchants. A sister company, the Company of the Mineral and Battery Works, like it, had a monopoly and a royal charter. This company worked on a much smaller capital, the whole of which seems to have been found at home; its field was the manufacture of brass and the drawing of wire by water power. In the production of iron wire the company was successful very soon, but they failed to set the brass manufacture going; this was done later on by private adventurers, who had to work under a licence from the company. The Mines Royal Company, although it started under very favourable conditions, must also be considered to have failed in doing what it set out to do—it did not set the copper industry on its feet in this country.

Alum Manufacture.

Another project upon which large sums of money were spent at this period was the manufacture of alum. Alum, although not required in very large quantities, was an essential commodity in the clothing industry; it was used as a mordant in dyeing, and for it we were relying upon foreign supplies. Lord Mountjoy worked for years on the subject (near where Bournemouth now stands); he said that he had succeeded in making alum, but there is nothing to show that he ever put any on the market, and he was very frequently trying to borrow money to carry on the works. He did carry on until his death, but he was at the same place making copperas, and this seems to have been a success and perhaps provided the funds on which the alum business was kept going. In the next reign the alum shales of the North Riding of Yorkshire were discovered, and the industry was very soon established on a considerable scale in that district. James I. thought that large profits were to be made, and took over the manufacture, which was carried on as a Royal monopoly until the Civil War. He spent large sums of money on the works—one account says as much as £120,000—but many years passed before the undertaking was set on a satisfactory footing; for one thing he failed to select agents and farmers who were at the same time men of ability and honesty. A better state of things came about after the accession of Charles I., when Sir Paul Pindar became the farmer; he paid the King a rent of £12,500 a year.

Saltpetre.

Another industry naturalised in the time of Elizabeth is the manufacture of saltpetre for gunpowder. A project for the production of sulphur came to nothing.

Glass.

For the manufacture of glass several bodies of foreign workmen were brought in. Glass was being made in a small way in Surrey, but it cannot be held that the native industry was likely to develop so as to render the country independent of foreign supplies. The progress of the imported industry was slow at first, but with the introduction of coal fuel and of the lead glass a great impetus was given it.

Papermaking.

Another project, that of papermaking, was inaugurated with a great flourish of trumpets. John Spilman set up a great mill at Dartford in Kent, bringing over workmen from Germany. Possibly he was not aware of it, but there were paper mills already at work in various parts of the country. The industry had been started at Hertford as far back as 1496, but this venture was discontinued, although very good paper was made. Spilman's mill, however, if not the first set up, was a school from which papermakers spread over Kent and other parts of the country.

John Spilman was one of Queen Elizabeth's goldsmiths, and it was with money earned in the pursuit of that calling that he was enabled to set up his paper mill, and perhaps to keep it at work. This brings us back again to the financial side of our subject, but it will be recognised that capital is a fundamental requisite in the development of manufacture; without its aid the possession of technical knowledge and organising ability of the highest order are of no avail. Many of the projects for new industries in the reign of Elizabeth were abortive, some from lack of knowledge, but perhaps quite as many because they had not enough money behind them. The available wealth of the country was but small; we have seen that half the capital of the great chartered Company of the Mines Royal came from abroad; the other half was furnished partly by noblemen and partly by merchants and traders. The position of the nobility and landed men was now a declining one; so far from having money to spare to invest in manufactures, it was as much as most of them could do to meet their everyday expenses. Lord Mountjoy, for instance, was constantly begging for money to carry on the alum business. The thriving people were the merchants and traders; some of them invested money in industry, as we have seen that Spilman did, but one imagines that at this period, for the most part, their savings went to further develop their own trade or in the purchase of land. Coming on to the latter part of the seventeenth century, we find that more capital was becoming available, and it is from this time that the great copper and brass industries and many others really commence their growth. Time will not admit of this part of our subject being pursued, particularly as something should be said on its technical aspects.

Natural Powers Harnessed to Industry.

In considering the development of our industries generally from the technical side there are three great changes to take account of. First, the introduction of mechanical power in the form of the water wheel (and later of the windmill and the horse gear); second, the substitution of the steam engine for the water wheel; and third, the introduction of pit coal as fuel in place of wood, charcoal or peat.

The introduction of the water wheel was not due to any desire for economising human labour (that was cheap enough); it had for its object the performance of operations that could not adequately or conveniently be done by men; for instance, the working of the great bellows and hammers in ironworks, and stamping mills for fulling, papermaking, and for pounding ores and gunpowder. The use of mechanical power, however, did lead to a very considerable increase in manufacture, to an increase in the number of works and of their size. This increase in the size of the unit of production, calling for an increased number of wage-earners and the consumption of larger amounts of raw material and fuel, would alone tend to drive out the small man and to place an industry, previously in his hands, in the hands of a capitalist employer. Still more perhaps would the cost of the machinery, the water wheel with its pond and leat and the water rights, tend to do this. In some cases, no doubt, the landowner built and owned the mill and leased it to a tenant; this was so with the corn mills and the fulling mills.

In this country the power available at any given spot on a stream is quite limited, so that although larger establishments become possible, the extent of the increase was limited. From one point of view, this was a good thing—it was against the growth of large industrial areas, and works were scattered along the banks of the streams all over the country; but to the manufacturer it was a great drawback. If his product was such as to demand more than one operation, he might have to cart his half-manufactured goods from one mill to another, some miles away. If his business was expanding, his only course was to set up another mill with its own overhead charges and other sources of loss. Then the seasons imposed another drawback; in winter the streams were locked by frost, in summer the water supply failed—in either case the mill was rendered inoperative. All this was changed by the introduction of the steam engine. It became possible to concentrate all the processes of manufacture in one establishment and to carry on the work throughout the year. The manufacturer, it is true, had to pay for these advantages, the coal bill became a permanent charge on his undertaking. The change was at first a gradual one; it originated with the desire of the owners of water mills to obviate the stoppages of work due to insufficiency of water in the summer months. The Newcomen or atmospheric pumping engine was applied to return the water from the tail-race to the head of the water wheel. The plan proved advantageous, and as time went on more and more reliance was placed on the engine, until it became the essential element of the combination, and the water wheel merely a means for producing rotary motion. Then the question arose whether a mechanism could not be contrived to convert the to-and-fro motion of the engine into one of rotation, and thus to dispense with the water wheel. The problem was solved and the rotative steam engine was produced, and at a critical moment. It came into use with amazing rapidity. The vast importance of the invention it will not be necessary to enter upon before the members of the Newcomen Society.

Slow Change in Industry.

It had been my intention to say something about the so-called "Industrial Revolution," but I must curtail my remarks. The capitalist employing wage-paid workpeople in comparatively large numbers in the same establishment is, as we have seen, by no means a modern form of industrial organisation, and even in the textile industries, to which the term has special reference, the change from the condition in which men worked in their own homes or in small workshops to the factory system was by no means so sudden as the term "revolution" suggests. The factory system was the natural sequence of the inven-

tion of the spinning frame and the power loom, and it is worthy of remark that the trouble in the cotton trade at the beginning of the last century was due, in great measure, to the fact that the power loom did not come into use until about thirty years after Arkwright's spinning frame.

ENGLAND'S POSITION IN INDUSTRY.

Our manufacturing industries include a group, and it is an important one, introduced as industries from the Continent, and it has been asserted that, say, in the time of Elizabeth, in regard to manufactures, England was one of the most backward countries in Europe. Certainly in one thing or another we were excelled by several of the continental nations, but no one nation excelled us in everything; one was distinguished for one product, another for something else, and so on. We got men from Germany to start copper mining and smelting, and the manufacture of brass. For the manufacture of glass of different kinds men were brought from Normandy, Lorraine, and Venice. We did not expect the Frenchmen to teach us to make all kinds of glass; indeed, in France at about the same time efforts were being made to establish the manufacture of Venice glass by the aid of Venetian workmen. England itself had a continental reputation for some things—tin, lead, cast iron guns, pewter ware, and beer. There can be no question as to our indebtedness to the alien immigrants, but it does seem that with some writers there has been a tendency to over-estimate the importance of their work; that the conditions in this country were not so backward, and that the foreign contribution did not have such an important bearing on technical development as has been supposed. An example of what I mean is afforded by the paper trade. Here is a clear case in which the industry came to us originally through foreign workmen—there is no question about that. Later, at the Revocation of the Edict of Nantes a large number of Huguenot refugees came into this country. Some of these embarked in paper making, and a great deal has been written of the great improvements they effected in the technology of the industry. I have given some attention to early paper making in England, and have to confess that I have failed to find that any new technical step was introduced by the Huguenots. This, however, does not imply that the trade did not benefit; there were among them men of great ability and enterprise, and they certainly brought in fresh blood and possibly some capital.

INDUSTRIES RISE AND FALL.

In the course of time industries rise and fall, and may rise and fall again and again. There is a distinct tendency towards decay after a certain degree of prosperity has been attained. We are prone, after a period of success, to be content to rest on our oars while a competing industry is being built up elsewhere. To retain an industry requires constant watchfulness on the part of the industrial leaders. As in other spheres of human activity, there is no standing still; we must either advance or retrogress. We hear at the present time charges of inertness and lack of initiative on the part of the leaders in some of our great industries. They may or may not be well-founded; but it may be some consolation to know that the complaint is a very old one. As long ago as 1553 "a true-harted Englysheman" was lamenting "oure beastly blyndnesse." On the other hand, the workmen are charged with laziness and inefficiency; this, again, is a very old complaint, so probably at bottom masters and men are much as they were hundreds of years ago.

The Motor Car Show.

No. I.

ALTHOUGH there is not, nowadays, the same amount of pleasurable anticipation, that there used to be, on the part of the motor using public with regard to the annual exhibition of motor cars and accessories, held at Olympia under the ægis of the Society of Motor Manufacturers and Traders, the Show is always a great attraction in spite of the fact that many of the new models are now to be seen and purchased before the doors of the Exhibition are opened. When the motor vehicle was passing through its evolutionary stages, each succeeding Show was characterised by some new invention, either in connection with the motive mechanism or with body work; but that time has long since passed, and the searcher after novelties has now to be content with minor developments. Last year's Show witnessed an increase in the number of six-cylinder cars exhibited. This year there is a still further increase, and it would appear that six-cylinder engines will, in future, be nearly as numerous as four-cylinder units—at any rate, for pleasure vehicles. This is a step in the right direction. For several years we have advocated that makers should turn their attention more to the six-cylinder motor, the extra cost of which, with modern manufacturing methods and appliances, is only comparatively slight, while the advantages to the owner far outweigh any disadvantage in the matter of cost. There are some very neat six-cylinder engines to be seen at Olympia, and the overhead valve unit with enclosed rocker arms and push rods is the favourite with designers. This type of engine is preferred because of its ease of access for adjustment and decarbonising, its rapid acceleration and even torque. For the car owner of average means six cylinders are likely to be the limit, at any rate, for many years. Eight and twelve-cylinder engined cars—one of the latter of which is to be seen for the first time at Olympia—are not likely to find many buyers. They are purely luxury vehicles, and the advantages gained by the extra number of cylinders are not commensurate with the increased first cost and upkeep.

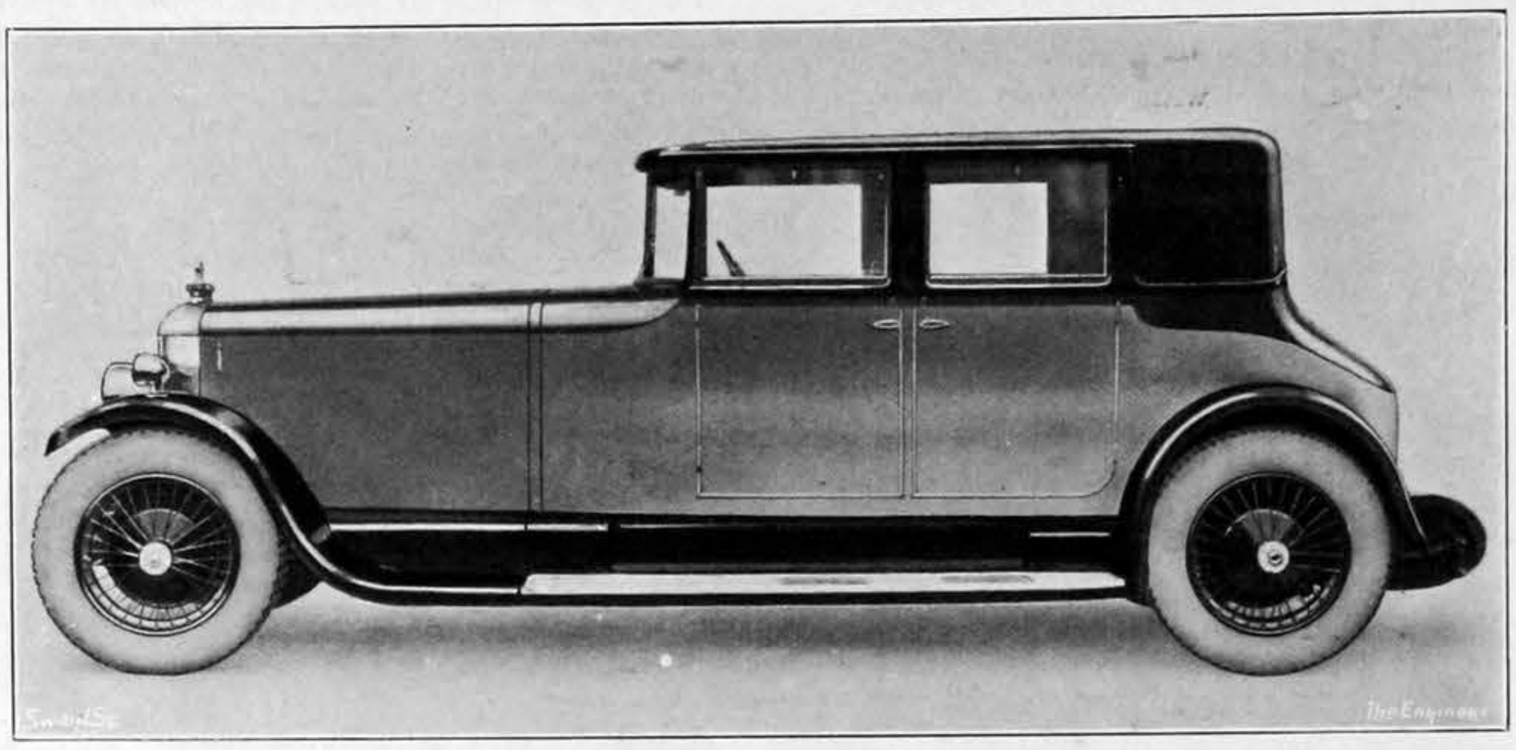


FIG. 1—DAIMLER 12-CYLINDER SALOON CAR

It does not seem that the prospects of coil and battery ignition are much improved amongst British car users, although American builders adopt that form of ignition for nearly all models. One of the objections to coil and battery ignition is the accumulator which, in its early days, was a fruitful cause of trouble. Accumulators are very differently constructed nowadays, and, provided they receive proper attention, they will last for years; but it is owing to lack of attention that trouble arises. Being out of sight they are frequently "out of mind," with the result that the plates are damaged either by want of acid or by the use of acid of the wrong specific gravity. Otherwise coil and battery ignition is better than the magneto for starting up, as there is always a "fat" spark available, which eases the work of the self starter and overcomes the higher compressions that are now almost universal. Its first cost is also less than that of the magneto.

As regards other details of engine construction, the more extended use of light aluminium alloys is noticeable, especially for reciprocating parts. This is a great improvement on cast iron, both on the score of lightness and of heat dissipation; but aluminium is not quite so durable, and we have met many cases in which pistons of that metal have had to be renewed owing to wear, especially of the grooves for the rings.

Transmission systems have not undergone any material change during recent years. The single plate clutch still holds the predominant position, while in the design of gear-boxes there is no serious rival to the sliding gear change with its well-known faults. Although there is a slight increase in four-speed gear-boxes the demand for four-speeds is not so insistent as it was a few years ago, on account of the greater flexibility and reserve of power in modern engines. With the improved torque given by six cylinders, three speeds are generally adequate. Four-wheel braking systems are now general, and the objections formerly urged against them on the ground of complication and uneven braking effect are no longer heard. Moreover, the higher road speeds which are common, necessitate better braking systems than were formerly needed, and there is plenty of room for further developments as regards the means of applying the retarding force. For this purpose, there is a tendency to employ pneumatic power in addition to that of the hand and foot control, by making use of the vacuum created by the engine exhaust. Although this arrangement would at first sight seem to complicate the mechanism, the complication need not be serious, because many of the usual links and rods required for compensating purpose can be dispensed with. For the final transmission gears the spiral bevel continues to grow in favour, although there are several of our leading builders who retain the worm and worm wheel. This latter gear gives rather slow acceleration, but otherwise is ideal if its lubrication is properly attended to.

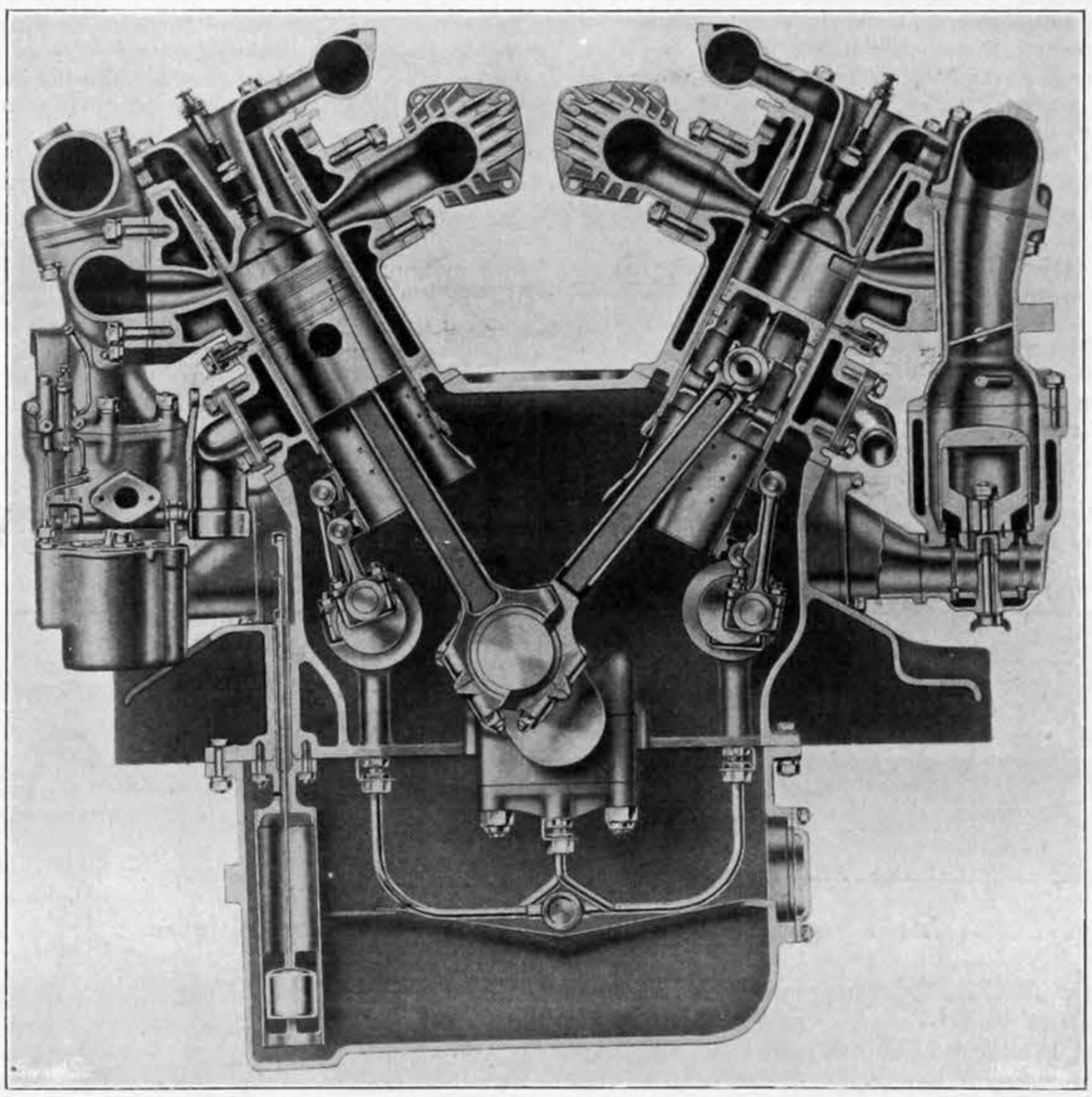


FIG. 2—SECTION THROUGH DAIMLER "DOUBLE SIX" ENGINE

We have never had any fear that British manufac-

turers would fail on the score either of quality or originality, and our views in these respects were amply confirmed by a visit to the present Exhibition, which is the finest that has yet been held in this or perhaps in any country. An idea of its importance will be gained from the fact that in the one section devoted to cars there are ninety-eight exhibitors of British, French, American, Canadian, Italian, Belgian and Austrian nationality. In the coach-work section there are sixty-three exhibitors; in the tire section twenty-one firms, while in the accessory and components section there are over three hundred exhibitors.

Trend of Design.

The trend of design with regard to bodies is still towards the closed saloon, and we were much impressed by the "roominess" and comfort of some of the saloon bodies applied to cars with quite a low

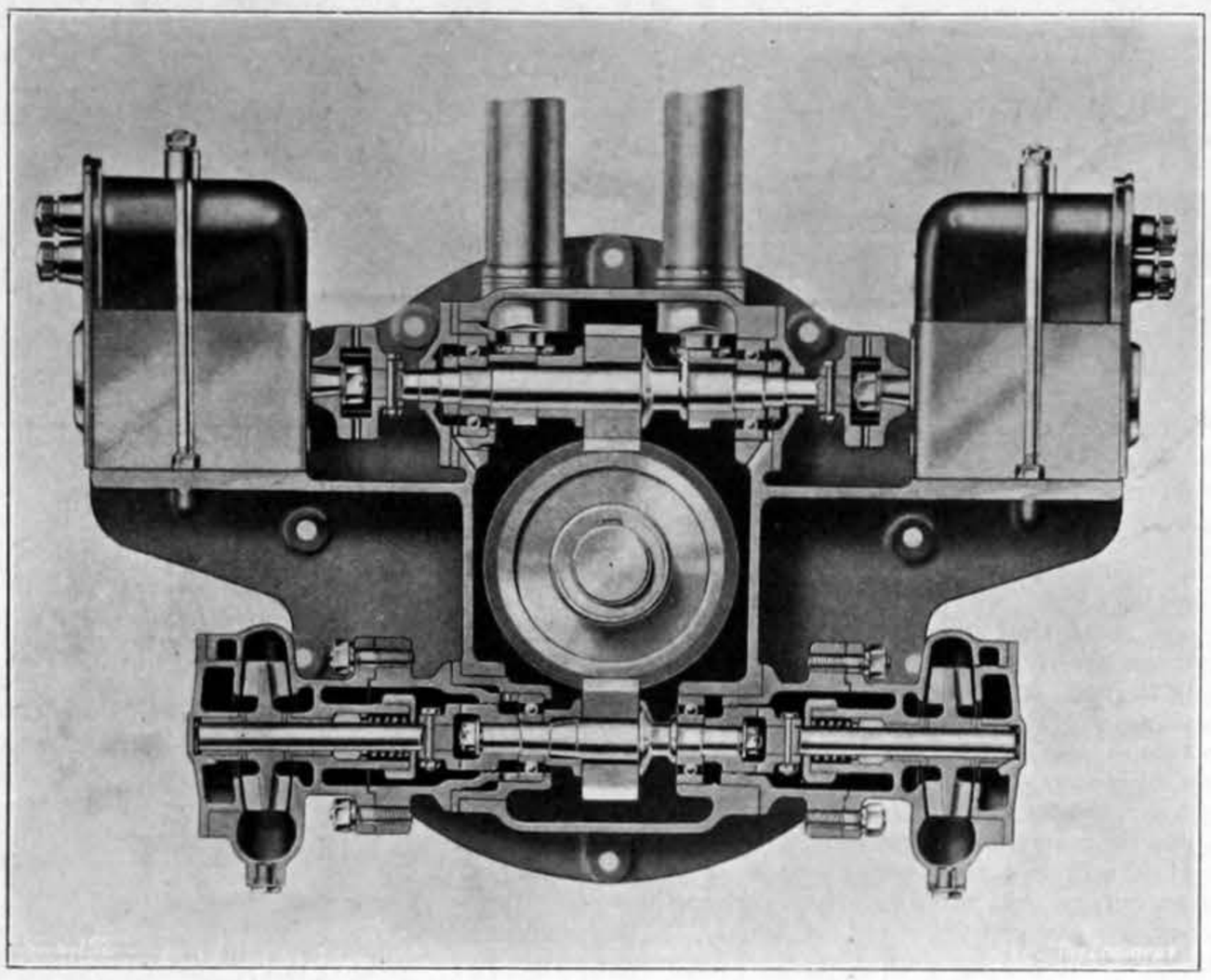


FIG. 3—SECTION SHOWING MAGNETOS, DISTRIBUTOR AND PUMP DRIVES—DAIMLER

Treasury rating. This improvement has been brought about by the co-operation of the coach builder—who is now producing such beautiful, light body work—with the engineer, who is getting so much more power out of a given cylinder capacity than he formerly did, and also with the tire manufacturer, whose low-pressure tire has been a real boon to the light car owner, who is now able to average annual mileages which were scarcely dreamt of until recently. The fabric type of body would seem to have come to stay, although it certainly lacks the dignity of the well-built and appointed coach-builders' body, over which, however, it has certain advantages, such as lightness and freedom from noise. Great strides seem to have been made in the cellulose finish, which possesses the advantage that mud and dust can be removed by means of a dry duster without scratching the surface.

Daimler Twelve-cylinder Car.

The Daimler Company has provided the only really sensational exhibit this year in the shape of a car fitted with a twelve-cylinder sleeve-valve engine, illustrations of which are given in Figs. 1 to 6 inclusive. The "Double Six" as it is called has a V-shaped engine with six cylinders disposed obliquely on either side of the vertical centre line and all working on a common crank shaft, as shown in Fig. 2. The cylinders are 81·5 mm. bore by 114 mm. stroke, and the Treasury rating is 49·4 horse-power. They have the customary steel sleeves, two automatic carburetters and automatically-governed dual ignition. The crank shaft is fitted with the Lanchester patented vibration damper and power is transmitted to the road wheels through a single disc clutch with fabric lining, a four-speed gear-box, propeller shaft and worm gearing. The connecting-rods of one side of the engine have forked big ends in order that the opposite cylinders may be situated in the same plane. The steel sleeves are operated by two excentric shafts, each mounted on four bearings and driven by separate silent chains from the rear end of the crank shaft; while a third chain drives the dynamo, which is mounted on the near side of the engine. An unusual feature of the engine is the method of heating the mixture in the induction pipes, which is done by means of an internal water pipe through which the jacket water circulates. The exhaust pipes are between the two banks of cylinders under the cowl and the fan delivers air into the channel thus formed.

The ignition plugs are connected to two six-cylinder distributors mounted on vertical shafts in accessible positions, and these distributors are supplied with high-tension current by separate magnetos mounted on opposite ends of a transverse shaft—Fig. 3—or alternatively by separate coils which take current from the battery. Fig. 3 also shows the method of driving the two separate water pumps by a second transverse shaft operated through gearing from the crank shaft. The brake system is of special interest. The hand brake operates on a drum behind the gear-box, but the foot brake acts on all four road wheels and is power-assisted on the Dewandre system. The arrangement is shown diagrammatically in Fig. 4 and in further detail in Fig. 5. The mechanical force on the brakes is applied by means of a piston operating in a cylinder that communicates with the induction pipe through a valve connected to the brake pedal. When the driver depresses the pedal, the valve is opened and the suction in the induction pipe creates a partial vacuum in the cylinder, causing the piston to travel and augment the force applied by the driver to the pedal. The connections between the piston and the brake mechanism on the one hand, and between the pedal and the valve on the other are so arranged that the driver's foot is the fulcrum of a system of levers through which the piston acts, and the consequence is that not only is the auxiliary mechanism

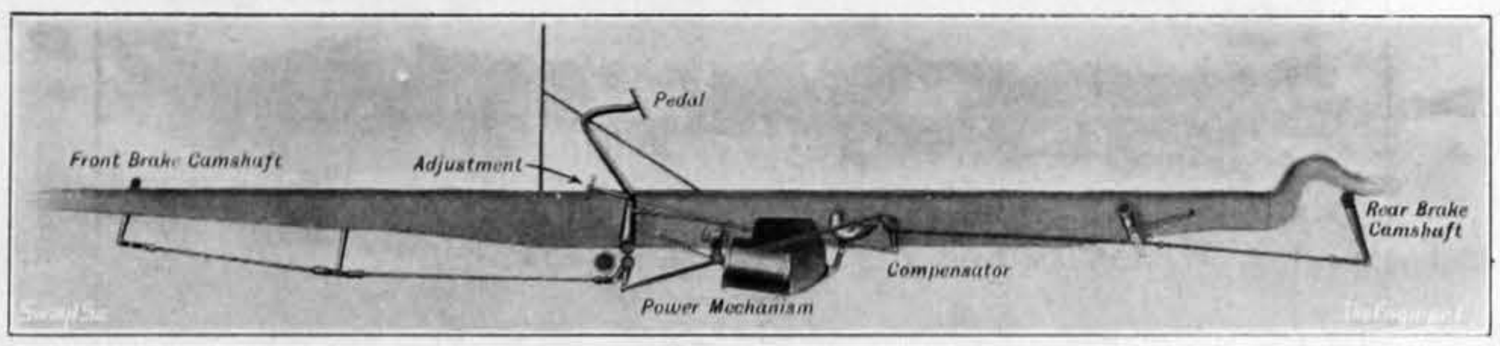


FIG. 4—POWER-ASSISTED FOUR-WHEEL BRAKE SYSTEM—DAIMLER

unable to operate independently of the driver, but its force is under direct control.

The diagram Fig. 6 will serve to illustrate this ingenious system. When the brake pedal is depressed the hinge C acts as a fulcrum about which the upper part of the lever A moves forward until the clearance between its boss and the pin A_1 is taken up. By means of the system of levers F this movement is sufficient to open the valve G and place the cylinder in communication with the induction pipe. The piston then moves forward and exerts a pull on the lower end of the lever A by means of the chain shown. The movement of this lever is communicated to the brake rod K through another lever B which is hinged to A at C and is fulcrumed at B^1. Actually A_1 and B^1 coincide, but are shown separate for the sake of clearness. All the force on the brake rod K is applied through the lever B and comes to this lever by the hinge C. The force on the hinge C is due partly to the pull of the piston and partly to the pressure on the pedal by the driver's foot. In fact, the driver by this means has a sensitive control over the braking effort applied. Any tendency on the part of the power piston to exert force on the lever A reacts on the pedal. If the driver merely exerts a light pressure on the pedal the position of H will be such that any tendency for the piston to move too far will cause the lever A to swing about H so as to close the valve G, thereby restricting the vacuum in the cylinder to an amount proportional to the force exerted by the driver on the pedal. The net effect of the power exerted by the piston is to treble the force exerted by the driver on the pedal over the first half of the range.

20–55 Horse-power Six-cylinder Humber.

The Humber Company's policy has hitherto been very conservative as regards the number of cylinders

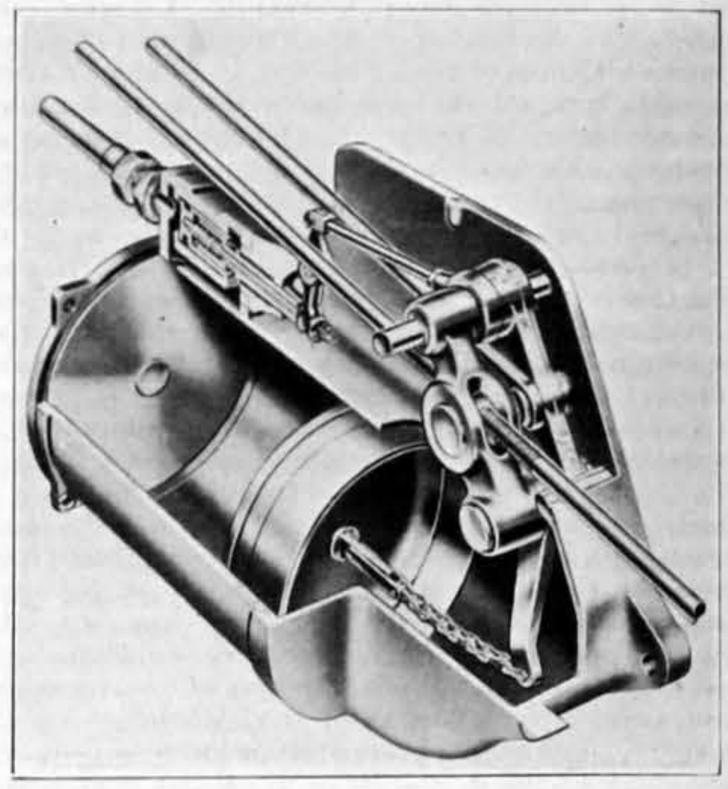


FIG. 5—PNEUMATIC BRAKE CYLINDER—DAIMLER

in its power units, but next year it is coming into line with the other principal makers with a "six," which, we are informed, is the outcome of long tests, both on the part of the company and in the hands of a limited number of "private" owners. In this case the bore and stroke of the cylinders are respectively 75 mm. and 116 mm., giving a cubic capacity of 3095 c.c., and a Treasury rating of 20·9 horse-power. This engine has a seven-bearing crank shaft, overhead inlet valves only, forced water circulation combined with thermostatic control and a cooling fan. Lubrication of the main and cam shaft bearings is under pressure, while the connecting-rod bearings are lubricated by a pump and trough system. All the oil is filtered under pressure. The ignition is by means of a Lucas magneto. The transmission includes a four-speed and reverse gear-box—with right-hand control, Ferodo cone clutch, and a spiral bevel final drive. The front wheel brakes, which are of the Humber-Perrot type, are fitted with semi-servo type shoes

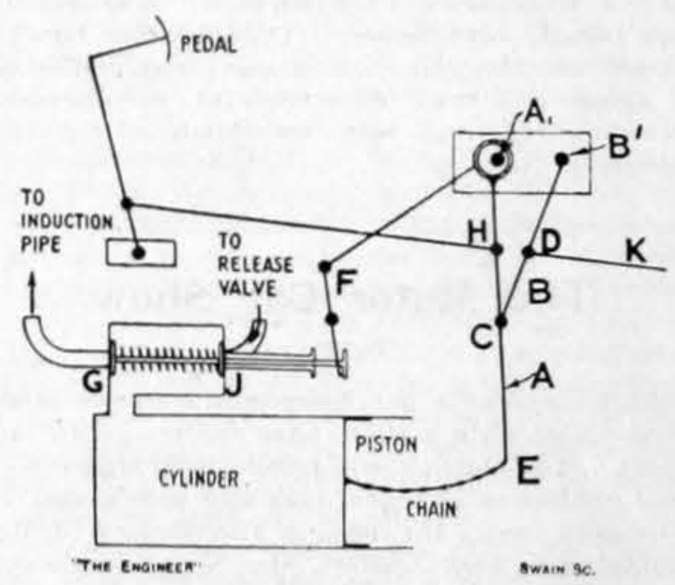


FIG. 6—DIAGRAM OF BRAKE MECHANISM

and are entirely enclosed in weather-proof covers. A foot pedal operates the front wheel brakes and transmission brake, a compensating device being fitted between the two. The wheel base is 10ft. 6in. and the track 4ft. 9½in. Lighting and starting are accomplished by C.A.V. dynamo sets.

Six-cylinder Bean.

Another newcomer in the six-cylinder class is the 18–50 horse-power Bean car, the engine of which has cylinders 69 mm. bore by 120 mm. stroke, the cubic capacity being 2692 c.c. The engine is of the monobloc pattern, with a detachable head and aluminium crank case. The valves are overhead, and the whole of the valve gear is enclosed by aluminium oil-tight covers. The cam shaft, water pump, magneto and dynamo are all driven by a very heavy silent chain. A good point in the design is that the cylinder head and valve gear can be removed without disturbing the timing. Lubrication is pressure-fed by a gear pump, through

the drilled crank shaft to the main and big end bearings, while the rockers are also lubricated under pressure through the rocker bearing shaft. Pump circulation of the water, together with a fan, is retained. Four forward speeds are provided in the gear-box and the rear axle is of the underslung full-floating pattern, the final drive being by means of spiral bevel gears. Four wheel brakes on the Perot-servo system are fitted. The pedal applies the brakes to all four wheels, while a hand lever controls an independent pair of brakes on the rear wheels only. We were pleased with the simplicity of the means for adjustment of all the brakes.

Six-cylinder Wolseley.

A new production which is being regarded with much interest is the 16-45 horse-power six-cylinder car by the Wolseley Company. This car—illustrated in Figs. 7 to 9—has been designed to give high road speeds, with a low tax at a moderate price. The bore and stroke of the cylinders is $2\frac{9}{16}$in. by 4in., and although the rating is only 15·7, the engine, so we are informed, is capable of developing about three times that horse-power on the bench, and revolves up to 4000 revolutions per minute without any fuss or vibration. This result is largely brought about by the use of a massive seven-bearing crank shaft, accurately balanced both statically and dynamically, and supported in a rigid and deep crank case. The diameters of the main bearings of the crank shaft are over 70 per cent. of the cylinder bore, while the fly-wheel bearing is $2\frac{1}{2}$in. diameter. The crank shaft bearings have white metal lined bronzed-backed shells, and all the bearings of the engine have pressure oil feed, except the gudgeon pins and the top vertical bevel shaft. The latter, however, has a direct feed from the cam shaft bearings. The magneto and dynamo cross shaft is provided with ball bearings. White metal bearings are employed in the case of the cam shaft, which is of large diameter. The overhead valves are operated by easily adjustable hardened rockers. The pistons are of aluminium alloy, and the connecting-rods of duralumin with white metal lined big ends. From the illustrations it will be seen that the auxiliaries on the engine are very easy of access. The transverse shaft which drives the dynamo and magneto receives its motion from worm gearing on the vertical shaft, which, in turn, drives the overhead cam shaft. The oil pump is placed low down in the front of the engine, and is driven by spiral gears on the forward end of the crank shaft.

Thermo-syphon cooling of the cylinders and cylinder head is employed, and is assisted by a two-bladed aluminium fan, belt-driven.

Cover plates on the engine cylinders are provided in order to give easy access to the water jackets for cleaning purposes—an unusual feature in modern engines. The cylinders are fed from a single S.U. carburetter with a controllable jet, the induction branch being of special design to give uniform distribution of the explosive mixture. A hot spot is provided in the induction branch to provide even running at low speeds.

The engine and gear-box unit is resiliently mounted with a three-point attachment, so as to prevent any distortion of the power unit by twisting or movement of the chassis frame. The fly-wheel is bolted to a flange attached to the rear of the crank shaft, and is enclosed in a casing, which supports the four-speed gear-box. The usual single dry plate clutch transmits motion to the main shaft in the gear-box. This shaft and the lay shaft are carried in ball bearings, while the reverse gears run in plain bronze bushes, entirely submerged in oil. Changing of gear is effected by a central lever working in a visible gate with a safety catch to prevent the accidental engagement of the reverse gear. At the rear end of the gear-box are arranged spiral gears for driving the flexible speedometer shaft. All the gears are made of case-hardened nickel steel, while the constant mesh and third speed gears are finished by grinding to ensure silence in operation.

From the gear-box to the back axle transmission is by means of an open tubular propeller shaft with universal joints of the fabric type at each end, provided with a centring device to relieve the fabric joints from the weight of the shaft. The rear axle is of the three-quarter floating banjo pattern, with spiral bevel gearing, 5 to 1 ratio. In connection with this portion of the mechanism, it should be pointed out that the bevel differential gear can be removed from the axle after the differential shafts have been withdrawn endwise. The front wheel brakes are of the Rubery, Alford and Alder pattern, with 12in. brake drums, and the steering connection of the front axle is of the spring-loaded ball type. The steering gear is of the worm and wheel type, with adjustment to take up wear and the meshing of the worm and wheel. The brake pedal is arranged to operate both front and rear brakes simultaneously through flexible

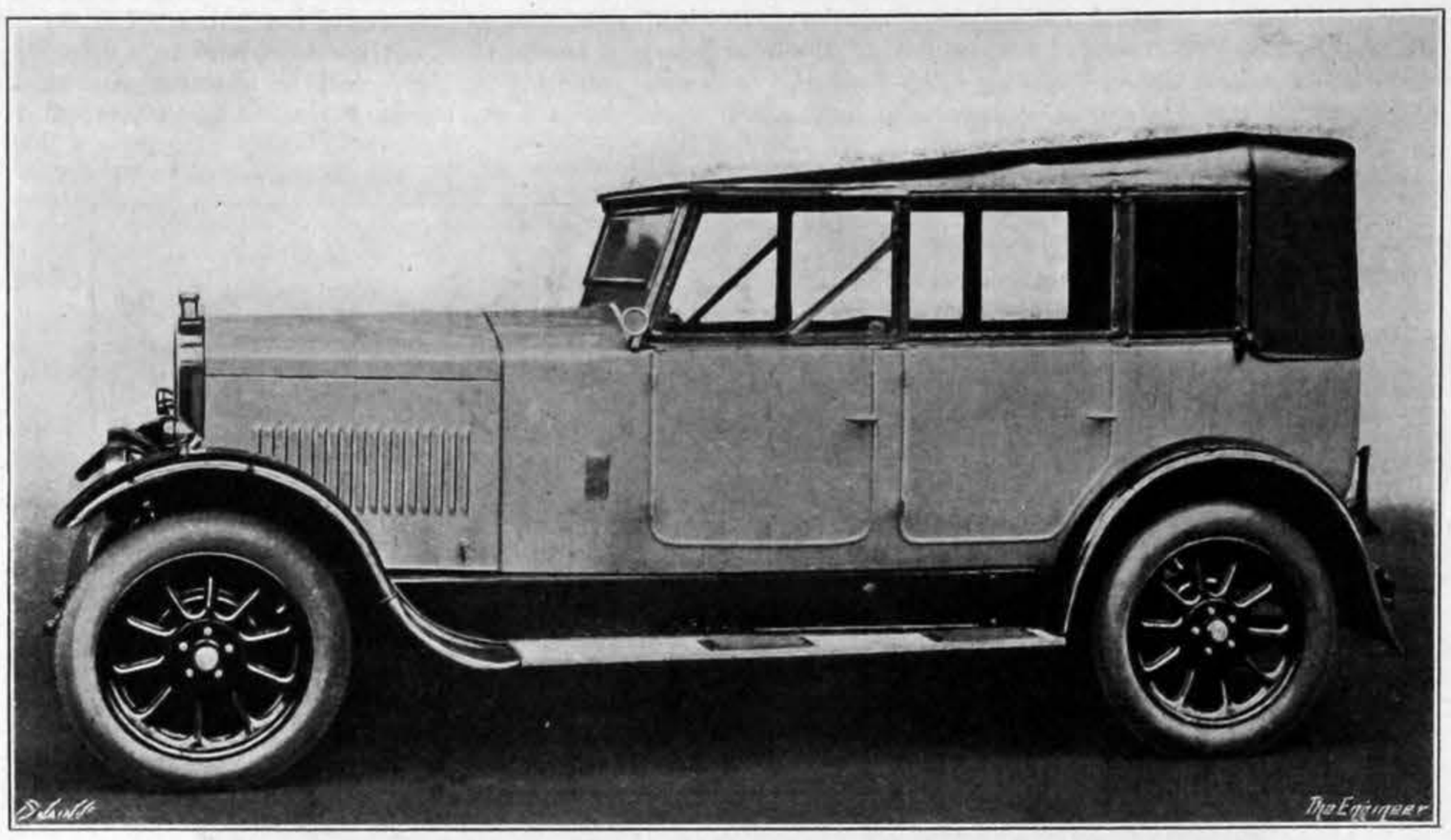


FIG. 8—SIX-CYLINDER, 16-45 H.P. WOLSELEY CAR

FIG. 7—CHASSIS OF SIX-CYLINDER 16-45 H.P. WOLSELEY CAR

cables which pass through levers provided with fair leads, so that all lost motion due to spring of the brake control details is eliminated. All four brakes can be adjusted simultaneously by a single hand nut under the bonnet, and means of further independent adjustment are provided on both the front and rear axles. A second pair of rear wheel brakes is actuated by a hand lever arranged on the off-side of the driver's seat. Both rear brake cables pass over pulleys, which are fitted at the forward attachment of the rear springs. In this way vertical movement of the rear axle does not affect the operation of the brakes.

The suspension of the car is by means of long semi-elliptic springs, at the front 36in. long by 2in. wide, and at the rear 52in. long by 2in. wide, the latter having eleven leaves. It is explained that the rear springs take the torque of the rear axle as well as supporting the weight of the car. Armstrong shock absorbers are also fitted. For chassis lubrication, the Tecalemit pressure gun system is provided, and accessibility of the various connections has been considered. The electric lighting and starting system is arranged for a pressure of 6 volts. We should prefer a 12-volt system. The dynamo is accessible and the starter is attached to the near side of the gear-box, where it can be reached by raising the floorboards.

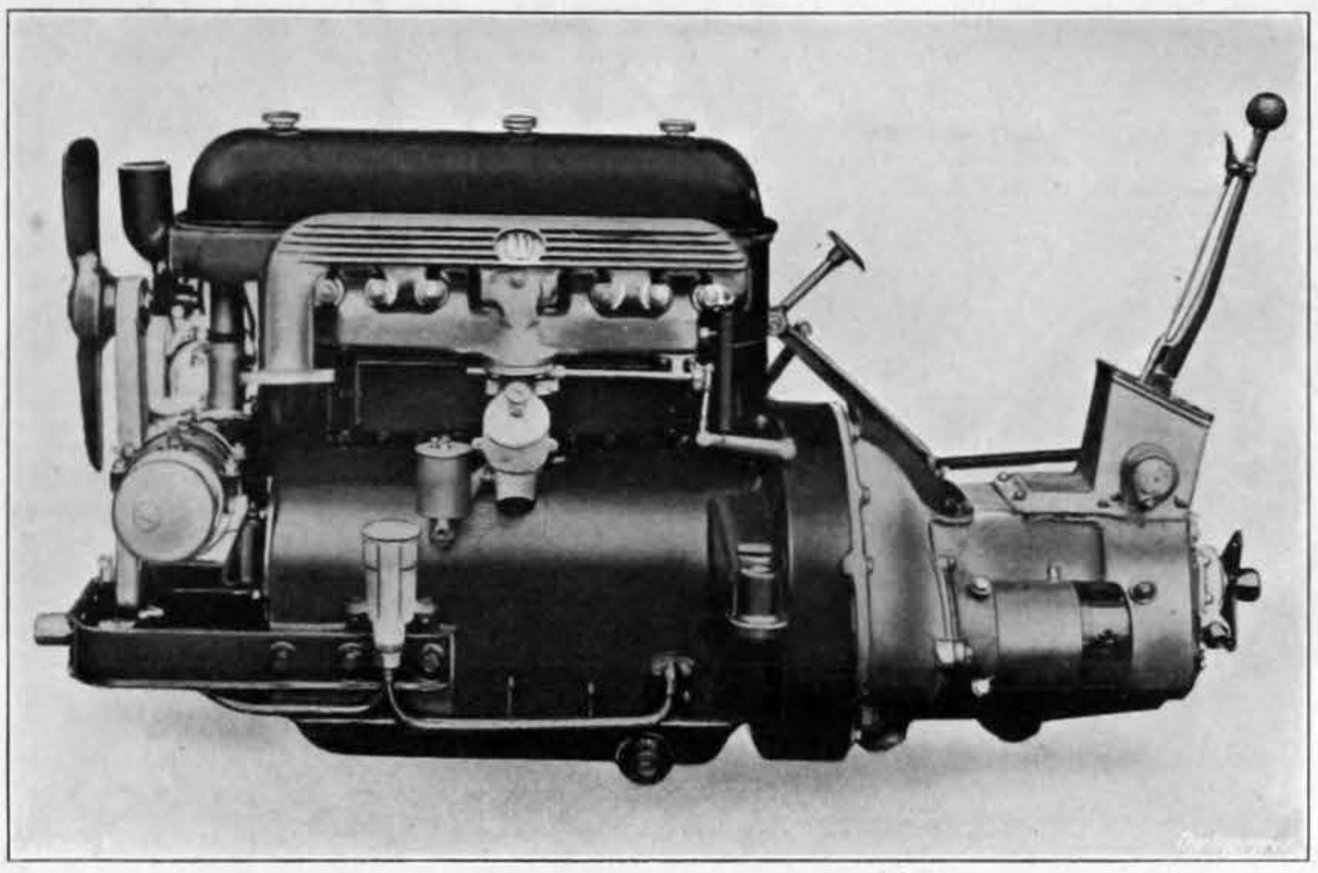


FIG. 9—16 - 45 H.P. ENGINE AND GEAR - BOX—WOLSELEY

14–45 Horse-power Six-cylinder Talbot.

One of the most popular exhibits at the Show, on account of its remarkably low price, is the new 14–45 horse-power six-cylinder car made by Clement-Talbot, Ltd., the chassis of which is shown in Fig. 10. In this vehicle the makers have introduced a neat-looking engine with cylinders 61 mm. diameter and 95 mm. stroke, the total capacity being 1666 c.c. and the rating 13·8 horse-power, which brings the car into the £14 tax class. The crank shaft has only four bearings compared with seven in the more powerful car made by the same firm, an arrangement which, while tending to cheapen the production, need not necessarily detract from the engine's sweetness of running, provided the crank shaft is sufficiently stiff and is accurately balanced. Another departure which the firm has made in order to keep down cost is the fitting of coil ignition instead of a magneto, and it will be interesting to note whether this departure meets with public favour. Hitherto, the British market has declared itself somewhat emphatically in favour of the magneto.

In order to meet the possible demand for the latter, provision is made for the fitting of a magneto when desired. The engine is cooled on the thermo-syphon system, with a V-shaped honeycomb radiator, while a fan in the fly-wheel induces a draught of air through the bonnet. Overhead valves with a simple device for regulating the clearance, a separate four-speed gear-box, single disc Ferodo-lined clutch, and spiral bevel final transmission gearing, are other features of this extremely reasonably priced car. As regards the chassis, we noticed that the front springs are anchored at their rear ends, instead of to the front dumb irons, and that the points requiring lubrication are more easy of access than is the case with some more expensive machines. The electric starting and lighting equipment includes a Rotax 12-volt set, and the carburetter is one of Smith's five-jet instruments, fed by an Autovac.

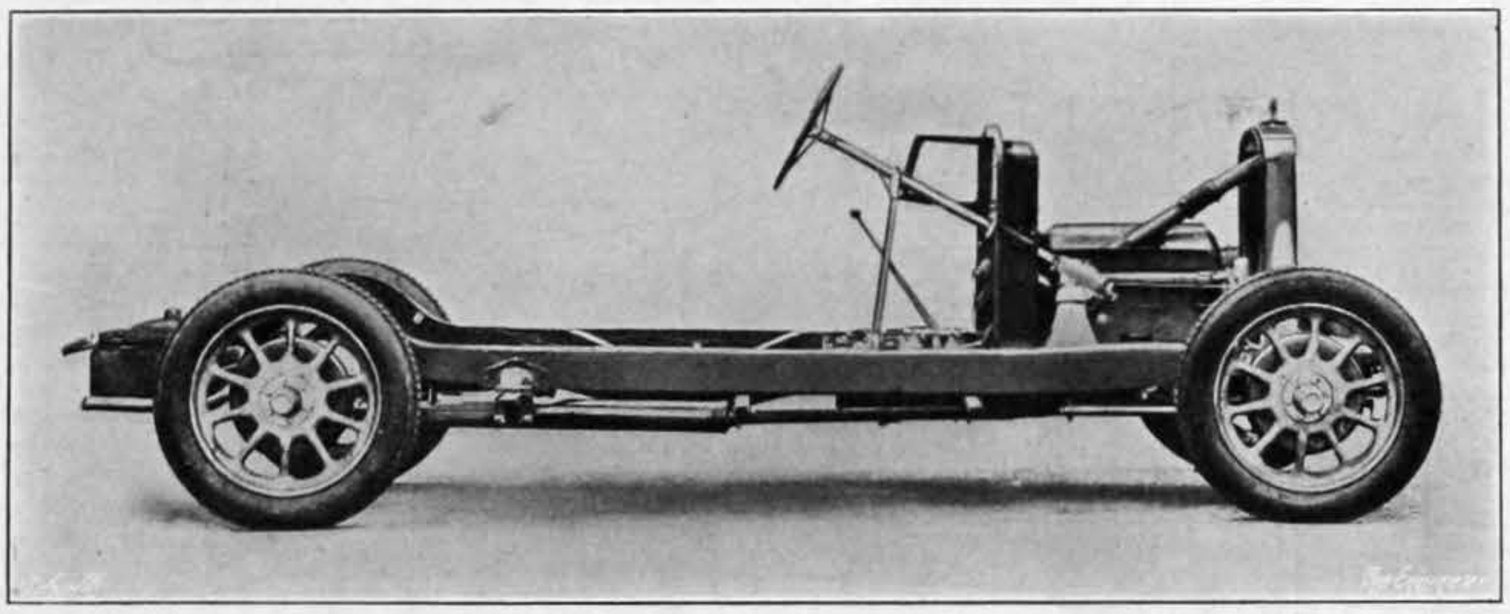


FIG. 10—CHASSIS OF 14 - 45 H.P. SIX - CYLINDER TALBOT CAR

Cast Iron for Diesel Engines.

At a meeting of the Diesel Engine Users Association on October 15th, Mr. Horace J. Young, F.I.C., read "A Note upon the Obligation of the Ironfounder to Diesel Engine Users," from which we take the following passages:

The future of Diesel engines, of all engines, depends upon efficient design and efficient material—the one without the other is inefficient and limited. It is futile to test the capabilities of any design when the material is varying in quality or unsuitable for the work. Probably 90 per cent. of Diesel engine users' records to date are prejudiced because the cast irons used were never twice alike nor really designed for the job. Progress in engineering has been delayed, and is being brought to a standstill in this country, by reason of the fact that the average ironfoundry is working on lines precisely similar to those used before Diesel engines were introduced. Few engineers and fewer foundries consider the metal at all. As for making two castings—one one year and the other, say, twelve months later—so that one is indistinguishable, metallurgically, from the other; as for deliberately making them to any precise composition; as for attempting anything drastically new—it is no exaggeration to say that any one of these conditions is seldom attempted seriously or considered necessary.

The engineer rather than the foundryman is to blame for this state of our foundries. The price offered for many ordinary castings has been, and still is such as to reduce foundrywork to the level of a "sweated" industry. The specification for higher class castings, for which to-day a big price is given, is unbelievably childish.

In the case of Diesel castings where the user is willing to pay a good price, the position to-day is that he rarely obtains value for money. He can never hope to obtain it from any foundry which is not going as deeply into the matter of cast iron and employing as skilled assistance as does the Diesel engineer in the design of his own work.

Expensive pig iron is worth using only when it is used with knowledge. Hundreds of tons of high-priced irons are purchased by foundries which need not use any; those which should use it seldom have the knowledge to benefit from so doing and often fail to purchase the right quality for their purpose. It is a rare experience to go into a foundry and not to find them blindly wasting money in this manner. As has been said, the ordinary foundry has no need for high-priced iron, whereas the foundry making Diesel castings can benefit only if it knows what is worth paying for.

Owing largely to continental enterprise in applying science to industry there is more known about cast iron with every year that passes. The trouble in this country is that long-standing lethargy has reduced our means of understanding and our power to keep pace with improvement.

It is for members of this Association to consider whether all is well in the foundries of this country, whether they are fulfilling or capable of fulfilling their obligations to the Diesel engine user. Not a few engine builders possessing foundries are either having their important castings made outside or are purchasing them abroad. This means to say that the very foundries which should be gaining experience and giving thought to the problems involved are not asked to make the important castings. It follows that whilst large sums are being spent upon castings, those spending them are gaining no knowledge, and no progress is being made on the metallurgical side of the question—the money expended going to outside people—or else abroad—instead of towards the improvement of their own foundries.

That our foundry people in the face of these facts should rest content is unbelievable; that the user of engines will need better material, and again better, is certain.

The fundamental requirements of engineering are:—

(1) That ironfoundries shall be capable of repeating times without limit any one casting of which the material within the casting—not in a separate test bar—is the same always in composition and physical properties as determined by analytical and physical testing and by the microscope.

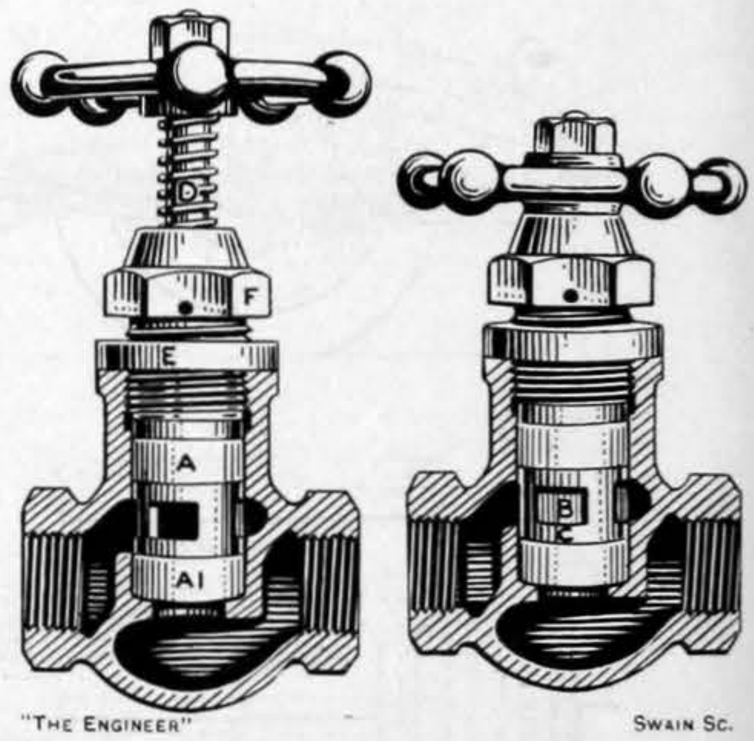
(2) That ironfoundries shall be capable of producing castings to definite specifications of composition and physical properties.

A Piston-type Steam Valve.

In describing the exhibits at the British Empire Exhibition, we made brief reference to a new type of steam valve made by Klinger Patents, Ltd., of 120, Southwark-street, London, S.E. 1—see The Engineer, June 27th, 1924, page 704—and gave an outline of its construction.

Since that time some slight improvements have been made in the design of the valve, and, in view of the promising nature of the idea, we have specially asked the makers to submit for our inspection a valve which had been actually in service for some time. Such a one was kindly supplied by Mr. Glass, the station superintendent at Carville Power Station, and our inspection confirms our previous conviction that the valve would eliminate many of the troubles experienced in keeping valves tight when working with high-pressure superheated steam.

The valve in question had been in service controlling a



"The Engineer" Swain Sc.

supply of steam at 250 lb. per square inch and a temperature of 700 deg. Fah., and showed not the least sign of wear about the metal parts; but just before it was sent here the Carville engineers had fitted it with a new pair of packing rings, so we are not in a position to pass any opinion on their condition. In any case, the cost of the rings is insignificant, and they are very easily replaced. The packing rings are shown, in the accompanying drawing, at A and A 1, and it may be as well here to recapitulate our description of the valve.

The body of the valve is more or less normal, and is bored out to receive the packing rings and the ported lantern C. The assembly of rings and lantern is held in place by the screw F and the lock nut E. Inside the lantern there slides a piston B, which is operated by the hand wheel and screw D. When the piston is in its upper position the ports in the lantern are uncovered and there is a free flow of steam; but when the piston is screwed down, it makes a tight joint, round its circumference, with the ring A, and the steam is shut off. The tightness of the joint is, of course, dependent on the pressure applied by the screw F to the packing rings, which are made of a special mixture prepared by the Klinger company.

One of the special merits claimed for the valve is that, should the edge of the piston become scored through the wire-drawing of high-pressure steam, it is only necessary to screw it down a little further to get a thoroughly tight cut-off of the steam.

Railway Matters.

THE Works Committee of the Westminster City Council has recommended the continuation of the experiment of railway light signals for controlling the road traffic into and along Piccadilly.

SPEAKING at the Labour Congress at Margate last Tuesday week, Mr. J. H. Thomas said that there were 45,000 railwaymen who had been unemployed since the general strike, and a further 200,000 were working only three days a week.

THE directors of the London and North-Eastern Railway have decided to construct a branch railway, 3 miles in length, to serve the Stanton Iron Company's new colliery which is in process of development at Bilsthorpe, in the Nottinghamshire coalfield.

IT is very unlikely that any restriction will for the present be placed on the railway services as a result of the continuance of the coal dispute. The freight train mileage has been reduced to correspond with the less tonnage carried and the winter passenger train service is in operation.

IN the Miscellanea column of our issue of August 27th last we quoted some comments from our contemporary, the *Electrician*, as to gas-lighted vehicles being concerned in the collision of May 10th at St. Margaret's, Edinburgh. In that relation it may be noted that the Railway Returns for 1925 showed that out of 1330 passenger-carrying vehicles built or purchased by British railways during that year, 1325 were electrically lighted.

WHEN giving evidence before the Railway Rates Tribunal recently, Sir Ralph Wedgwood said that about a month ago the statement was very widely made in some of the technical and lay Press that the general strike had put the companies in the position of being able to reduce their staff by 4 per cent. He did not agree. It was not such a simple matter as was suggested. The companies would reduce staffs as and when they could, but the reduction would be very slight, and the strike had certainly not provided them with a royal road to cutting down.

THE clerks employed in the travelling post-offices in France have made a protest against the vehicles in which they ride being placed next to the locomotive, as, in the event of an accident, the leading coach is likely to suffer the most. Such an attitude was taken, twenty and more years ago, by the postal clerks in America, with the result that in 1907 the United States Postmaster-General made it a requirement in the contract for carrying the mails that the post-office vehicles were to be of steel construction. That was the introduction of the all-steel passenger coach into America.

SEVEN months before it was legally required to complete the work, the Illinois Central Railroad has just finished and opened its electrification in Chicago. The work has called for the erection of 900 catenary structures, the running of 293 miles of current transmission wires, and of 470 miles of messenger and contact wires. For the new services 130 motor and 130 trailer cars have been provided. The electrification is only part of a big scheme which eventually will involve the removal of approximately 10,000,000 cubic yards of earth, the addition of 250 miles of track to the terminal facilities, the electrification of 420 miles of railway, the depression or elevation of 80 miles of line and the realignment of 120 miles.

THE London correspondent of the *Manchester Guardian* anticipates that there will be co-operation instead of competition between air lines and railways. He says that one step in that direction has recently been reported from Sweden, where an agreement has been arrived at between the State Railways and the A/B Aero-transport with regard to the conveyance of parcels and express freight. The railways will carry the goods between Stockholm, Gothenburg, Norrkoping, Orebro and Malmö, while the aeroplanes will link up Malmö with the aerodromes at Berlin, Hamburg, Amsterdam, Paris, and London. The agreement will be worked for a trial period until the end of the current year, and is said to be the first of its kind in Europe.

THE railway statistics for July of the Ministry of Transport, issued last week as a Stationery Office publication, price 2s. 6d., show that, mainly as a result of the coal stoppage, the number of passenger journeys made, when compared with those for the corresponding month of 1925, fell by 19·7 per cent., whilst the receipts therefrom experienced a decrease of 13·1 per cent. The passenger traffic receipts generally had a drop of only 11·7 per cent. The passenger train mileage, on the other hand, was reduced by 21·3 per cent., which would effect a considerable reduction in the working expenses. The tonnage fell by 64·6 per cent. Necessarily most of this reduction was in the coal traffic, but as that is very lowly rated the decrease in receipts was 43·1 per cent. Here again there was a considerable saving in working expenses, as the freight train mileage was reduced by 41·5 per cent.

ANOTHER phase of the level crossing question is prompted by the facts revealed at the inquest on a motor cyclist who was knocked down and killed by a train recently at Hensall, on the Wakefield–Goole line of the London, Midland and Scottish Railway. The crossing in question is one of a type of which there is a considerable number. It is that of a public road where the gates are worked by the wife of a platelayer, who, in consideration of that work, lives rent free in the lodge at the crossing. The woman has to attend to the gates at all hours, and thus is always on duty. Signals are provided for protecting the gates, but there is no interlocking between gates and signals; all that is provided is an indicating instrument that repeats the block signals. Instructions are given that before the gates are opened to allow road traffic to cross it must be seen that no train is signalled on the block instrument, and that the fixed signals—which normally stand "off"—are put to "danger" before the gates are opened. On the night in question two motor omnibuses were expected, and the platelayer volunteered to see to them and allowed his wife to go to bed. In anticipation he unlocked the gates, and they were found in that condition by the cyclist, who opened them, and was crossing when he was hit by a passing train.

Notes and Memoranda.

A PROCESS for making carbon dioxide by mixing sodium bisulphate with sodium bicarbonate, has been discovered by a Swedish chemist. The resultant gas is said to be cheap and pure.

VERY encouraging results have attended the experiments in sugar beet growing in Manitoba this summer. From 160 plots grown in widely separated areas high averages were secured.

IT is claimed, in the *Iron Age*, that a crane being installed in the Homestead Works of the Carnegie Company will be the largest steel plant crane in existence. It is to have a capacity of 275 tons, and will be used for lifting out and changing complete mills, instead of only changing the rolls. This principle of working is, of course, familiar in England, but, we believe, not on quite such a grand scale.

IN preparation for making the welded joints of a 26in. steel water main, in California, considerable work was involved in cleaning off the protective coating of tar, until a tool described in the *Engineering News-Record* was adopted. It comprised a piece of ⅛in. copper plate 3½in. square, to three edges of which strips of hard steel were brazed. It was fixed to a tubular handle down which there was sent a supply of low-pressure acetylene for heating the blade.

THE Secretary of the Department of Scientific and Industrial Research announces that a licence under Sec. 20 of the Companies (Consolidation) Act, 1908, has been issued by the Board of Trade to the Research Association of British Paint, Colour and Varnish Manufacturers, which has been approved by the Department as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. The secretary of this Association is Mr. J. B. Graham, 8, St. Martin's-place, Trafalgar-square, W.C. 2.

THERE are, it is estimated, about three and one-half million tons of black manganiferous iron ore—low phosphorus, high silica—and about twenty-four million tons of brown ore—high phosphorus, low silica—in the deposits of the Cuynna range in northern Minnesota. The figures represent what might be called proven ore, and do not indicate the ultimate tonnage which may be produced. In order to show the composition and extent of known deposits, the various bodies of brown and black ores have been segregated according to composition and tonnage.

THE American Bureau of Mines has been investigating the effect of change of temperature on pipe lines used for conveying natural gas. A transmission system in a hilly district was tested for leakage. In the roughest part of the district where the lines were uncovered on account of the high initial cost of ditching, the annual leakage averaged about 2,000,000 cubic feet per mile of 3in. line at 100 lb. per square inch gauge pressure. On the same transmission system, where the topography was more favourable for ditching, and the lines were buried, the annual leakage varied from only 100,000 to 200,000 cubic feet.

AMONG the most useful tests for ascertaining whether too much lime has been added to boiler water in the process of softening it, is, according to *Vulcan*, that of using silver nitrate as a reagent. Some of the water is taken and a drop or two of 10 per cent. silver nitrate solution is added. If excess of lime or caustic soda be present a yellow precipitate will be produced. Another test of value is to add a crystal or two of barium chloride, filter off, and estimate the alkalinity with standard acid, using methyl orange as indicator. Any retained alkalinity is then due to lime, as barium chloride precipitates that due to sodium carbonate.

A FORMULA for waterproof glue, giving a degree of water resistance comparable with the best casein glues is, according to the *Chemical Trade Journal*, as follows:—A grade of animal glue suitable for woodworking is soaked in such a proportion of cold water as is required by its grade and is then "melted" in the glue pot. Paraformaldehyde of 50 mesh fineness and oxalic acid are then added in the proportions respectively of 10 per cent. and 5 per cent. on the weight of dry glue taken. As soon as the oxalic acid has dissolved the glue is ready to use and will remain in a suitable condition for application for seven to nine hours at a temperature not exceeding 45 deg. Cent.

FROM January to August of the present year 1575 men have been killed by accidents at the coal mines throughout the United States, resulting in a death-rate per million tons of 3·84, as compared with 4·03 for the same period last year, a reduction of nearly 5 per cent. Reports for bituminous mines alone showed an eight months' fatality rate of 3·65, as against 3·58 for the corresponding months of 1925, a slight increase, which was more than offset by the decrease of the anthracite rate from 6·35 to 5·08. An analysis of the 1575 fatalities for the first eight months shows a reduction in the death-rate per million tons as a whole, and also for falls of roof and explosives; no change in the rate for haulage accidents; and a slight increase for explosions and electricity.

WATER seepage into quarries is very costly and troublesome, particularly in northern localities, states the American Bureau of Mines. In summer time the expense of pumping may be high, and in winter there is difficulty, danger and additional expense through accumulation of ice. Lately a great improvement in such conditions has been accomplished by a new method of drainage. In a carefully selected position outside the quarry some distance back from the face in the direction from which the water naturally flows toward the quarry, a 6in. well-drill hole is sunk to such a depth that it pierces the water-carrying beds. Charges of dynamite are then fired in the hole in or near the water-bearing strata. Thus the rock is so fractured that water may readily flow to the drill hole. A pump is then installed to remove the water from the hole. Thus the drill hole taps the joints and seams through which the water travels, and intercepts the flow before it reaches the quarry face. The system is in successful operation at a slate quarry at Pen Argyl, Pa., the flow of water over the quarry face being reduced to a mere fraction of its former volume.

Miscellanea.

A FACTORY is to be put up in Western Canada for the manufacture of paper from straw.

A COMPANY with a capital of £10,000 has been formed to run a service of taxi-cabs in Peking.

THE Tungting Lake, in the Yangtze Valley, is to be surveyed by the Yangtze River Improvement Commission.

SOME extensive deposits of nickel ore have been discovered near Maikop, in the Caucasus, by a geological survey party.

A LARGE deposit of phosphate rock has been discovered in the Seschensk district of Russia, and is to be converted into fertiliser locally.

AN iron and steel works is to be put up at Corral, in Chile, and will employ the local water power, which amounts to some 120,000 horse-power.

A COLD-STORAGE plant, which, it is said, will be one of the largest in Western Canada, is to be put up at New Westminster, at a cost of 4,000,000 dollars.

AN experiment is to be made at the West Rand Consolidated gold mine on pumping slimes with a rubber-lined centrifugal pump, the invention of the Hon. R. C. Parsons.

THE Kawasaki Dockyard, Japan, is making arrangements to increase its output of sheet steel to 150,000 tons in 1929. The principal product is No. 30 sheet according to the American gauge.

THE Paotowchen–Ninghsia road, in China, is roughly 400 miles long, and carries a considerable amount of motor car traffic. The whole journey occupies three days, and the fare by passenger car is about £4 10s.

A PRELIMINARY survey of agricultural lands in the district between Gypsumville and Grand Rapids is being undertaken by the Provincial Government to assist in the establishment of a second pulp mill in Northern Manitoba.

THE Shanghai Arsenal is to be converted into a limited company, under the title the Shanghai Iron and Steel Works, with a capital of £300,000. The company will be principally engaged in refining steel and the manufacture of machinery.

A WELDING exhibition is to be held in connection with the annual autumn meeting of the American Welding Society at Buffalo, N.Y., on November 17th, 18th and 19th, 1926. Headquarters will be at the Broadway Auditorium. A feature of the exhibition will be a large variety of welded products.

NEW equipment and new construction, costing 500,000 dollars, will be added to the Imperial Oil Company's plant at Regina, Saskatchewan in the present year. A cracking plant to handle crude oil from Montana will be built. Machinery has been ordered, and it is hoped to have the new facilities operating early in the new year.

THE initial official step towards the erection of a new bridge over the Niagara River, connecting Canada with the United States, is a notice given in a local newspaper that application is to be made to the Federal Government for the incorporation of a company, to be known as the Niagara Falls Memorial Bridge Company. The bridge is to be constructed at a cost of 4,000,000 dollars, and will join Surrey-street, in Niagara Falls, Ont., with Fall-street, in Niagara Falls, N.Y. The new bridge will be 70ft. wide, as compared with the 45ft. width of the International Bridge.

WITH much regret it has to be recorded that the condition of the Tsingtao wharves and harbour is passing from bad to worse, says Mr. Wm. Macdonald, Commissioner of Customs for Kiaochow, in his annual report for 1925. Not only have all the shore properties been neglected, but the fairway and the shipping basins have not been dredged for a long time, thus causing inconvenience, even danger, to the vessels entering and leaving the port; and, if the present state of affairs continues, the ruin of the shipping facilities must follow in the near future. It is earnestly hoped that the authorities concerned will consider the matter seriously and take active measures before it is too late, for the prosperity of this port very largely depends on the good condition of the harbour and the efficiency of the wharves.

ACCORDING to Mr. R. Boulter, Commercial Secretary, H.M. Embassy, Tokyo, the reconstruction of the two principal cities—Tokyo and Yokohama—which were severely damaged by the earthquake of 1923, has been disappointingly slow. The preliminary work of adjusting land in accordance with town-planning and street-widening requirements has proved a laborious task. So far as Tokyo is concerned, it may be said that little has been done in the way of permanent construction to replace temporary buildings. The latter have been given until August, 1928, as a period of grace during which they are exempted from compliance with the town-planning regulations. Some new construction is, of course, proceeding, but in general the temporary erections put up hurriedly after the earthquake remain typical of the buildings in the devastated areas.

WORK has been started on the new plant of the Chapei Electricity and Waterworks Company, Shanghai, and the new plant is expected to be ready for operation by June, 1927. Its daily capacity in the beginning will be 10 million gallons and may be increased to 40 million gallons. Water will be drawn from the Whangpoo River instead of the Soochow Creek, which is the present source of supply. The new plant will have (1) two coagulation basins, twelve rapid sand filters, and two chlorinators, all of which will have the combined capacity of 10 million gallons; (2) one pump house to be equipped with a centrifugal pump driven by a motor with 1000 kilowatt power and with a water pressure equivalent to 100 lb. to the square inch at the works and 40 lb. per square inch for hydrants; (3) five purified water reservoirs with a capacity of 957,000 gallons; (4) a water tower, 95·5ft. high, with a capacity of 170,000 gallons; and (5) water mains consisting of cast iron pipes, 36in. in diameter, which will aggregate a total length of 7·5 miles, and which will be connected with the existing distribution system. The cost of the new plant is estimated at 2,000,000 dollars (say, £200,000).

KILLERMONT BRIDGE, GLASGOW

MR. THOMAS SOMERS, M. INST. C.E., GLASGOW, ENGINEER

(*For description see page* 448)

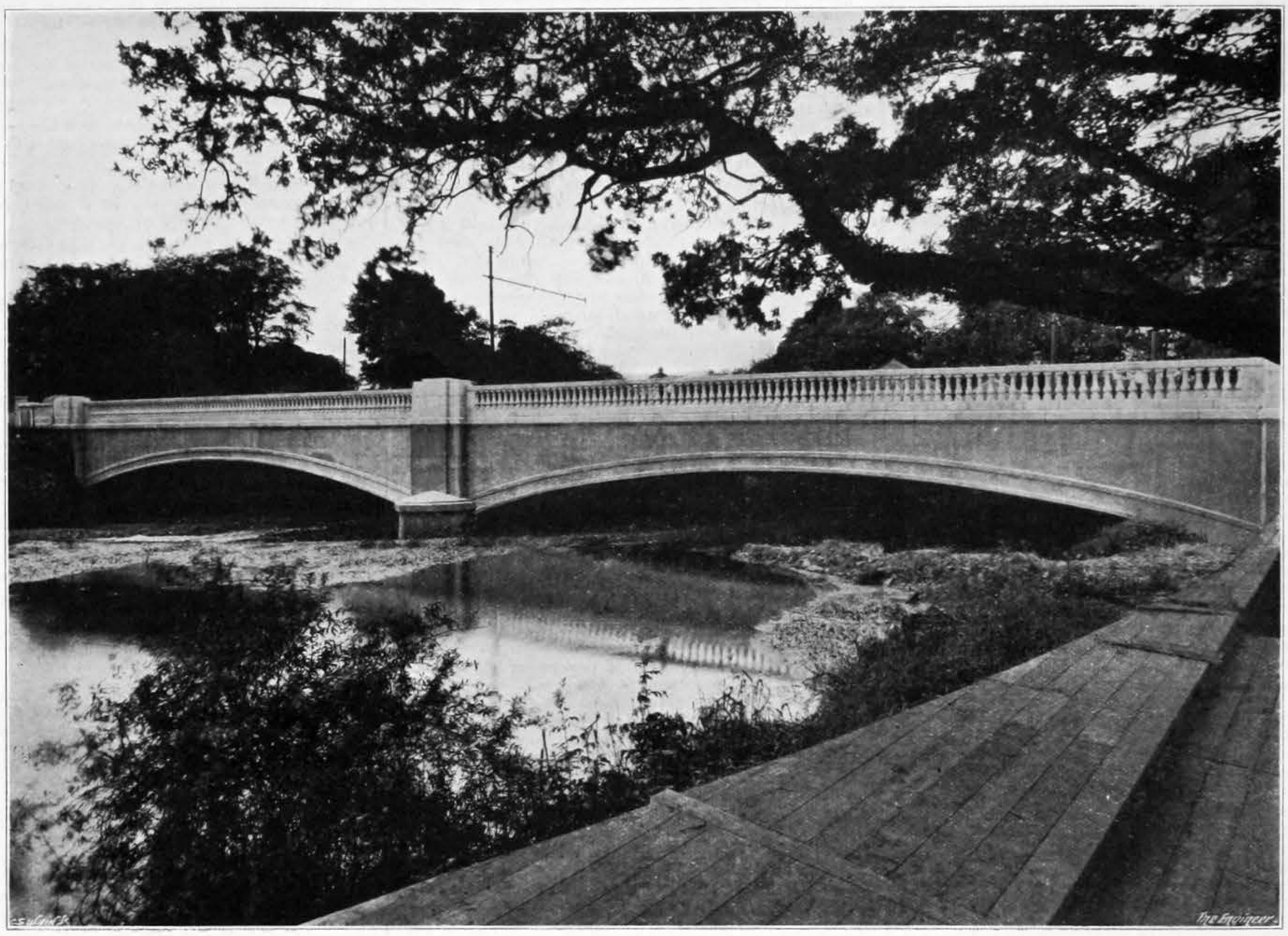


FIG. 1—VIEW OF THE BRIDGE WHEN PARTIALLY CONSTRUCTED



FIG. 2—FIRST SECTION NEARLY COMPLETED

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OCTOBER 22, 1926.

The Guns of the Fleet.

THE new battleships Nelson and Rodney, now nearing completion, are in many respects the most interesting vessels of war which have been built in this country for the past twenty years. In appearance, armament and, probably, in structural detail as well, they differ radically from all preceding battleships. It is understood that they are, in effect, reduced copies of the 48,000-ton battle-cruisers of the "super-Hood" class which were ordered in 1921, but subsequently cancelled under the Washington Treaty. As the "Nelsons" are 13,000 tons smaller, it is evident that they must be considerably inferior to the prototype in one way or another, but the sacrifice appears to have been made chiefly at the expense of speed. If so, the decision is to be commended, for the complete suspension of battle-cruiser construction brought about by the Treaty, added to the fact that of the eight vessels of this type now in existence four belong to the British Navy, has necessarily diminished the importance of high speeds so far as capital ships are concerned. A reduction in engine power was therefore preferable to any sacrifice of armament or protection, and we shall not be surprised to learn that this principle has governed the design of the "Nelsons." It is now common knowledge that the main armament of each ship consists of nine 16in. guns, a calibre new to the British service. Particulars of the new gun are lacking, but its ballistic properties are presumably not very dissimilar to those of the 16in. pieces listed in the ordnance tables of Vickers, Elswick, and Beardmore. Taking the Elswick gun as typical, it is found to have a length of 45 calibres, a weight of 108 tons, and a projectile of 2130 lb. The initial velocity is 2630 foot-seconds, and the muzzle energy 102,160 foot-tons. According to the Tressider formula, the gun will penetrate 58in. of wrought iron at the muzzle, or 4·3in. more than the 15in. weapon of 45 calibres. The rate of fire is returned as two rounds per minute. These figures refer to the wire-wound model, but both Elswick and Vickers list an "all-steel" 16in. gun, the Elswick piece weighing only 83 tons, though the initial velocity is 2700 foot-seconds, with a 2130 lb. projectile. The relative merits of wire and all-steel guns have, no doubt, been fully canvassed by the Admiralty ordnance officers. The wire gun has hitherto held the field in this country owing to its superior margin of safety as compared with the solid gun, this advantage being considered to compensate for the greater weight involved. On the other hand, there is no record of any failure in recent years of the all-steel guns with which American, French and German warships are exclusively armed. In the case of a vessel carrying nine 16in. guns, the substitution of all-steel guns for the wire variety would represent a saving in weight of 225 tons.

To a certain extent the calibre of the guns in the "Nelson" class was determined in advance by the Naval Treaty, which fixes the limit at 16in. As weapons of this bore were already mounted in foreign battleships, it would have been bad policy to accept anything less powerful for our new vessels. But apart from this consideration, there were sound reasons for choosing the heaviest gun permissible. All the experience gained during the war points to the superior effectiveness of large-calibre guns under modern tactical conditions. Only six of our ships present in the Jutland action had a 15in. armament, and only four of them were closely engaged, yet it is made clear by the data now available that a large proportion of the most damaging hits sustained by the German ships was inflicted by 15in. projectiles. At a range of 18,000 to 19,000 yards the fire of the 5th Battle Squadron—Barham, Valiant, Warspite, and Malaya—was so effective that it compelled the van of the German battle fleet to turn away. Even at this great distance the 15in. shells had a remaining velocity of about 1400 foot-seconds, and were thus able to penetrate 8½in. K.C. armour. Destructive hits were made on the Grosser Kurfürst and other German battleships, and shortly afterwards the Derfflinger had two of her turrets destroyed by shells of the same calibre. It is true that the German guns of much lighter calibre—12in. and 11in.—showed themselves capable of delivering a most punishing fire, but this circumstance was due in part to the remarkable efficiency of the German A.P. shell, and in part to the relatively close range at which atmospheric conditions compelled the British Fleet to engage. Our battle-cruisers, in particular, had been expressly designed for long-range fighting, and were therefore endowed with great speed and heavy guns, but moderate protection. Their thin armour, which would have been adequate at the great range at which they were expected to fight, became a serious source of weakness at anything below 16,000 yards, and as ill fortune would have it, the heaviest exchange of fire took place at ranges considerably less than this. All German versions of the battle are in agreement as to the material and moral advantage that the Grand Fleet enjoyed by virtue of its ponderous guns. Nor should it be overlooked that the Germans themselves had decided, two years before the war, to adopt 15in. guns for their battleships of the "Bayern" class. A novel feature of the "Nelsons" is the mounting of their 16in. guns in triple turrets. They are the first British ships to be equipped with such turrets, though every other major navy save the Japanese had introduced that system before the war, and as long ago as 1909 a British firm—Armstrong, Whitworth and Co.—designed and manufactured 12in. triple turrets for the Italian battleship Dante Alighieri. The delay in adopting three-gun mountings for British ships was due, not to official conservatism, but to cogent reasons of a very practical nature. In the first place, our standard system of armament before the war provided for two turrets forward and two aft, in order to bring at least four guns to bear on any point of the horizon. As our ships were, as a rule, armed with guns of heavier calibre than those in foreign vessels of the same period, it was not thought necessary to mount more than eight per ship. It will be seen, therefore, that the triple turret offered no particular advantage to our Navy in pre-war days. But war experience has induced a revision of the tactical principles that influence battleship design. Special importance is now attached, first, to the maximum weight and volume of fire, and, secondly, to the strongest possible protection of gun positions. To meet these two *desiderata* it has been found expedient to mount nine heavy guns instead of eight, and to house them in triple turrets for economy of weight; further, to group all three turrets in the forward part of the ship, this concentration enabling strong armour to be worked into the gun houses, barbettes and trunks. By this method a higher degree of protection has been given to the nine guns than would have been feasible in the case of eight guns twin-mounted in the conventional fore and aft positions. While objection may possibly be raised to the loss of stern fire which this arrangement entails, we are inclined to think that the designers of the Nelson and her sister have found the best solution of a difficult problem. A theoretical drawback to the triple turret is its lower rate of fire per gun as compared with that of a twin mounting, but it will be within the recollection of our readers that exhaustive tests with an experimental three-gun turret were carried out by the Admiralty five

years ago. Had these proved unsatisfactory in respect of firing speed or any other essential quality, it is unlikely that the turret would have been approved for the new ships.

The normal development of naval artillery has been arrested by the restrictions imposed on capital ship construction by the Washington Treaty. But for the Treaty, it is morally certain that the trend of progress would have been towards larger calibres. Guns of 18in. bore were produced in this country during the war, and one was actually mounted in the battle-cruiser Furious, though it was soon found to be too powerful for her scantling. Lord Fisher told us in his memoirs that had he remained at the Admiralty "a 20in. gun would have been in the Incomparable"—a ship he had designed as the "last word" in battle-cruisers. It was just as well for the tax-paying community, perhaps, that this "battle of the calibres" was abruptly terminated by international agreement. In 1921 we were already in sight of the 55,000-ton ship, armed with 18in. guns, and costing £10,000,000. Competitive building on this basis would have been ruinous to a war-impoverished nation, and capital ship supremacy—which does not necessarily imply all-round naval supremacy—would soon have passed to the competitor with the longest purse. Barring unforeseen contingencies, the Treaty will remain operative till 1936, so that no increase in the calibre of naval guns is to be anticipated for the next ten years.

An Instructive "Water Hammer" Explosion.

Familiar as we are with the conditions under which "water hammer" is produced, experienced though we be in the steps to take for its avoidance, there is still much connected with the phenomenon concerning which we can as yet formulate only unsupported theories. In these circumstances it is perhaps natural to turn to water hammer as a last resort in the explanation of any particularly puzzling explosion. We might be pardoned if at first sight we concluded that some such influence had led Mr. Wren, the Board of Trade's Surveyor, to ascribe the cause of the explosion at the Barking Station on December 14th, 1925, to water hammer. The element concerned in the explosion was a valve chest barely four months old, forming part of the equipment of a turbo-generator supplied by a firm of no less standing and experience than C. A. Parsons and Co., Ltd. The set was in charge of a careful driver, who carried out correctly, except in one apparently small respect, the builders' starting instructions. A new and up-to-date plant supplied by a firm of renown and operated by a skilled driver; yet water hammer of a very intense character, according to Mr. Wren's report, was developed. Before accepting the Surveyor's verdict we are bound in the circumstances to examine alternative possible explanations of the mishap. Having made a close study of the matter, we have come to the conclusion that while alternative causes may have been in action, they could only have played a secondary part, and that water hammer as an explanation holds the field, not only by the elimination of other prime causes, but because all the conditions for its existence seem to have been present. While, however, we are so far in agreement with Mr. Wren, we find ourselves unable to accept completely the details of his theory as to the origin of the water hammer action. There is, as we hope to show, reasonable ground for believing that the action could not have taken place as Mr. Wren suggests it did. At the same time, there is another equally probable sequence of events which escapes the serious objection which we find in that advanced in the official report.

On page 452 of this issue the reader will find drawings reproduced of the valve chest which formed the seat of the explosion. The chest lay between the main stop valve and a turbine supplied with steam at a boiler pressure of 375 lb. and a boiler temperature of 725 deg. Fah. It contained a runaway valve designed to shut down the turbine when the speed rose to 3300 revolutions, and a double-beat relay valve operated from the governor. These two valves were placed in series. A central web containing the valve seats divided the chest into an upper and a lower chamber. In the upper chamber a cage was associated with the runaway valve, and a strainer of $\frac{5}{16}$in. steel, perforated with $\frac{1}{4}$in. holes, with the governor valve. A starting valve by-passing the main stop valve was provided to admit steam into the lower chamber at a level above rather than below its horizontal central plane. The whole of the generating station had been shut down at noon on Saturday, December 12th, for repairs, and the fires in the boilers had been banked. After a week-end of severe weather one of the boilers was under steam at 2 a.m. on the Monday morning. By eight o'clock two of the turbo-generators were under load and at 10 a.m. preparations were begun to place a third—that one of which the valve chest subsequently exploded—in commission. At 10.45 a.m. the condenser of the third set showed a vacuum of 7in. and at 11.30 a.m., half an hour before the explosion, a vacuum of 27in. During this period the by-pass at the section valve on the boiler side of the main stop valve was open, the drain adjoining the main stop valve on the boiler side slightly open, and the other drains closed. From 10 a.m. onwards, therefore, there was steam pressure on the boiler side of the main stop valve and the starting valve and a vacuum of some sort on the turbine side of the governor valve. At 11 a.m. the section valve was opened, so that from this time onwards the pressure behind the main stop valve and the starting valve was presumably the full working pressure. At 11.30 a.m. the drain leading from the lower chamber of the valve chest was opened and steam admitted to that chamber from the starting valve. When the water had been blown out of the lower chamber its drain and the starting valve were closed. At about 11.56 a.m. the runaway valve was opened and shortly afterwards the governor valve was lifted off its seats. At about noon the starting valve was eased, but as the turbine did not start it was opened wider. The explosion immediately followed. The cover of the governor valve, 3ft. in diameter and 3$\frac{1}{2}$in. thick, was violently projected from its seating, injuring four men and doing damage to the floor plates and floor joists in its descent. The failure was confined to the twenty-four 1$\frac{1}{2}$in. studs holding the cover in place, every one of which was fractured. Neither the cover of the runaway valve nor the chest itself was affected. As the studs were made of 30-ton steel, it is apparent that the governor valve cover was subjected to a force of at least 1250 tons, or about twelve times the force exerted on it by the normal steam pressure. According to Mr. Wren's theory, we are to suppose that either the main stop valve or the by-pass valve was leaking and that the leakage was condensing in the lower chamber of the valve chest and adding to the water already there, possibly from the previous run. This process would continue until the lower chamber was full, when we are further to suppose that the water continuing to accumulate would leak past the runaway valve and enter the upper chamber. When at 11.30 a.m. the drain was opened for a short time, the water in the lower chamber was drawn off, but because the runaway valve was not opened at the same time the water in the upper chamber remained where it was. At 11.56 the runaway valve was opened, but as the drain was now closed the water simply fell from the upper into the lower chamber. Up to this point there is little or nothing in Mr. Wren's theory which calls for criticism on the ground of improbability. Beyond it, however, his reconstruction of the sequence of events seems open to question. He suggests that the water which fell from the upper chamber was sufficient in volume to create a plug filling the lower chamber, and that this plug, exposed to a vacuum on the turbine side and boiler pressure on the other, was, when the starting valve was opened, shot forward against the governor valve cover with sufficient force to fracture all the studs. We are disposed to dissent from this view, firstly, on the ground that, judging from the proportions of the chest, the water contained in the upper chamber, even supposing that chamber were fully charged, would, when the runaway valve was opened, be insufficient to form a plug occupying anything like the full cross-sectional area of the lower chamber, but would lie merely as a layer covering the floor of the chamber. A second and graver objection to Mr. Wren's theory is to be found in the presence of the cage and the strainer in the upper chamber. The blow of the water hammer before it reached the underside of the governor valve cover would have to pass through the passages and perforations of these two elements. It is difficult to believe that it could do so, particularly as regards the strainer, without having most, if not all, of its energy dissipated. It is particularly difficult to believe that, while the blow, after traversing the cage and strainer, wrecked the governor valve cover, it failed before passing through either cage or strainer to produce any outwardly visible effect on the runaway valve cover.

The water hammer blow which wrecked the governor valve cover was, in our view, delivered from within the strainer without passing through the perforations. The runaway valve cover was saved because it followed, and did not precede, the governor valve cover in the direction taken by the travelling plug of water. It survived because the governor valve cover, receiving the blow first, was projected from its seating and released the pressure and would in any event probably have survived because of the baffling action of the strainer and the cage in that sequence. The blow was delivered upwards through the double-beat valve straight against the overlying cover and not sideways through the strainer perforations, as Mr. Wren suggests. That such a blow could be delivered can readily be understood. When the steam from the starting valve entered the lower chamber it encountered not a plug, but a layer of water on the floor of that chamber. The upper surface of the layer would be hot as a result of its contact with the leakage steam and would be speedily blown over through the runaway and governor valves down into the pipe bends below the governor valve. There is no record of these bends having been drained immediately before the mishap, and even though they had been, the hot water layer would in itself probably have been sufficient to form a plug in them which the vacuum at that distance from the condenser would fail to extract. When the hot layer had been driven from the accumulation in the lower chamber of the valve chest, the incoming steam from the starting valve would encounter the lower relatively cold layers and would quickly condense, creating a considerable vacuum inside the chest, a vacuum greater than that exerted by the condenser on the other end of the plug in the pipe bends. The plug produced by the hot water layer would as a result be rapidly drawn backwards up the bends, gathering pace as it travelled, and even though it suffered some restriction in passing through and around the double-beat valve, would strike the cover above with sufficient force to cause the recorded damage. This explanation can be given a quantitative basis and it can be shown that an effective difference of vacuum of about 10in. on the ends of the plug would be more than sufficient to endow the plug with the momentum required to fracture the twenty-four studs in the cover. There is evidence to show that the steel of which the studs were made had been slightly affected by the working conditions since the chest was first used, and that the cover when steam was admitted at the start of a run cockled on its seat by reason of the differential expansion of the internal flange to which it was attached. These factors may have weakened the resistance of the studs to the stress thrown on them, but it seems clear that they were not of sufficient moment by themselves to cause the failure, without the decisive factor of water hammer. Water hammer alone could have produced the enormous pressure required to fracture all the studs, and water hammer produced in the way we have indicated and to the extent necessary was a reasonable possibility of the conditions as set by the design and handling of the parts involved. The immediate outcome of the explosion is that the makers have fitted a drain above the governor valve and have adopted an alloy steel for the studs. From the general point of view the accident teaches us that precautions against water hammer still require meticulous attention on the part of designers, and that provision should be made that will compel their correct use at the correct time and in the correct order.

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Models and Analogies for Demonstrating Electrical Principles.

No. XI.*

On the occasion of a lecture on "Secondary Physical Phenomena," delivered by Dr. L. Fleischmann in Berlin in 1925, it was shown by means of the arrangement illustrated in Fig. 100 that in slotted armatures the teeth are principally the seat of the forces that cause revolution, and not the windings embedded in the slots. If a conductor carrying current is placed in a magnetic field it becomes exposed to a force the strength of which is determined by the strength of the magnetic field and the current density. A conductor which lies in a constant field will be exposed to a small force if a weak magnetic induction be created by a magnetic screen at the place where the conductor is fixed, and this phenomena occurs in slotted dynamo armatures. Electrical machines are universally built with the current-carrying conductors fixed in an iron mass, which is made up of thin iron sheets, and a magnetic field is generated by direct current flowing through electromagnets of suitable shape. In spite of the fact that as the conductors are embedded in slots they are only cut by a weak field, as the greater part of the flux passes

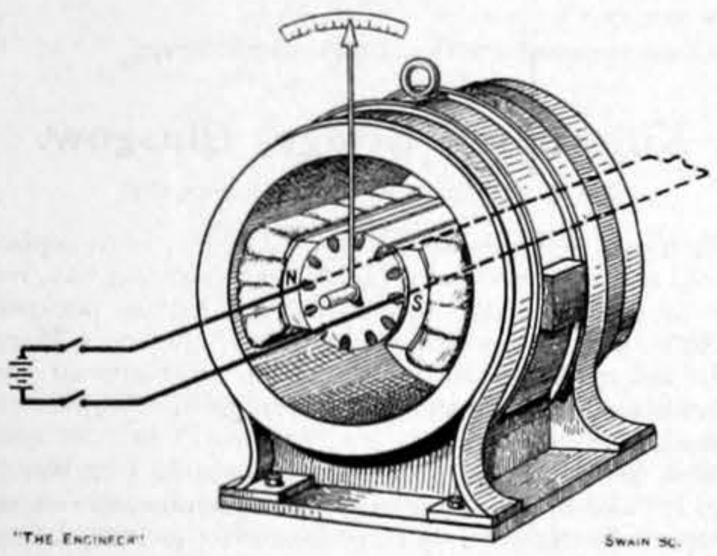


FIG. 100—ELECTRIC MOTOR EXPERIMENT

through the teeth, and notwithstanding that they are only exposed to small forces, the aggregate pull on the armature is the same as if the conductors were in a field of full strength. The question of where the component forces that are necessary to produce the total force are applied therefore arises, and the answer is that they are applied to the iron teeth; or in other words, to the iron pieces between the conductors. The apparatus for making this phenomenon clear—see Fig. 100—consists of a fixed housing which carries the windings necessary for generating the magnetic field and a slotted armature which can revolve in roller bearings. A loop of copper is placed in two slots, 180 deg. apart, and is connected to a battery. If the magnetic field is generated by direct current and a current is also passed through the loop, the latter will not move, but the armature will be deflected to the right or left, according to the direction of current in the loop, the movement being limited by the width of the slot. The force on the armature, which is provided with a pointer as shown, is proportional to the current.

The uneven distribution of an alternating current in

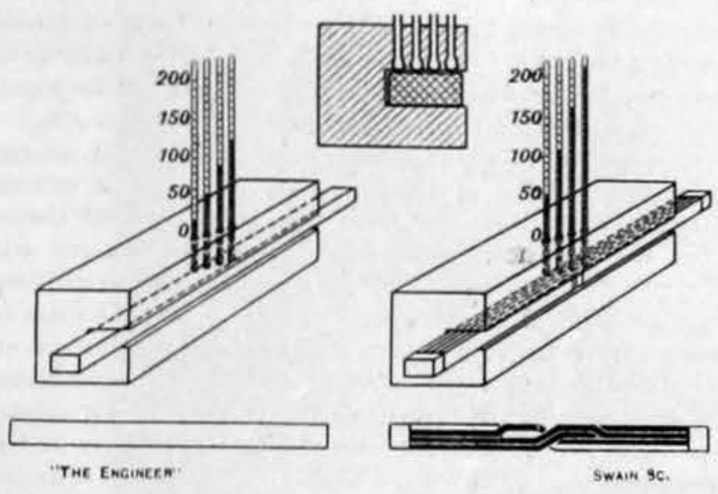


FIG. 101—EXPERIMENT SHOWING UNEVEN DISTRIBUTION OF CURRENT

a conductor embedded in a slot was also demonstrated with the aid of thermometers, as shown in Fig. 101. A high-frequency alternating current of constant strength will attempt to distribute itself over a conductor in such a way that the magnetic energy will be a minimum; that is, so that the self-induction coefficient will be as low as possible. The result is that the uneven distribution of current will cause the heat losses that occur in the conductor to be higher than is the case with direct current of the same mean density. In the arrangement shown in Fig. 101, the conductors are placed in an iron mass built up of sheets. One of the conductors is composed of four copper rods in parallel, whilst the others consist of twisted copper rods. In the latter case the losses under certain circumstances are higher than when the conductors are arranged in simple parallel fashion. The uneven distribution of current is indicated by the readings of a thermometer, the place where the maximum current occurs being shown by the highest temperature. Dr. Hillebrand has suggested that the vacuum space in the thermometer might be used as a Geissler tube, the length of the illuminated part being inversely proportional to the temperature. In order that the value of the self-induction may be low, the current tends to concentrate itself towards the outside of the conductor; in other words, towards the mouth of the slot, and this can be demonstrated by the thermometer readings. In the construction of large dynamos it is essential to devise means of avoiding these losses, and the practice of drilling the rods according to a definite law will give a conductor system in which these additional losses do not occur.

While Professor Wm. Cramp, of the Birmingham University, is apparently interested in the use of models and analogies for demonstrating electrical principles, most of his own work in this connection seems to relate to the development of methods of measurement by analogy. Strictly speaking, this is a matter which is outside the scope of these articles, but a brief account of his method of measuring capacity by analogy as described in *World Power* of November, 1924—page 267—may be given. His object has been to develop a method of measurement by analogy which is capable of giving very accurate results that can be applied to all condensers, even those of most irregular form, and which calls for no more equipment than a source of direct current, a voltmeter, an ammeter, and a standard that is quite easily made.

The capacity of a two-plate condenser on the rational or Heaviside system of units is the number of tubes of electrostatic flux that spring from one plate and terminate on the other per unit difference of potential between the plates. It is thus equal to the number of tubes from each square centimetre of plate surface per unit difference of potential between the plates multiplied by the area of one plate. But the number of tubes from each square centimetre per unit of potential difference is inversely proportional to the average length of tube at that square centimetre of surface, and directly proportional to the specific inductive capacity of the medium. Thus the capacity C of any condenser is the sum of the products of two factors, namely, the specific inductive capacity K of the insulating medium employed, and a geometric quantity determined by the shape of the condenser, having the dimensions of length, equal to each element of effective area of one surface divided by the length l of the appropriate tube of electrostatic flux. The capacity of any condenser may be written $C = \Sigma K a/l$, where K is the dielectric constant, a the element of area of one plate, and l the length of tube as defined above. If C is in micro-farads, a in square centimetres, and l in centimetres, then the value of K for air is $\cdot 0884 \times 10^{-6}$. K is the capacity of the medium in micro-farads per centimetre cube, and the quotient $\Sigma a/l$ is called the geometric permittance.

If, in place of the dielectric a homogeneous high-resistance conducting medium be employed, which displays no electrolytic effects, no polarisation nor contact drop, then any current which flows from one plate to the other under a constant potential difference will follow the same lines, and have the same distribution, as the tubes of electrostatic force which exist in the dielectric between the two plates; and, consequently, if a medium can be found having the attributes mentioned, the measurement of the conduction current would also give a measure of the capacity of the condenser. But unfortunately such media are not available, or, if they are, their conduction is so small as to make accurate measurement of the current as troublesome as the usual method of measuring capacity. Their conduction current, however, when a constant potential difference V is maintained across the plates, would be $I = \Sigma V \gamma a/l$, where $\Sigma a/l$ is the same geometric quantity as for the capacity, and γ is the specific dielectric conductance.

Thus, on the one hand, we have for a given medium $C = K \Sigma a/l$, and, on the other hand, $G = \gamma . \Sigma a/l$, where G may be termed the conductance. Since $\Sigma a/l$ is the same for both cases, the ratio of the capacity to the conductance is K/γ.

If, instead of the supposed homogeneous non-electrolytic medium an electrolyte be used, the conductance can be easily measured; but the experimenter is then faced with the question as to how far changes in the density of the electrolyte, polarisation effects, temperature and contact potential will invalidate the analogy between the two equations just given. A method of measuring capacity, similar in principle to that outlined above and involving the use of an electrolyte, has been put forward and to some extent examined by Kennelly and Whiting.* In that case, however, the conductance measurements were made by means of a Wheatstone bridge, and it was apparently assumed that, except for the existence of a polarisation voltage, the electrolyte would behave in the same way as a homogeneous non-electrolytic fluid conductor. This seemed to Professor Cramp to require experimental proof; and he therefore first arranged for a careful research on this point to be carried out in the laboratories of the University of Birmingham. That work has been done by Dr. A. A. Ahmed, and the general results appeared in the *Journal* of the Institution of Electrical Engineers, Vol. 62, No. 328. Having settled this matter, he next made a series of experiments on the form and use of calibrating standards designed to avoid the necessity of measuring the conductivity of the electrolyte, on the precautions to be adopted to secure reliable results, and on the order of accuracy to be expected.

It is well known that, when an electrolyte is employed, the sum of the decomposition voltages and the polarisation effects can be reduced by suitably choosing the materials of the plates, as well as those of the electrolyte. For this reason, it is well to adopt such combinations as pure copper plates and a solution of copper sulphate. The question that remains is whether alterations in density in the electrolyte and other phenomena at the electrodes will substantially modify the current stream, as compared with the corresponding stream of electrostatic flux. To this question the work carried out by Dr. Ahmed supplies the answer. It is not necessary to repeat what he has written, but it is sufficient to state that he has proved the three following propositions, using an electrolytic cell consisting of copper plates in a solution of copper sulphate:—(1) That the distribution of potential gradient in such a cell is analogous to that which exists between the same plates when hung in air; (2) that the specific resistance at every part of the electrolyte is substantially constant; and (3) that the current stream lines are practically identical in distribution with the stream lines of electrostatic induction when the plates are hung in air.

With regard to the conditions existing at the surface of the plates, Dr. Ahmed found definite evidence of a contact resistance, which was largely affected by the condition of the surface of the plates, being lower when the plates were rough. He also found that the pressure drop, due to this resistance, was proportional to the current density at each point of the plate. But the maximum value of this effect was, in his experiments, never higher than 6 per cent. of the total cell potential difference, and more usually was of the order of 4 per cent. Thus, by using a high cell potential difference and a low-current density, this inherent error may be reduced to a negligible quantity. It is true that a small difference between the theoretical electrostatic flux distribution and that of the corresponding current in the electrolytic case was found to exist near the boundaries of the cell, owing, as would be expected, to the presence of those boundaries which distort to some extent the natural lines of current flow. But, in general, this effect is so small as to be negligible, so long as the distance of the boundary from the edge of the plate is not less than the width of the plate, and that the distance between the plates is less than half the width of the plate. The following conclusions may therefore be drawn:—

If the plates of an air condenser of any form be made of copper, and immersed in a solution of copper sulphate having a specific conductivity γ, and if, when the potential difference of V volts be maintained between these plates, the current I flows, then the capacity of the condenser in air is given by the relationship—

$$C = \frac{I}{V}\frac{K}{\gamma}$$

The value of γ for the solution which Ahmed used was $\cdot 0202$ mho per centimetre cube, so that the general formula connecting the current and pressure with capacity becomes, for his electrolyte—

$$C = 4 \cdot 376 \ \frac{I}{V} \text{ micro-micro-farads.}$$

For a condenser in which a dielectric other than air is used, K must be multiplied by the dielectric constant of the insulator employed as compared with air. The electrolyte having the above conductivity at 15 deg. Cent. is a solution of 100 grammes of pure copper sulphate crystal per litre, so that the saturation of the solution was 32·8 per cent.

It follows, then, that for the measurement of capacity of any condenser, no matter how intricate its shape, it is possible to make in copper one of similar form, having plates similarly spaced, immerse it in a tank of the above solution at the correct temperature. On applying a small voltage across the plates, and measuring the current, the capacity is at once given from the simple equation just quoted.

The trouble of standardising the solution may be avoided by calibrating it, using for that purpose a condenser with a capacity that is either known or that can be calculated. Certain troubles have, however, led Professor Cramp ultimately to abandon all forms of standard in which the tubes of flux could not be restricted to definite and measurable boundaries and instead of plates, strips or rods, he decided to adopt a pair of concentric cylinders. Such a standard has indeed the disadvantage that the two electrodes cannot have the same area, so that on reversing their polarity slightly different results are to be expected. If, to minimise this evil, the internal cylinder be made as nearly as possible equal in diameter to the external cylinder, another source of error is introduced, for the resistance of the electrolyte to be measured, and consequently the voltage drop across it, becomes so small as to be comparable with the surface contact pressure; and accurate readings become impossible. A compromise is therefore necessary, and as a final and satisfactory form, Professor

* No. X. appeared October 15th.

* Kennelly and Whiting, *Electrical World*, December 29th, 1907.

Cramp has adopted the standard shown in Fig. 102.

This consists of two concentric pure copper cylinders C C. The external diameter of the inner one is 3·44 cm., and the internal diameter of the outer tube is 8·9 cm. These cylinders are supported and kept apart by perforated ebonite discs E E, and it will be observed that both tubes are let into the lower disc so as to prevent any possible flow of current from the ends of the tubes. The face of the lower disc thus becomes one boundary, while the other is the surface of the liquid itself when the standard is immersed, the immersed length being in most of Professor Cramp's experiments about 22 cm.

There is no special virtue in the above dimensions, except that by experiment it has been found that such proportions reduced the errors due to the two causes just mentioned, and led to satisfactory and consistent readings. It was found, for instance, that if the diameter of the internal cylinder were reduced to 1·3 cm., the difference observed on reversal was too marked to be neglected.

The metal of the standard must be scrupulously clean. No reliance can be placed upon it unless it is free from roughness, impurities, grease or oxidation. The metal surfaces must be first made smooth by lapping, or by means of very fine emery cloth. They must then be freed from all grease and impurities by washing, first with hot caustic soda, then with dilute nitric acid, and finally with clean water. After this, no part of the surface that is to be active must be touched again, and the design must be such that the fitting together can be accomplished under these conditions. Once the standard has been immersed in the electrolyte, it should be kept immersed, otherwise, in drying, oxidation of any deposited copper takes place, and when re-immersed the readings become uncertain. The electrolyte should be re-calibrated by means of the standard each time it is used, because it is very sensitive to variations in

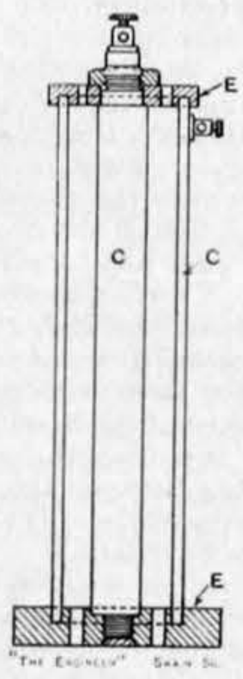


FIG. 102—CONCENTRIC STANDARD

temperature and density. When these precautions are observed the standard is found to be very reliable, as the following test will prove.

A solution of pure copper sulphate crystal* was made up, and a sample of it was taken and placed in an apparatus similar to that employed by Professor S. W. J. Smith,† so that by means of a standard resistance and an electrometer, its resistivity could be measured. It was found to be 109·55 ohms per c.c. at 15 deg. Cent. In a glass tank, 12in. by 6in. by 14in. deep, containing the same solution, the standard was immersed to an active depth of 21·9 cm., and a current was sent from the outer to the inner tube. The strength of the current varied from 0·1 to 0·99 ampère, the corresponding voltages varying from 0·12 to 0·8. These values were plotted and found to lie very consistently along a straight line which cut the voltage axis at 0·055 volt. The slope of this line, calculated from twenty-three readings, showed the mean value for the conductance G of the electrolyte in the standard to be 1·3296 mhos, with a departure above and below that value of 0·93 and 1·7 per cent. respectively. From the measured value of the resistivity of the solution (ρ) and the dimensions and immersion of the standard, the conductance can also be calculated, thus—

$$G = \frac{2\,\pi\,l}{\rho \log \frac{r_2}{r_1}}$$

where l is the active immersed length and r_2 and r_1 the radii of the inner surface of the outer cylinder and the outer surface of the inner cylinder respectively. These dimensions have already been given, and, filling them in, we find—

$$G = 1{\cdot}323 \text{ mhos.}$$

The discrepancy is therefore less than 0·5 per cent. of the measured conductance, and the reliability of the standard is established. There was no difficulty in repeating these results, and reversal of polarity produced inappreciable discrepancies. Since no printed curve can indicate how consistent the readings are that are obtained with this standard, the table below, which shows the results of one test, is given. In each case the voltage at zero current—·055—has been deducted from the actual reading of the voltmeter.

Ascending.			Descending.		
Volts.	Amps.	Conductance.	Volts.	Amps.	Conductance.
·153	·200	1·307	·745	·991	1·330
·23	·305	1·326	·682	·906	1·328
·3	·400	1·333	·600	·800	1·333
·375	·500	1·333	·525	·700	1·333
·45	·600	1·333	·448	·600	1·339
·53	·702	1·325	·375	·500	1·333
·603	·800	1·326	·300	·400	1·333
·683	·905	1·325	·230	·305	1·326
·745	·990	1·329	·153	·200	1·307

It will be noticed that the current densities employed are very low and do not exceed 0·005 ampère per square centimetre. This for less accurate work might certainly be increased, but a limit is soon found when, on account of rapid polarisation, the voltmeter needle refuses to remain steady while readings are taken. There is also the further disadvantage that at high-current densities other surface phenomena become more pronounced, as has already been mentioned.

The capacitance of the standard is—

$$C = \frac{\cdot 0884}{10^6} \cdot \frac{2\,.\,\pi\,.\,l}{\log \frac{r_2}{r_1}} \text{ micro-farads;}$$

or, putting the constants together and introducing logarithms to base 10—

$$C = \frac{0{\cdot}241}{10^6} \frac{l}{\log_{10} \frac{r_2}{r_1}} \text{ micro-farads.}$$

Having constructed the standard, it can be retained for the special purpose of calibration, and the measurement of a capacity proceeds as follows:—The calibrating condenser is immersed in any solution of copper sulphate contained in a suitable vessel. A measured pressure is then applied across it and the corresponding current is read. Dividing the current by the pressure gives the conductance G. The system of which the capacity is to be measured is then made also in copper, with adequate clearances as regards the boundaries of the tank, and immersed in the same copper sulphate solution. A suitable pressure is applied across it, and the current again read, which, divided by the pressure, gives us another conductance G′. Now, let C be the capacity of the calibrating condenser, as deduced from the formula given above, then the capacity of the new system is—

$$C \times \frac{G'}{G}$$

The question arises as to whether the model immersed in the electrolyte need be made the full size of the condenser the capacity of which is required, or whether, from a model made strictly to a proportional scale, the capacity of the original can be deduced. Kennelly and Whiting have given an answer to this question merely as a statement, without proof. They say—

"If the pair of conductors on which the measurement of conductance is made be a perfect model of the condenser n times reduced in linear scale, so that every centimetre in the actual condenser is represented by $1/n$th of a centimetre in the conductance model, then it is known that the conductance of the model will thus be reduced n times below the value that would be obtained with a system of full size."

This statement may be proved as follows:—The geometric part of all the conductance and capacity formulæ is, as shown above, in the form $\Sigma\, a/l$, so that if all the linear dimensions be increased n times, we have $\Sigma\, a\, n^2/n\, l$, which is $= n\, \Sigma\, a/l$. This is a valuable proposition, and the proof is perfectly general. It shows that there is no limit to the form of the condenser plates that can be dealt with. Thus, suppose it be required to measure the capacity of a complicated system consisting of an aerial of any shape, suspended at any height from the ground, and having any form of connecting wires passing in proximity to walls or buildings. The aerial system is made to scale by using appropriate copper wire for the aerial and its connections, and the earth, walls, and buildings are suitably represented by copper plates made to scale and placed with respect to the aerial in the proper relative positions. The whole is then immersed in the tank of copper sulphate, which has been calibrated as explained, and the capacity of the system is deduced from the ratio of the conductances measured in this simple manner multiplied by the scale ratio of the actual condenser to the model.

There are certain cases in wireless telegraphy in which capacity has never satisfactorily been deduced theoretically; and there are also many occurring in ordinary electrical engineering applications. It seems scarcely possible to hope that any mathematical theorem will ever be capable of solving some of these, but by the above method they can be deduced practically—much in the same way as the figures regarding ship propulsion are usually deduced from scale models in experimental tanks.

A limit to the accuracy of this method arises in the case of radiating systems, which are intended to affect, not merely a restricted region, but a vast volume; in other words, when the dimensions of the dielectric are virtually infinite. It is impossible to have infinite tanks full of electrolyte, and in consequence these cases require judgment in the selection of a ratio between the size of the model and that of the tank, so as to reduce the inevitable error to a negligible quantity. It is obvious that the measured capacity will always be smaller than the actual, but the discrepancy in most cases may be made inappreciable.

Other limitations, of course, arise in connection with capacity measured in this way, as compared with that which will be effective when the system is excited by alternating potential differences, and this may be urged as an objection to the method. It is well known that many factors come in to modify the static capacity of a condenser when it is used on an alternating-current system of high frequency; but these corrections are also involved in most of the existing methods of capacity measurement, since it is hardly possible to drive commutators at a speed corresponding to the frequencies used in wireless work. At its worst, Professor Cramp's method will at least give an easily measured approximate value; at its best, for frequencies such as occur in ordinary electrical engineering problems, the value of the capacity given by the test is substantially accurate.

Killermont Bridge, Glasgow.

By W. L. SCOTT, Assoc. M. Inst. C.E.

The new Killermont Bridge, Glasgow, is to replace an old three-span stone arch bridge, spanning the river Kelvin. The bridge has a width between parapets of 80ft., and it was designed to carry the main Maryhill-road traffic, including two lines of tramway cars, in addition to the standard loading of the Ministry of Transport.

The new structure—a view of which is given in Fig. 1, page 444—is a two-span arch bridge, the superstructure being entirely in reinforced concrete, except the string course and parapets, which are of gray granite. The work is being carried out to the general requirements and under the supervision of Mr. Thomas Somers, M. Inst. C.E., City Engineer of Glasgow. The bridge has a total length of 185ft. between abutments. The width of the roadway is 56ft., and the two footpaths are each 12ft. wide. The road gradients and levels were fixed by the road approaches at either end, whilst the springing levels of the arches were determined by the requisite waterways to be provided. Each span is 86ft. 7in. clear between supports.

The following accommodation for pipe mains, &c., was specified:—*Post Office*, cable space 2ft. 6in. wide, 3ft. deep; *Water Department*, two mains 38¾in. external diameter and one pipe 5in. external diameter, and provision to be made for one main to be laid under each footpath at such times as may be convenient to the water department; in addition, provision had to be made for one main to be laid temporarily under the portion of roadway first constructed, and upon the completion of the bridge for that temporary main to be transferred to its final position; *Gas Department*, one main 20¼in. external diameter and one main 13¼in. external diameter; *Electricity Department*, two cable spaces, 3ft. wide and 2ft. deep; and *Tramway Department*, central duct, 14in. wide, 28in. deep and with 36in. of cover. The City Engineer also specified that "the roadway be kept open for all traffic at present carried by the existing bridge during the entire course of the work."

The foregoing factors principally affected the design of the new bridge and determined to a great extent the type and form of structure required to meet them.

The arrangement adopted for the abutments and the river pier was decided by the natural conditions at the site and the information given by the journal of bores supplied. The strata supporting the main concrete foundations are of sandstone, and the maximum pressure imposed on that material is 5½ tons per square foot. The form of these foundations is shown in the accompanying drawing. There is nothing unusual in their design, and they were constructed without any difficulty.

In the superstructure, however, one or two novelties have been introduced. They resulted from the following factors:—(1) The "flatness" of the arches or small rise available in each span; (2) the necessity of a complete transversal expansion joint owing to the overall length of the reinforced concrete construction; (3) the requirement to construct the bridge in two longitudinal halves, so as to permit of the passage of traffic; and (4) the pipe and cable accommodation specified as described above.

The general arrangement of members employed is shown in the drawing, and in Fig. 2, page 444. There are in each span ten longitudinal arch ribs stiffened by a vault slab, cross walls, and, as far as possible over the width of the roadway, by a deck slab 8in. thick. The entire construction, including the granite parapets, is severed by a transversal "expansion" joint over the central support—Fig. 2, page 444. The pipe ducts under each of the footpaths are filled solid, the footpaths themselves resting upon the

* About 50 grammes of pure copper sulphate crystal per litre is very suitable.

† "Proc," Phys. Soc., Vol. XXV., Pt. ii., February 15th, 1913.

filling, so that the mains in those spaces can be laid, renewed or repaired in exactly the same way as for the remainder of their lengths.

The pipe ducts under the roadway are permanently accessible from above, as will be seen on reference to Fig. 2, page 444. Precast filling pieces of reinforced concrete form the decking over these ducts. The remaining ducts under the roadway, which contain the cables, &c., of the various departments are accessible through manholes arranged at the river pier.

Probably the principal feature of interest in the structure is the provision at the springings of continuous hinges in reinforced concrete. These hinges are permanent and comprise two curved surfaces, one resting within the other. The surface, which may be termed the "fixed face," is that formed on the

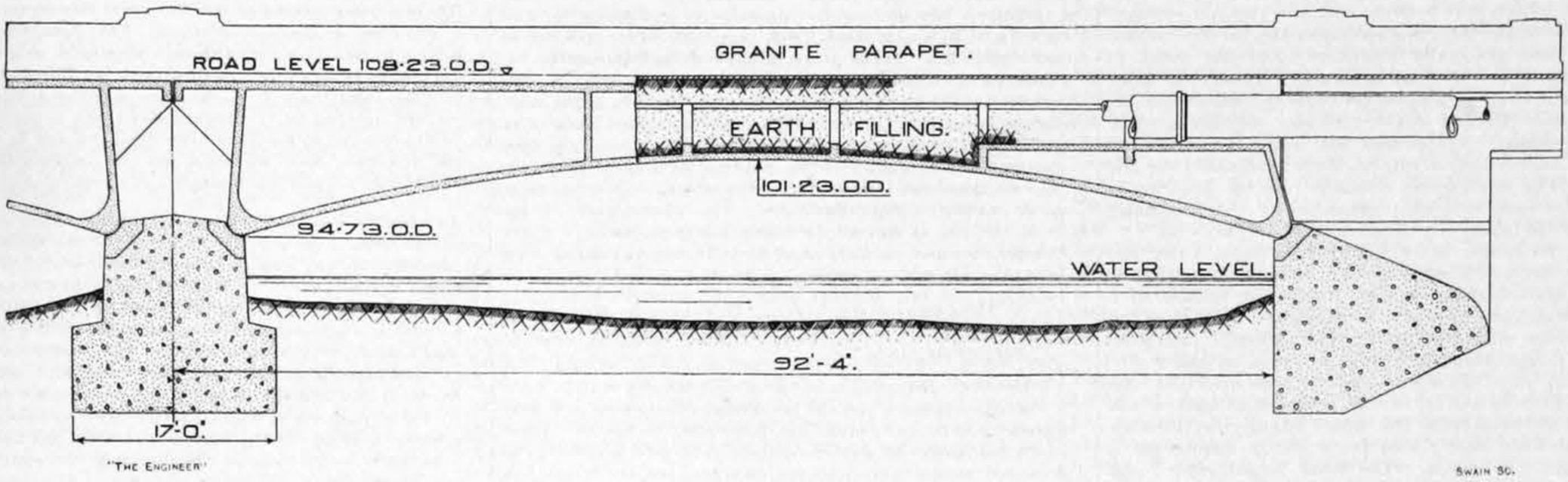


FIG. 3—KILLERMONT BRIDGE, LONGITUDINAL SECTION THROUGH ONE SPAN

supporting member; in this case, either at the abutments or the river pier. These "fixed faces" are concave and receive the movable surfaces which are convex, and of a smaller diameter. Both curves are struck from radii of lengths depending upon the pressure transmitted through the portions in contact. The stress upon the contact faces is much higher than is permitted elsewhere in the structure, that being essential if the hinges are to operate efficiently. That such higher pressure can be imposed in these circumstances is equally true with concrete suitably reinforced, as with other structural materials of a homogeneous nature.

The method of constructing the hinges is simple. The larger concave surface—for example, at an abutment—is formed in the usual manner with the necessary steel reinforcement left projecting along the centre line of contact. Plaster of paris is then screeded upon it, increasing in thickness from the centre line of contact, so as to form a mould for the reception of the concrete forming the convex portion

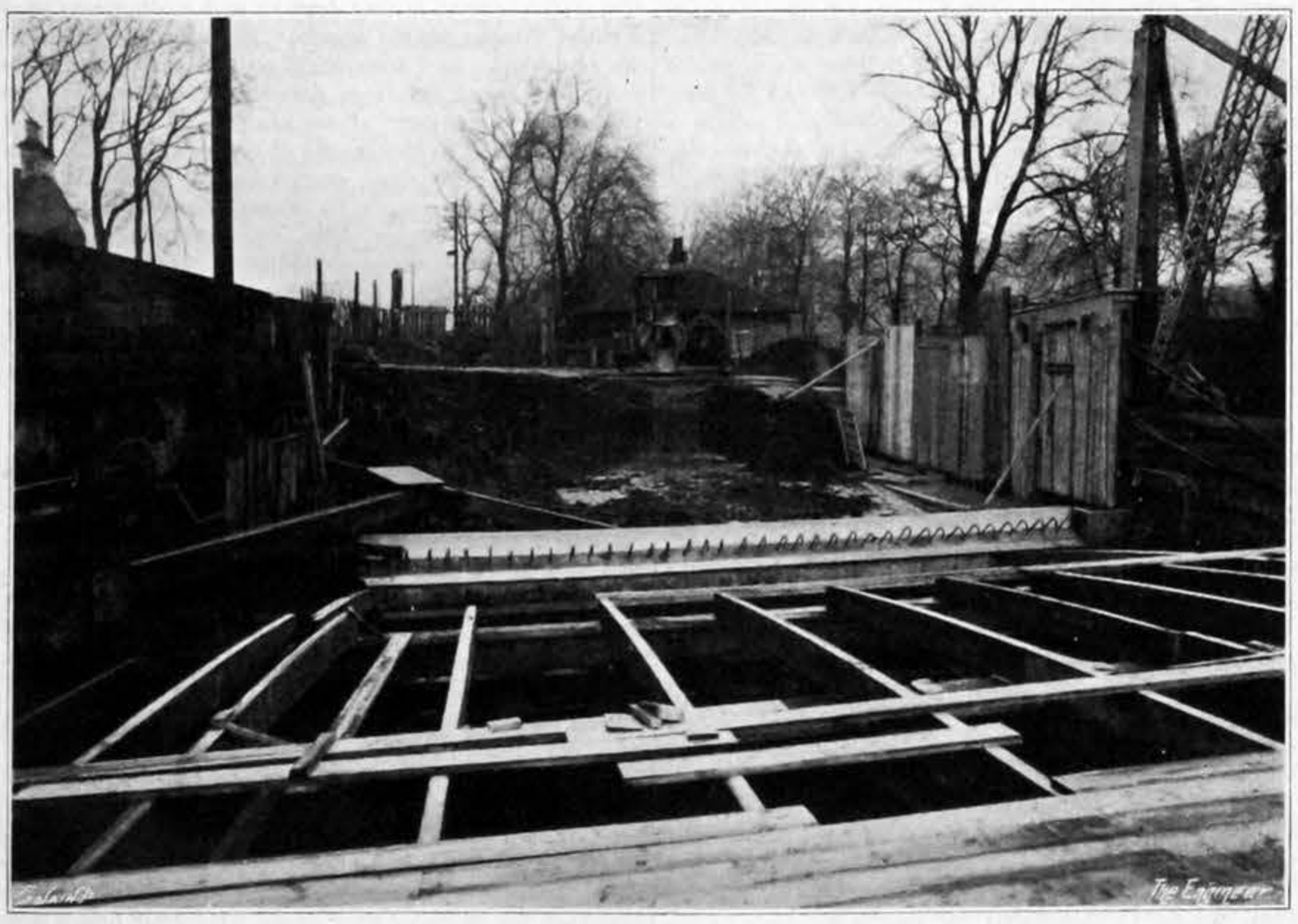


FIG. 4—VIEW SHOWING CONSTRUCTION OF CONTINUOUS CONCRETE HINGE

of the hinge. Fig. 4 shows the plaster mould in position. After completion, the outer portion of the plaster is hacked out, the remainder being allowed to crush when the hinge works. With the introduction of this type of hinge, the thrusts for the superstructure are applied in a uniform manner to the mass concrete supports. Also, owing to the precise point of application and direction of the resultant thrusts from the superstructure being known, the design of abutments, &c., was simplified.

The main arch ribs are 8in. thick, and they are reinforced in the usual manner. The mixture of concrete throughout the superstructure is 1 : 1½ : 3, that is to say, approximately 6 cwt. of cement per cubic yard of finished concrete. The larger aggregate was crushed granite, and the resultant concrete of a very high standard. Having regard to the various provisions made in the design above, a relatively small amount of concrete has been introduced, it being equivalent to a flat slab over the area of the bridge of 22in. thick. As a result of the accommodation required for the large pipe mains, the architectural treatment was rendered somewhat difficult, and the appearance of lightness so desirable in bridges of this class was to some extent precluded. Nevertheless, the general appearance of the bridge, as may be seen from the view on page 444, which shows the bridge in a partially completed state, is satisfactory and in keeping with its surroundings. The concrete surfaces have not been rendered in any way, and are exactly as left from the shuttering, except for the customary rubbing with soft stone and cement grout to obtain surfaces of even texture and colour.

The contractors for the work are Messrs. Melville, Dundas and Whitson, of Glasgow, and the designers of the bridge Considère Constructions, Ltd., of London.

Bradford Waterworks: Pressure Filtration Plant.

A MECHANICAL filtration plant to remove peat stain from, and to counteract the plumbo-solvent action in a portion of its water supply has recently been put to work by the Bradford Corporation. The following particulars of the installation have been prepared from a description prepared by Mr. Lewis Mitchell, the borough waterworks engineer.

The Stubden reservoir was constructed under the powers of the Bradford Corporation Act, 1854. Its catchment area includes a portion of the Oxenhope Moors, which are covered to a large extent by peat. Water drawn from such an area is invariably acid, especially after heavy rainfalls, when a considerable quantity of humic acid, which is continually being formed in the moist peat by bacterial action, is carried by the streams into the reservoir. Unless it is treated with an alkali to counteract its solvent and corrosive ability, it has a plumbo-solvent action, and its use, except in the case of lead service pipes on which a protective calcareous coating has been formed through long use, or in the case of copper service pipes, is inimical to health. Moreover, the Stubden supply is liable to serious pollution from ordinary farming operations on certain portions of the watershed, over which the Corporation cannot at present exercise effective control.

This supply forms about 10 per cent. of the total yield of the Corporation's water undertaking, and has hitherto been delivered into the city in an unfiltered condition. Its quality would have been considerably improved had there been facilities for storing it for a sufficiently long period to allow of adequate sedimentation and the consequent elimination of pathogenic organisms, but the storage capacity of the reservoir is not nearly sufficient to deal with the watershed that drains thereto. The available rainfall over the said watershed in dry years is 23·2in. per annum, and the average daily yield is 1,793,450 gallons, in order fully to utilise which the reservoir should have storage accommodation for 175 days' supply, or 314 million gallons, instead of only 93 million gallons. As the reservoir is required to supply, when circumstances permit, 2 million gallons per day, it follows that the water is deprived of over half of the period requisite for effective sedimentation.

It is not practicable for various reasons to filter and treat the Stubden water by means of slow-sand filters, and, in view of the fact that it is open to such contamination and requires systematic treatment to render it alkaline and thereby remove its capability of attacking and dissolving lead, there can be no question that the installation of mechanical pressure filters is the most effective and economical means of treating and purifying it.

The Water Committee has accordingly provided a pressure filtration plant consisting of sixteen cylindrical steel shells, 8ft. internal diameter, filled with quartz or Leighton Buzzard sand, and capable of dealing with 2 million gallons of water per day. They are of the closed pressure type and will operate under a head varying from 30 lb. to 50 lb. per square inch.

The decision to adopt mechanical filters in this instance was reached chiefly on account of the following considerations, viz.:—(*a*) There is no suitable site on which to erect slow-sand or open gravity filters between the reservoir and the first point of delivery; (*b*) peaty discoloration can be effectively removed; (*c*) acidity can be readily neutralised, thus removing or reducing metallic solvency and corrosion; (*d*) initial cost of construction is less than that of slow-sand filters; (*e*) contamination from the air and the encouragement of the growth of algæ are avoided, as the filtrate is delivered direct to the district of supply; (*f*) no interruption from frost; and (*g*) the bacterial purification is as efficient as in slow-sand filtration. The operating and maintenance charges are higher, owing to the cost of the coagulant—sulphate of alumina—used to effect colour removal, and the wash water used may be greater, owing to the increased burden on the mechanical filters arising from the decolorisation process. But these factors are largely, if not entirely, offset by the interest received on the greatly reduced capital expenditure for the mechanical filters, which entirely remove the peaty stain and give a clear, colourless water.

The reagents used for the purification of the water are alumino-ferric—sulphate of alumina—for coagulating the impurities and for the removal of the colour, and a trace of lime or chalk for neutralising the acid tendency of the natural moorland water. These reagents are automatically applied to the water in ratio to any variations in the rate of flow, so that once the required dosage has been decided and adjusted, the reagents are added at that prescribed rate, at all times proportionate to any variations in the flow of the crude water. This flow is measured by a Venturi meter, which, in addition to giving a record of the flow of raw water through the plant, also serves to actuate a mercurial differential gear, operating in turn a small electrical rheostat. The purpose of this rheostat is to regulate the current to a variable speed direct current motor, so that the speed of this motor, and consequently the discharge of the chemical reagent pumps which are driven thereby are at all times proportionate to the volume of water to be treated. The installation includes the necessary rotary converter for transforming the alternating current supply into direct current, as required by the variable-speed motor. The chemical reagent pumps are of the plunger type, and means are provided so that immediate adjustment of the reagent dose can be effected to compensate for variations in the nature of the raw water, thus ensuring at all times accurate and efficient treatment. The alumino-ferric solution is prepared and stored in two reinforced concrete tanks fitted with agitators to ensure the solution being properly mixed. From these tanks the solution is drawn by the pumps and delivered into the raw water main at the required rate. The lime or chalk is prepared in an overhead mixing tank, and is thoroughly mixed into a cream which is run into the container below and diluted to the prescribed consistency. The container is fitted with continually rotating horizontal paddles, so as to prevent settlement of the mixture, the chemical reagent pumps again drawing their supply from these tanks and being arranged to deliver the required quantity of the reagent and to apply it either before or after filtration.

The filters consist of sixteen 8ft. diameter standard

Paterson pressure units, giving a total filtering area of 800 square feet, each unit being independently connected to the raw water inlet and pure water outlet mains and fitted with inlet and outlet valves. In addition, each filter is fitted with an air valve connected to the compressed air supply, a by-pass valve and a waste valve discharging into the drain channel. The filters are arranged in two rows of eight on either side of a wide open gangway from which the whole of the valves controlling the filtering and washing processes are operated.

The filtering medium consists of specially graded Leighton Buzzard sand supported on graded layers of pebbles, ranging in size from grit to large stones, the strainer system being arranged at the bottom of the filter bed, and connected to the pure water outlet.

The raw water, after being treated with alumina, enters the filter by means of a centrally placed trumpet pipe of large diameter, so that its flow causes no disturbance of the sand bed nor of the filtering film formed thereon. The water is filtered in its passage through the sand bed, from beneath which it is collected by the strainer system. The deposition of the intercepted impurities on the surface of the filter bed gradually increases until the point is reached where it becomes necessary to cleanse the filter and so restore it to its original condition for further service. This cleansing is effected in the ordinary way by upward flow, the necessary compressed air being provided by means of a motor-driven rotary blower situated in the filter house. The wash water is taken from the pure water main and is, of course, readily provided by the remaining filter units of the plant which are still in commission.

The filter washings, after being discharged from the waste valves, are collected in a large tank situated below the floor of the chemical house, where, by means of a rectangular weir, the quantity is measured and recorded by the Paterson float-operated "Fluxograph," situated in the filter house, thus providing a record of the wash-water consumption. This wash water flows into two long rectangular concrete tanks, in which the great bulk of the impurities abstracted from the water rapidly settle, thus ensuring that only water free from heavy impurities is discharged into the drain. The filter house, which has been built of stone obtained from Darley Dale quarries, Derbyshire, stands at a height of 920ft. above sea level.

The filtration plant was provided and installed by the Paterson Engineering Company, Ltd., Windsor House, Kingsway, London, and the filter house was erected by John Dickinson and Co. (Bolton), Ltd., Bolton.

SIXTY YEARS AGO.

We are sometimes apt to be oppressed with the complexity which modern invention is adding to the mechanical arts and life in general and to regret the simplicity of ruder times. It is true that sixty years ago the field covered by engineering, however immense those of the time regarded it, was, compared with that over which it extends to-day, very restricted. The reciprocating steam engine was still the sole source of driving trains, ships and road vehicles. The internal combustion engine was in the hands of Lenoir still little else than a curiosity. The electric dynamo was still a device relying on permanent magnets and used principally for lighthouses. Yet the times had a complexity of their own, which has since passed away, even although we have added fresh complexities to our burden. Take the case of the United States frigate Madawaska, a 22-gun vessel, 335ft. long, and 2135 tons by the "new" measurement, built at the Brooklyn Navy Yard. She was claimed to be one of the fastest screw ships in the world, and in this country she and her sisters were referred to as "hornets," for they were regarded as likely to prove very troublesome in the event of war. She was driven by engines consisting of two inclined cylinders, 100in. in diameter by 48in. stroke, supplied with steam by eight boilers. The engines were of Captain Ericsson's vibrating lever type. Each piston had two piston-rods, which pointed outwards to the sides of the ship, and which, by means of a crosshead and link, transmitted the power to a lever on a rocking shaft, of which there was one for each cylinder, the two shafts lying parallel with the propeller shaft. On each rocking shaft a second lever transmitted the power through a connecting-rod to the main crank. The rocking shaft levers were of unequal length, with the result that the crank throw was much greater than the piston stroke, being 38in., as compared with the 24in. ordinarily obtained. The horse-power of the engines was not stated in an article describing the vessel, which appeared in our issue of October 19th, 1866, nor was the boiler pressure, except as implied by the remark that the boilers had withstood a test pressure of 60 lb. per square inch. If there are some marine engineers who, in these days of high-pressure high-temperature steam, turbines and reduction gearing, sigh for the time when the Madawaska stood for all that was most modern in steamship machinery, is there any shipmaster of to-day who would wish to see restored the auxiliary sailing equipment with which, as a matter of course, she was provided? She carried a mainmast, a foremast and a mizen mast, a fore-top, a foretop gallant and a main top gallant mast, a fore yard mainyard, fore topsail yard, main topsail yard, fore topgallant yard, main topgallant yard, fore gaff, main gaff, spanker boom and spanker gaff. Her sails had a total area of 25,000 square feet, and consisted of a fore-sail, fore topsail, fore topgallant sail, fore topsail, fore staysail, jib, flying jib, main sail, main topsail, main top-gallant sail, main topsail, main staysail, spanker, gaff, top sail, main topmast staysail and mizen staysail. To-day our complexities are concentrated in the engine-room, but viewed in perspective, we doubt if even the King George V. in the equipment provided for her propulsion, can outrival in complication the Madawaska of sixty years ago.

A power station for Senekal, South Africa, is to be put up on Bremer's Branch Railway, at a cost of £18,000. It is to include three 70-kilowatt and one 25-kilowatt gas-driven units.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

ISAAC DODDS AND D. & K. LOCOMOTIVES.

Sir,—Some years ago you were good enough to review at length my biography of Isaac Dodds, C.E. (1801–1882), and I have for a long time intended to offer further evidence respecting this engineer's contributions to railway engineering.

Unfortunately, prolonged absence from England has prevented this, and the death of Mr. E. L. Ahrons has further delayed the publication of some interesting information.

"A Story of Railway Pioneers" gives a brief reference to Isaac Dodds' connection with Charles Vignoles and the Dublin and Kingstown Railway.

The history of the engines of this line, as used in the first few years, is obscure. Some notes were published in The Engineer of February 23rd, 1883, page 150, being included in an article entitled "Links in the History of the Locomotive."

Controversy arose respecting certain statements in this description of the first engines which were brought from England. Sufficient interest was aroused to draw a former locomotive foreman into the discussion, and Thomas Hunt, who was first in charge of the locomotive depôt, wrote some interesting details of his experiences in Ireland during the 'thirties. He, however, seemed puzzled and doubtful over the illustrations of the D. & K. engines, as shown by the writer of those notes.

Perhaps therefore publication of the following may throw some light on the subject:—

Copy of Document with Title "Dublin and Kingstown Railway Report of I. Dodds in Reply to the Directors, 1833."

Cylinders.—Dimensions of which we perfectly agree.

We recommend perfectly horizontal cylinders with either Parallel motion or guides, but if parallel motion we would adopt our improved motion as the most likely one not to be deranged by the compound jolting occasioned on the railway at quick speeds.

Vertical Cylinders in our opinion are objectionable in as much as they can't have their pistons, piston-rod and parallel motion or cross head balanced conveniently, consequently always producing accellerated and retarding motions, thereby causing a jolting which in Locomotives is highly detrimental, and in a short time draws upon it most expensive keeping up of wear and tare; that is in the downstroke you have the whole gravity of the above named machinery attached to piston, beside one part of the bell crank, plus the steam power on the piston, and in the upstroke you have the power of the steam on underside of the piston minus the gravity of the above appendage and having no means of balancing this, the disadvantage becomes immediately apparant; taking it for granted that you are already aware that the cranks do not balance each other in any more than two points in describing their circle, as has been asserted by some but which need only have one moments consideration to prove it false.

The jerking of the piston rod & etc., is most likely to be done away with in perfect horizontal Cylinders and no crank'd axles with a proportionably long connecting rod.

Slide Valves.—The patent slide valve as manufactured by us, is perfectly adjustable both as regards wear of packing and also to take the passages at such cuttings off of the steam as may be deemed prudent and can be done with the least possible delay decidedly better (in our opinion) than in any other valve now in use, and is considerably less liable to friction than any other valve either circular or D shaped as it has so much less rubbing surface; but our patent equally extends to the packing of D valves or otherwise providing they use the inclined plane or cone.

Instead of eccentric motion we would advise an eliptical motion which could be brought adjustable close to the Engine, although multiplicity of workmanship we condemn, where a simple motion can be given to the valve without great rubbing surface as in the eccentric and by allowing the steam to remain on the piston during the time of the eliptical pin passing its major axis and being cut off almost instantaneously when it passes its minor axis. You save condensation by its rapid transit, and also have the privilege of working expansively as the piston can have any lead as is now the case with eccentric motions which can, as before stated be regulated at pleasure.

Forcing Pumps.—We see no objection to your mode of using the Force Pump.

Wheels.—The Wheels we see nothing to object to, but as you are aware of our manufacture of wheels that is all done by shrinking, turning & etc., and no wood, the nave only being cast iron, spokes and trees wrought iron, which have since you saw them been tried and from their simplicity and easy mode of repairing them in any part renders them an advantage which in use must show its superiority over others; as spoke or spokes, tire or Tires or if necessary a Nave, now, the whole or any part of these might be applied materially altering the effect of the wheel, altho' in case putting a single spoke or two in you might put them in in two pieces without taking off the tire.

Wheels & Connecting Rod.—We advise the cylinders so adapted as to lead the motion to the centre of large wheel and therefore would not have the small wheel axle bearings outside of the wheels as the advantage you would gain by having small bearings would be overruled by the Machinery being thrown farther from the Centre of the Engine and consequently reduce its stability unless extra strength and stays, consequently extra weight would be necessarily wanted, the working part of the machinery being all outside of the wheels and so low as to be immediately in reach of Engine attendant whether in motion or at ease, would be an advantage and always be at pleasure within sight for either repair or lubrication. Yet all would be partially hidden at will, in case the Framing need not be crank'd, small wheels may be made to either of your dimensions say 3/9 or 47″.

Axles.—The axles of Driving wheels of best faggotted wrought Iron, perfect in every respect and to be 5″ Diar. but would advise them a little tapering to the ends or necks maintaining an uniform strength throughout; smaller Axles 4″ Diar. and so constructed, this in a great measure does away with the tremolous motion so observable in motor power. Oilers in all cases to be used in a most improved manner.

Framing.—This in your description in the specification is unobjectionable.

Springs.—These as well do do do

Fire Boxes.—We would say use rolled Copper or rolled Brass as in case you use Cast you will have to cast it thick to ensure its soundness and even in its annealed state its liability to breakage is much more than rolled material and its tenacity is very slight. Copper Fire Boxes in round or semi shapes wear exceedingly well. A Fire Box the material being good and well manufactured will wear out some parts of the shell of the boiler, that is where Fire Box and Boiler are connected and also where Chimney end and Boiler are connected. Those parts have very frequently failed before the interior of the Fire Boxes. We would say put in stays to the Fire Boxes, and let them be screwed at both ends, as you seldom see any semi-circle box bût will, when it does give give at the interior plate, that is where without stays more especially any part near the bottom where it is likely to be acted upon by mudded or impure water.

Tubes.—The tubes we consider in your specification quite sufficient.

Safety Valves & Gauges.—We agree with your specification as it regards the safety valves, but would advise a mercurial Thermometer instead of the Mercurial Barometer.

Eccentric & Eliptical Motions.—The Eccentrics we would advise to be laid aside, although we would recommend them preferable to any other mode except the Elliptical Motion as we have had these at work a few months in a Locomotive we are satisfied of the effects and there is no likelihood in ordinary working for these to be deranged and by this method the Engineer does not clash the two engines together, but the Motion is given moderately and so taken of as required.

This report was made by Isaac Dodds in 1833. So far as one can find from records of the meetings of the directors (of the D. and K. Railway) the question of locomotive power was first brought up in December, 1833. Dodds has himself made a written statement to the effect that the directors of this line consulted him respecting the engines and rolling stock at the instance of Charles Vignoles, C.E. The document reproduced above is a copy of the original report—no doubt, an office copy.

It reveals the fact that Dodds had in mind some definite ideas of sound designs for various parts of the locomotive. Apparently, some engines with vertical cylinders did find their way to the Dublin and Kingstown Railway, in spite of Dodds' objections to them.

In the early 'thirties there was a return to the practice of vertical cylinders for locomotives; it did not last long, however.

If the above specification is read in conjunction with the article which appeared in The Engineer for 1883—which I mentioned earlier—it will go a long way towards clearing up matters concerning the first engines of the Dublin and Kingstown Railway.

Sidney Snell, A.M.E.I.C.

Grindleford, Derbys., October 12th.

WORKMEN IN ENGLAND AND AMERICA.

Sir,—In reference to your valuable paper called The Engineer, of which I am a constant reader, I wish to make a statement on industry in United States and Great Britain, especially in the engineering line, having had twenty years' experience in United States foundries and visiting the up-to-date foundries in Canada. Question, what is the secret why Czecho-Slovakia and United States and India offer our best workmen as much as £800 to £1000 per year as foundry managers, and at home they are not required, except at a low wage? I am out for production at the least possible cost, so that we may compete in the markets of the world. How is it done? For my part, I have been long convinced that one of our troubles is production at the least possible cost; another trouble is too much theory instead of practical men at the head of our industries. Again, foundries and engineers years behind the times and not up to date with the latest labour-saving devices and methods as practised in the United States and Canada. Standardise construction, open up our works and foundries, so that any man wishing to work may have that privilege according to law. We are all slowly learning the futility of strikes; that lesson has been and is being enforced in the school of grim experience. There must be mutual consideration and respect between employers and workers; there ought to be no place in industry for parties. The interest of all are alike, and a single spirit should prevail. If that unity could be established there would be no need to talk of peace; it would have arrived. Let us get together and turn our depression into prosperity; it can be done. Have the United States anything to tell us in that line? Yes. I have learned this lesson with twenty years' experience: they do more than we, put their heads as well as their hands into their daily work. Yes, low production means low wages, high production means high wages. What, then, is the secret? Organisation and standardisation of construction and the appreciation of work, with the latest methods of production; that is the secret of the United States. Have we as Englishmen dwelt too long on the wrongs of past generations and devoted ourselves more to raising hell than to producing the goods, and have not our unions become infected with the Bolshevist bug, and while not actively adopting the Communist theory of making capitalism impossible, have passively acquiesced in it, to the extent of seeing nothing in their work except its week-end reward. Here you will find labourers receiving more pay than skilled men. Who is to blame? The employer as well as the men. I am impelled to ask the question by my experience, because again and again I have found United States workmen held up to the world as a model, both for production and high wages, where Jack Jones, of Liverpool, earning 70 dollars per week and a contract for three or five years, fifty-four hours per week, nine hours per day, comes back home and is unemployed. I have worked with Poles, Russians, Slavs, Hungarians, Germans, French, proving that a Britisher can hold his end up with any country if given encouragement. In England the cry is too old over forty; cut that out; also advertisements with wages expected, references, age, &c. They don't recognise such trash in other countries. If you are the man for the position and able to do the work, well and good; if not, get out and give someone else the chance. Here it is man plus machinery, come day go day; in America it is machinery plus man. Machinery will work two or three shifts at a little over one wage per shift; high production means relative cheapness of the articles man requires. When you go to America you are surrounded by a system in which counts the latest labour-saving devices money could buy, and you are paid on production. In England the good man has to make up for the bad one; results, ca' canny. At one time Great Britain was leader of the world's trade, but during the last five years she has been steadily, yet surely, slipping back. What do we find? Czecho-Slovakia heads the list with an increase of exports since 1922 amounting to no less

than 53 per cent.; Great Britain with an increase of 2½ per cent. These figures showed that the world-purchases of manufactured goods were increasing, but that the world was buying more from our competitors. During the late years something had been going wrong with our industrial affairs; disputes had been more frequent. With 1½ million people out of work we must improve our methods. We are disposed to cling to machinery and methods which were out of date; in export business we did not sufficiently consult the requirements of foreign countries. The fact was we must give and take, we must have co-operation with all those engaged in industry and find the men best fitted for the jobs. Here there are too many square pegs in round holes; in America every effort was made to discover ability in employees. Here we fear over-production, in fact it is often misleading. There can be no such thing as over-production until every individual in the world has everything he wants. Our only salvation is the right man in the right place, with high production and high wages.

J. H. Jones.

Liverpool, October 16th.

ST. PAUL'S CATHEDRAL.

Sir,—The recent movements in the structure of St. Paul's Cathedral which were mentioned by Canon Alexander in his evidence before the Commission on Cross River Traffic, raise once more the question whether more comprehensive measures of repair are not urgently needed if our great metropolitan cathedral is to be preserved. It is now nearly two years since the St. Paul's Commission advocated the repair of the piers under the dome by means of cement grouting and the replacing of cracked facing stones with new material, but the confession that movements are still continuing bears out the truth of the protest I made at the time in The Engineer, January 30th, 1925, to the effect that such "patching will only prolong the agony."

The subject of movement in structural masses is, or should be, one of vital interest to the engineer as well as to the architect, and when those movements take place in a monument of vast scale, in which very considerable pressures are generated, the opportunity for investigation is almost as valuable in the interests of science as it is absolutely essential in the interests of adequate repair. The part played by excentric loading and by bursting pressures due to the oblique thrusts of the heavily loaded arches was indicated in the above-mentioned article, and, more particularly, in my book "The Preservation of St. Paul's Cathedral," though the Commission's final report only recognised the effect of temperature changes in producing movements at the present time, though initial settlement was credited with having produced movements in the past. The admission of the Dean and Chapter that the vibration from heavy traffic may also affect the building is in direct contradiction to the conclusion of the St. Paul's Commission "that no deleterious effect is taking place from this cause," and further evidence on this point is distinctly desirable. My own observations of buildings in decay under the influence of imperfectly abutted arch thrusts leave me in no doubt that vibration and alternations of pressure due either to wind or to addition or subtraction of support by water saturation in the subsoil are positively destructive to stability.

But the investigator must not allow himself to be led to overestimate the effect of any single one of these agencies of decay at the expense of the rest. As I have pointed out in The Engineer of April 2nd of this year, the loading conditions are of primary importance. "Given an arched building of ordinary architectural form, with the arches elevated upon vertical supports, the inherent defect due to the departure of the line of resistances from the ideal line of thrusts is so grave as to dominate almost all causes of decay. The characteristic distortions of the supporting and buttressing masses are seldom or never suppressed and are almost invariably increased by other accidental sources of damage." The continuance of the movements which I predicted makes it the more urgently necessary to advocate again the complete survey of the building in relation to its deflections and fractures, the scientific analysis of pressures throughout the building, and the comprehensive control of those pressures by adequate repairs specially devised to meet the necessities of the case. As things stand, the repair of the cathedral seems to be regarded by architects as an affair for engineers and by engineers as an affair for architects. As long as this is the case, only such repairs as are easy of execution are likely to be attempted, and such measures fail to do justice to the very serious needs of the building.

William Harvey.

October 18th, 1926.

LOCOMOTIVE DESIGN.

Sir,—Your leading article of October 15th has fired my imagination, and although I may be rushing in where others have feared to tread, I venture to ask for a little space to put some points of view which may be considered suggestive.

You discuss three or four cylinders. As a student of engineering progress I say: why not six, eight, or even twelve? Your modern engines, what are they? Rockets. A few improvements have been added and they are larger, more complicated and more powerful, but still Rockets in essence. Why is the boiler mixed up with the engine? Well, Stephenson did it. The modern motor car engineer would never do it.

Why does the regulator work from side to side instead of to and from the driver? I suppose Stephenson did that also.

Why is the fuel fed to the boiler by manual power and sweat of brow?

Why should there be any hammer blow on the rails?

Why is the beautifully made engine exposed in its sliding surfaces and joints to wet, dust, and grit? Why is it not enclosed?

Why is not the lubrication automatic? Why is the draught not continuous?

I have seen (in America it is true) a fireman, after wandering round an engine with a long-spouted oilcan, climb up to the footplate *vid* the slide bars, adding (from his boots) grit, wet and cinders, to what must already have been there before he did it.

Why is the piston speed limited by the axle speed?

Why must the wheels race and slip when starting?

Why is there not a low gear?

Why is the driver at the wrong end of the engine?

Why has he to go from side to side to see his signals?

Why must he be such a dirty dog? Why cannot he sit in ease and comfort like the driver of a modern road vehicle?

Is it because locomotives must be cheap and modern amenities and improvements not to be afforded? Locomotives are not cheap and improvements generally repay their cost. Is it because Stephenson and the early pioneers still live?

I am happy in the acquaintance, and can even say friendship, of several C.M.E.'s, but I will brave their wrath, as they are mostly gentle in nature. If they defend themselves, I trust they will handle me gently, as I do not really know much about it. But still, the questions are there and have not yet been answered.

Coventry, October 18th. P. V. Vernon.

South African Engineering Notes.

Harbour Improvements.

Official figures of work completed at Durban Harbour (Natal) during the year 1925 show that over 11 acres of land were reclaimed to the north of the Bluff main line, bringing the total area to nearly 50 acres; 450ft. of the retaining bank was completed and over 4500 cubic yards of spoil were off-loaded and levelled; 60ft. of skeleton wharfing were constructed to improve the loading arrangements for coal punts. At Maydon Wharf 1872ft. of wharfage was completed up to the graving dock, and 1250 yards of new railway sidings were laid, in addition to 2½ miles of sidings adjoining the grain elevator for handling the maize traffic. Approximately one and three-quarter million cubic yards of spoil were dredged from the graving dock channel, 781 loads being pumped by pipe line from the dredgers Labrus and Oceanus to the area under reclamation, where 1100 truck-loads of refuse and spoil were also off-loaded and levelled. The graving dock has recently accommodated the latest and largest dredger in the Union service, the Sir Thomas Price, of East London, a vessel of over 2000 tons, which came from England under her own steam. Though her buckets are only of 3 tons capacity, she has been employed in removing 5-ton concrete blocks from the breakwater on the east bank of the Buffalo River, and local harbour officials consider the work quite beyond her capabilities; hence the need for her visit to Durban for overhaul and repairs.

New Water Supply Scheme.

The municipality of Mossel Bay, the growing Union port next to Capetown on the voyage round to Durban, is taking in hand a new water supply scheme which will involve the expenditure of approximately £55,000.

Standard Brass Foundry.

A large addition to the premises of the Standard Brass Foundry in Benoni, Transvaal, has just been opened. This company first started operations in a space 25ft. square, but has now expanded to a great extent and is associated with J. Stone and Co., London. Much engineering material, formerly made overseas, will now be made by the Standard Brass Foundry. The modern equipment includes a fine laboratory, under the charge of Mr. A. K. Gold, late of Stone's, London. The opening ceremony was performed by Sir Wm. Hoy, General Manager of the South African Railways, by turning on the switch which set a large transport crane in motion. The Transvaal has now by far the greatest number of engineering establishments of any of the Provinces, having 255 such establishments, the Cape coming next with 183. The total for the whole of the Union is 573, the total amount of salaries and wages paid is £5,792,972, and the gross value of output £12,709,337.

Protecting South African Industries.

The present policy of the Government is becoming more protectionist than ever. A report has recently been issued by the Board of Trade and Industries on customs tariff amendments. As the Board's recommendations are almost invariably carried out by the Government, they are worth noting by British manufacturers. The Board states that as the production of iron and steel from local ores has actually commenced, it now recommends that a duty of 17 to 20 per cent. be imposed on angles, bars and rods of iron and steel weighing up to 20 lb. per running foot, 20 per cent. on battery shoes and dies, and 20 per cent. on rails up to 45 lb. per yard for railway or tramway construction, as well as on fastenings. It recommends that a suspended duty of 17 per cent. be imposed on plain corrugated or galvanised sheets, including bolts, nuts, rivets, screws, &c., and 15 per cent. on wire ropes. There is at present a large factory at Germiston, controlled by Messrs. Hoggie, Son and Love, manufacturing wire rope up to the heaviest sections. The wire used—formerly imported—is being manufactured at Vereeniging by the Union Steel Corporation, and a large factory has just been started on the Rand for the manufacture of bolts, nuts, rivets, and nails. The value of imports which will be affected in greater or less degree by the new tariff is little short of £3,000,000 per annum. The engineering industry, the Board states, is still mainly a repairing industry, but on various occasions manufacturing has been undertaken with satisfactory results. Rock drills and spares, tube mill liners, windmills, milk cans and buckets, harrows and other agricultural implements and spare parts are being made, but the industry has been held back, first, by the need of importing most of the raw materials, and secondly, the lack of any tariff assistance on the finished articles. The engineering industry—including railways—employs about 5000 white men and 10,000 coloured persons. The wages paid amount to over £2¾ millions a year. There is used £3,044,000 worth of material and there is added, by the process of manufacture, £3,685,000. The Board therefore proposes to assist it by imposing duties in cases in which articles are capable of being produced in existing works. Three firms on the Rand have specialised in the manufacture of rock drills. At East London and Capetown two firms have specialised in the manufacture of agricultural machinery and implements, windmills, and spare parts; one firm at Johannesburg is making fire-extinguishing appliances and brass pump cylinders; while the ports have for several years done a good deal of marine and structural engineering. The Board therefore recommends that a duty of 17–20 per cent. be imposed on rock drill spares, liners for tube mills, agricultural machinery, girders, iron bridge work, and on culvert tops, trolleys and cane trucks; 20 per cent. on spare parts of engines for fishing and whaling boats, on smokestacks and metal fire escapes; 15 per cent. on riveted wrought iron or steel pipes; and 25 per cent. on steel windows. In order to stimulate the engineering industry to reach out in new directions the Board recommends that a suspended duty of 15 per cent. be imposed on buckets, skips, trucks and tubs, on rails or wires; 17 per cent. on axles, springs, steps, and other metal parts; 20 per cent. on fire-extinguishing appliances and apparatus (excluding fire engines and hose) and other articles that cannot so far be economically manufactured in the Union.

Concrete Mine Supports.

A decided advance in the methods of supporting the hanging walls in the gold mines of the Rand has been made by the successful application of concrete columns with a timber capping, in the New State Areas and Van Ryn Deep Mines. In the New State Areas octagonal monoliths have been adopted, while in the Van Ryn Deep it has been found more convenient to build the concrete supports of circular slabs, 4in. thick, with a 4in. hole in the centre and having a diameter of 2ft. 6in., the weight per slab or "pancake" being 250 lb. The progress of the experiments and their practical outcome have been discussed recently in three papers: by Mr. J. D. Marquard, in the *Journal* of the Chemical, Metallurgical and Mining Society of South Africa; and by Messrs. A. E. Payne and James Richardson, in the "Transactions" of the Association of Mine Managers of the Transvaal. Details of the work carried out at the New State Areas are given in Mr. Richardson's paper. He also describes the equipment required and the method adopted for building a pack, and gives costs of the materials used. With regard to the Van Ryn Deep system, details are given in Mr. Payne's paper of the method and the cost. Taking everything into consideration, as Mr. Marquard points out in his summing up of the whole position, concrete supports are cheaper than "pigstyes," and are going to afford a better means of support for flat mines. The effects on mining operations generally are going to be beneficial; money is going to be saved in various directions and stoping is going to be cleaner. "It appears," he adds, "these supports will be sufficient to keep all workings in safety, and probably without the primary form of support in the shape of pillars, long enough for all necessary work to be completed therein." The discussion on these papers should be of interest and value, especially if it leads to practical suggestions for the employment of concrete supports in mines with a higher degree of dip than those in which they have originated and are now being used so successfully.

Pretoria Iron Ore.

It is stated that negotiations have been going on for some time now with the Government by persons interested in the exploitation of the iron ore deposits of Pretoria. Difficulty has hitherto been experienced in raising the necessary capital, and the Government is being asked to provide the requisite guarantee of interest. The latest development was a deputation of representative citizens to the Minister of Justice, with the object of enlisting his sympathy. The Government is stated to have an open mind on the question, but the enormous expenditure that might be involved necessitates serious considera tion. It is alleged by those favouring the idea that the presence of a rival company—already operating at Newcastle and Vereeniging—is being used by the enemies of Pretoria to dissuade the Government from the contemplated enterprise. In view of the facts, however, it does not appear necessary for "enemies" to do anything—the facts are sufficient. The Newcastle blast-furnace will supply 60,000 tons of pig iron per annum, and the Union Steel Corporation will require much of it for its output of iron and steel (including wire), which is being increased to 50,000 tons per annum, but will be able to supply the engineering works requiring a supply. It is very certain that the Union of South Africa will not for years to come be able to support two large iron and steel concerns.

Rock Drill Efficiency.

The number of rock drills in use last year on the Rand—4624—was considerably less than during the previous year, but the tonnage broken per rock drill rose to the rate of 5852 tons per annum, as compared with 4814 tons in 1924 and as little as 2784 tons in 1921. The tons milled per native in service increased from 158 in the year to 162, but per white man unit the figure dropped from 1538 to 1482, this decline being probably explained by the shortage of native labour, coupled with the general policy of keeping white men on as long as possible.

New Talc Plant.

The Leon Talc and Grinding Company, Ltd., is erecting new plant near Kaapmuiden, Transvaal. It has opened up large quantities of the mineral and has secured contracts in the overseas market for over 50 tons per month. The talc exposed is of the foliated and massive variety, and contains only a small percentage of impurities; in fact it is reported to be equal to the best Italian talc. A new type of machine for the grinding of the mineral is being employed, and the plant, when finished, will, it is understood, be capable of turning out 2000 tons per year. Talc is finding a ready sale in the local market.

Union Coal Industry.

Coal sent by rail from collieries in the Union during June, 1926, constituted a record, amounting to 1,140,369 tons, and representing an increase of 84,336 tons over the June, 1925, figures. The British coal strike has increased the demand for South African coal for export; the total shipped in July amounted to 160,525, an increase of 73,265 tons compared with July, 1925. In that month the ss. Statesman shipped 6956 tons of coal for Great Britain. Other coal went eastward to replace British coal that could not be obtained.

Explosion of a Valve Chest at Barking.

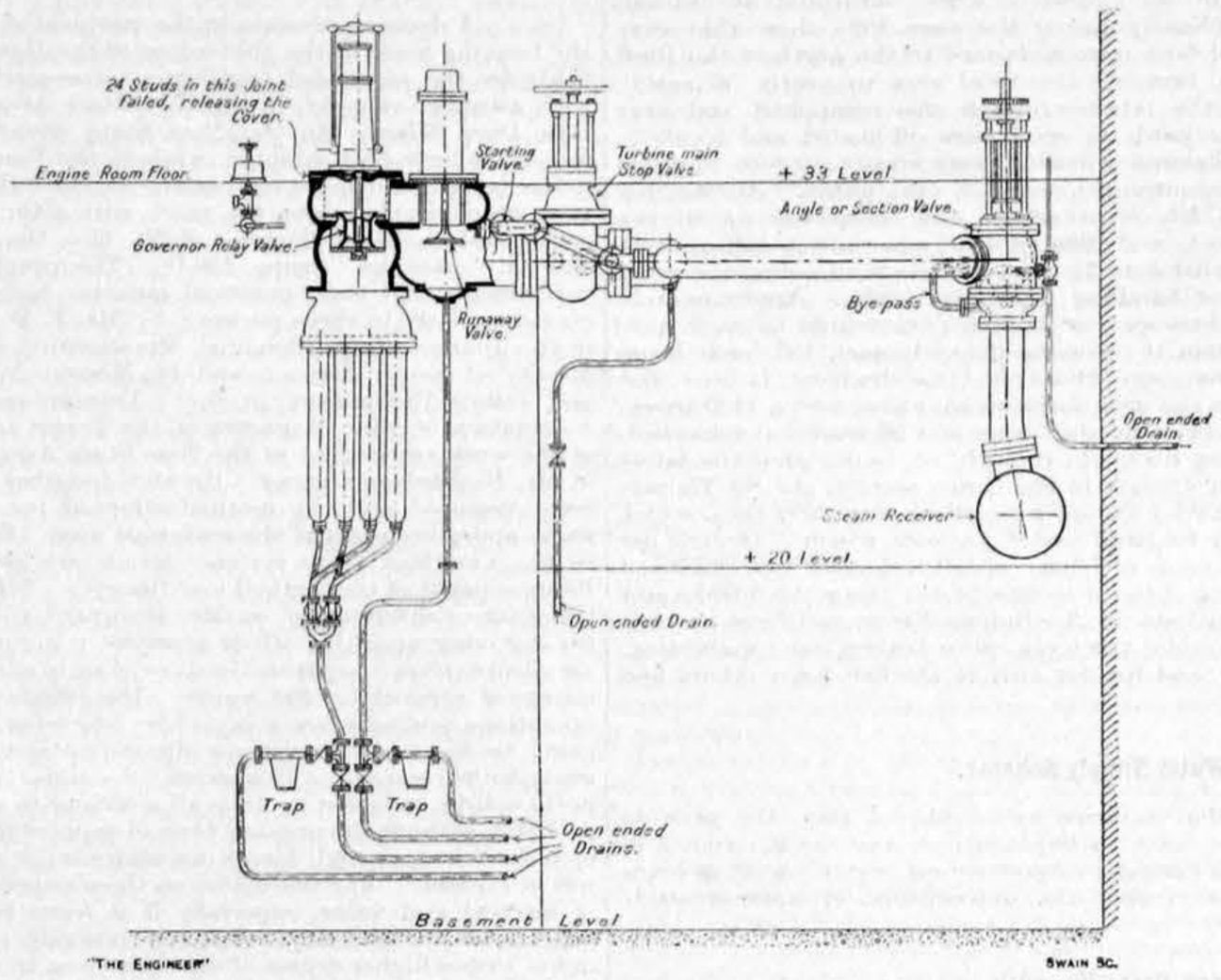
On December 14th, 1925, an explosion occurred at the Barking generating station of the County of London Electric Supply Company, Ltd. The mishap occurred at a valve chest made of cast steel and used in connection with a 32,000-kilowatt turbo-generator set. The chest contained a double-beat relay valve operated by oil from the governor and a runaway or emergency valve, which, through the agency of trip gear, was arranged automatically to shut down the turbine should the speed reach 3300 revolutions per minute. The valve chest had been in service for just under four months when the explosion occurred. Four men were injured as a result of the accident.

The explosion occurred while preparations were being made to put the generator under load. The governor relay valve cover was violently forced off the chest and in its fall to the floor below broke the floor plates and bent the floor joists. The chest was designed to handle steam at a boiler pressure of 375 lb. and a temperature of 725 deg. Fah. The relay valve cover was 3ft. in diameter and 3½in. thick at the flange and was fastened to the chest by twenty-four studs, 1½in. in diameter. On the completion of its manufacture the chest with its covers in place had been hydraulically tested to 700 lb. per square inch. When the exploson occurred the steel casting forming the chest was not fractured, nor was the cover of the runaway valve displaced. The governor relay valve cover broke away from the valve chest by the fracturing of all the twenty-four studs provided to hold it in place.

The Board of Trade Surveyor's report concerning the accident has now been issued. In it the explosion is attributed to water hammer. The whole station had been shut down at noon on Saturday, December 12th. The weather at the time was keen. On Monday, December 14th, two turbo-generator sets were under load by 8 a.m. and preparations were being made to bring a third into action for the afternoon peak load. At 11.30 a.m. the drain below the runaway valve was opened and when the draining was thought to be complete it was closed. The explosion occurred half-an-hour later, when the starting valve was being opened.

The Surveyor's opinion that steam had condensed in the valve chest to a sufficient extent to produce excessive water-hammer action rests not only on the fact that the conditions were suitable for the accumulation, but also on the fact that subsequent microscopical examination of the broken studs disclosed Neumann bands indicating breakage partially or wholly from shock. Other than water-hammer, no shock occurred. The Surveyor suggests that, although the casing below the runaway valve had been drained half-an-hour before the explosion occurred, the chamber above the runaway and relay valves still contained water. When, four minutes before the explosion, the runaway valve was opened this water simply fell into the casing below the runaway valve, and as the drain and main stop valve were then closed it stayed there until shot forward by the incoming steam admitted to the casing when the starting valve was opened.

Some comments on this explosion will be found in a leading article appearing elsewhere in this issue.



STEAM PIPE AND VALVE ARRANGEMENT AT BARKING POWER STATION

Imperial Wireless Communication.

An official certificate received by the Marconi Company from the Engineer-in-Chief of the Post Office states that the wireless stations constructed at Bodmin and Bridgwater for communication with Canada on the Marconi short-wave beam principle, have passed their official seven days' test, and the General Post Office announces that a high-speed wireless telegraph service between Great Britain and Canada through these stations will be opened on Monday, October 25th. With the first Dominion beam service thus established, Great Britain's world leadership in wireless communication is maintained.

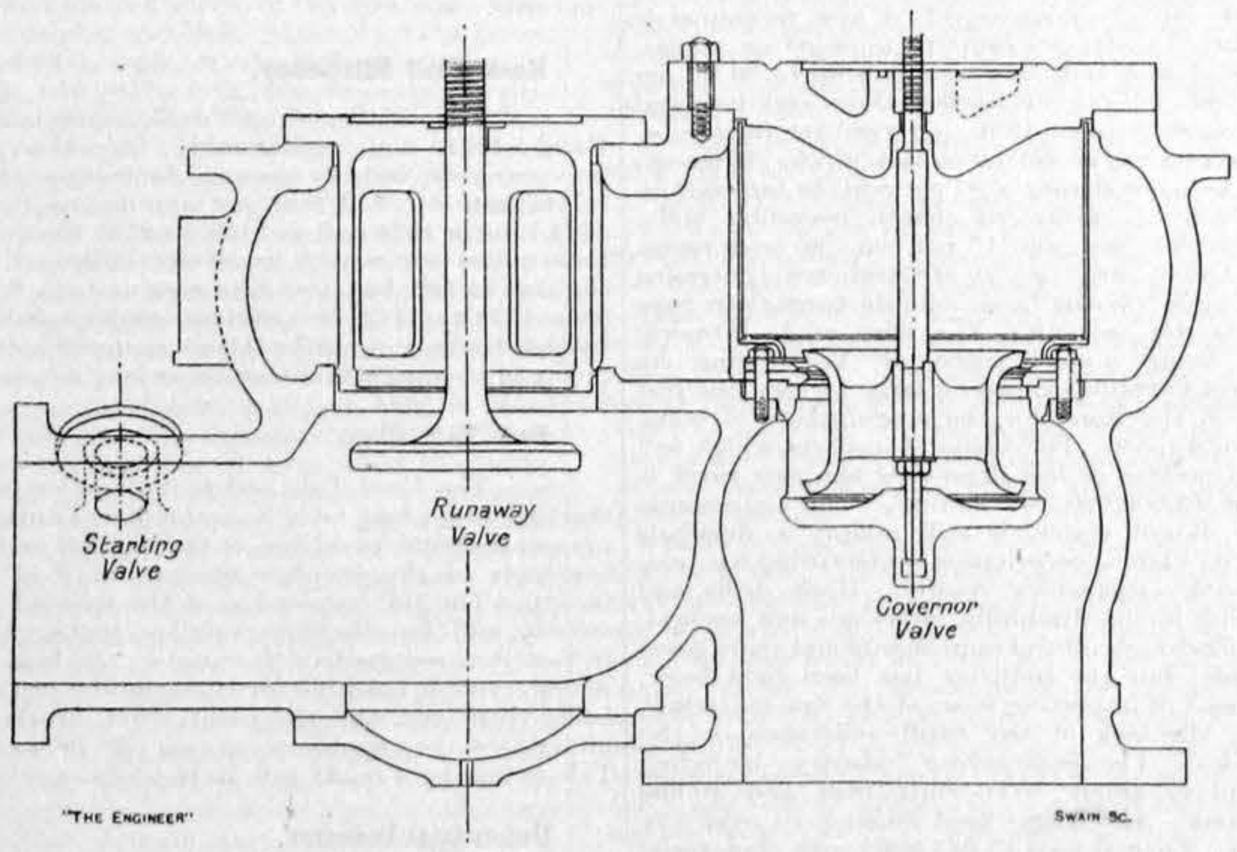
So convincing were the arguments in favour of the beam system that the whole of the original technical policy of Imperial wireless communication was revised, and the Government entered into a contract with Marconi's Wireless Telegraph Company, Ltd., to build short-wave beam wireless stations in England to communicate with Canada, South Africa, Australia and India. The Governments and wireless companies in each of these Dominions were equally impressed with the value of the beam system, and contracted with the Marconi Company to build corresponding stations to communicate with those being erected in England. The building of the stations was started in April, 1925. They have been longer under construction than was at first anticipated, but this has been due to the fact that research work has been carried on simultaneously with constructional work, and many valuable improvements on the original designs have been made as the work progressed. Power valves have had to be specially designed to deal with the extra high frequencies of short-wave working, and the Marconi oil-cooled valves at the transmitting station are claimed to be the most efficient of their kind in the world.

The official Post Office tests laid down that the stations for the Canadian service should be capable of communication at a speed of 500 letters per minute each way—exclusive of any repetitions necessary to ensure accuracy—during a daily average of eighteen hours, and that a demonstration fulfilling this condition should be given by actual working for seven consecutive days. This test took place between October 7th and 14th, and the guarantees—which were regarded by everyone as being extremely stringent—have been fulfilled. During these and the preliminary tests carried out by the Marconi Company, speeds of 1250 letters per minute in each direction, equal to 2500 letters per minute over the complete circuit have been worked for many hours on end. Counting every hour of the seven days' test, the average speed of signalling was about 600 letters per minute in each direction, or 1200 letters per minute for the complete circuit. This result justifies the claims made for the beam system, and indicates that the stations will be capable of handling all the traffic that is likely to be available between England and Canada for some years to come. Wireless telegraph engineers are accustomed to high signalling speeds, but the extraordinary achievements of the beam system have been the cause of several surprising and amusing incidents due to the speed of working during the recent tests. On more than one occasion the engineer has put a message on the Canadian circuit, and before he could reach the recording room in the same building he was handed the reply from Canada.

The institution of direct Marconi wireless telegraph services between London and Paris and other continental centres has shown that new telegraph traffic is created by the provision of new and rapid means of communication. It can therefore be confidently anticipated that the establishment of the beam services, which can be worked at a speed which will enable large volumes of traffic to be dealt with in the shortest possible time, will create new business that has not previously been possible, and so bestow a great benefit on the commerce of Great Britain and Canada. The beam transmitting station in Canada is situated at Drummondville, 30 miles east of Montreal, and the receiving station at Yamachiche, 25 miles north of Drummondville. These stations are linked up by land line to the central office of the Canadian Marconi Company in Montreal in the same way that the English stations are linked to the General Post Office. Beam stations are also being erected in Canada for direct communication with Australia, and corresponding beam stations are being built at Melbourne.

The sites occupied by the beam stations at Bodmin and Bridgwater for communication with Canada are also utilised for the stations to be employed for communication with South Africa. These South African stations are practically complete. Similar stations are being built at Tetney, near Grimsby, and at Winthorpe, near Skegness, for communication with Australia and India—the Grimsby stations being transmitting stations and the Skegness, stations receiving stations. Corresponding stations are being built in the Dominions near Capetown, Melbourne, and Bombay. All these stations are in an advanced state of construction and are expected to be opened within the next few months. This will complete the present Imperial scheme; but outside this scheme the Marconi Company is already engaged on a considerable development of commercial telegraph services on the beam principle. The company holds a licence from the Post Office to conduct wireless telegraph services with certain continental countries and with all other foreign countries outside Europe. In addition to the wireless stations it has been operating on these services for some years, it has a beam station nearly completed at Dorchester for communication with North and South America. A corresponding station is also in process of erection at Rio de Janeiro.

Another important scheme in which beam stations are included, and are already under construction, is the Portuguese scheme for linking up Portugal and its Colonies. Some time ago the Marconi Company obtained a concession from the Portuguese Government for the establishment of wireless telegraph stations in Portugal and its Colonies for the purpose of linking them together, and establishing wireless communication with other parts of the world. These stations are now being built at Lisbon, in the Cape Verde Islands, the Azores, and in East and West Africa. When they are completed wireless services will be established with England and the principal continental countries and with South America. The Marconi short-wave beam stations in this scheme are being erected at Lisbon, Loanda and Mozambique.



SECTION OF VALVE CHEST

Engineers in China.—Prospects for engineers in China were discussed by Mr. R. L. Sarjeant in a lecturette delivered before the Junior Institution of Engineers on October 15th. Mr. Sarjeant gave an idea of the difficulties, both racial and technical, which kept the conditions of life in China in such an elementary state. There was entire lack of co-operation amongst the Chinese, he said, and there were no really practical native engineers. There were some highly trained technical men, but they were of the class that would be horrified at the mere idea of soiling their hands with manual labour. It might be thought that in those circumstances there would exist golden opportunities for foreign engineers to take public works in hand, and there were no doubt many Chinese who would only be too glad to see that take place. That, unfortunately, was where racial prejudice came in, and the anti-foreign feeling of uneducated masses rendered outside assistance extremely difficult of application. Even when influential Chinese did promote public schemes for lighting, &c., and install the necessary plant, maintenance and depreciation were items grossly neglected, so that the undertaking did not endure for long. However, the present disturbances would pass over, and in a very few years great progress should be made. Mr. Sarjeant gave in his lecturette, and also in answers to specific questions from members, particulars of the training, experience and duties required of young engineers for different parts of China, and he also described the kind of life that was led and what it cost.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

The Iron Trades Only Hope.

As I write this letter the question is being asked whether the miners who have resumed work will come out in answer to the propaganda which the Miners' Executive has now started. The situation on Cannock Chase, in Warwickshire, in Leicestershire and Derbyshire gives room for concern. As my letters for some weeks have shown, the colliers in this district have been going back in increasing numbers, with the result that some of the ironworks and a few of the engineering shops have been able to increase their activities. The carrying of the campaign into the Midlands is undoubtedly having the effect of lessening the number of miners descending the pits in this area. It is generally felt in the Midland coal districts, however, that any success the "War Council" may secure will be of a temporary nature. In this lies the only hope for the Staffordshire and Midland iron trade. Happily, as I pointed out some weeks ago, the majority of the miners in this area have lost faith in the ability of their leaders to better their position, and undoubtedly the speakers will have to be well equipped oratorically to persuade these men to down tools again. Fortunately, the activities of the "Council" will be carefully watched by the authorities, in order to ensure that they do not go beyond the bounds of peaceful and legitimate persuasion. Some Staffordshire ironmasters, I am glad to state, take a less gloomy view of the new situation than others. They describe the miners' policy as a "doctrine of despair," showing that they are on the verge of surrender. I trust sincerely in the interests of trade that those members of the iron trade who express this opinion may prove to be correct in their judgment. But at the moment the situation is undoubtedly very harassing and one full of grave concern.

The Strike's Ravage.

The havoc wrought by the coal dispute on the iron and steel industries of the country is clearly demonstrated by the statistics of production for the past month, which show a still further decline in output as compared with the previous month. The production of pig iron declined to 12,500 tons, compared with 13,000 tons in August and 539,100 tons in April, and with an average monthly production in 1925 of 519,700 tons. This reduction is, of course, not surprising when one remembers that by the end of September only five blast-furnaces throughout the whole of the kingdom remained in operation, compared with 147 on the eve of the stoppage in the coalfields. Steel production amounted to 95,700 tons compared with 52,100 tons in the preceding month and 661,000 tons in April, and with an average monthly output in 1925 of 616,400 tons.

Market Position.

Buying of material has now become all but impossible. It is generally agreed that contracts would be altogether too speculative in the absence of knowledge as to prices and possibilities of production and delivery. Last week's quarterly meeting did nothing to facilitate business. It proved that producers and manufacturers who have anything to sell are few and far between, and made apparent the fact that supplies generally from home sources are not likely to increase under present industrial conditions. Values in all departments tend to appreciate, and there are consumers who declare they will no longer engage in competition for supplies at prices which they claim to be prohibitive. Shipments from the Continent are getting farther into arrear, and the scarcity of all classes of material is becoming more marked each day. Manufacturers' difficulties are increasing and the impossibility of gauging the future trend of events compels everyone to adopt a "wait and see" attitude.

Steel.

The steel position has become more stringent through the rise in price of continental products, due in part to the operations of the international Cartel. Belgian billets now cost £6 10s. delivered in Birmingham, and sheet bars anything from £6 15s. to £7 5s. Steel supplies at the moment depend on the Continent, either directly or indirectly. Re-rolling plants are kept going in this district, but congestion at Antwerp has disorganised deliveries, and operations at the mills are becoming more irregular. A limited tonnage of angles, joists, and small bars are available at £8 15s. or thereabouts. A little business has been accepted at £7 15s. for execution after the stoppage is settled. Staffordshire steel hoop values have further advanced, being now quoted £11 10s. per ton, an advance of 10s. per ton on recent prices. Engineers are in difficulties over supplies of steel, and unless additional plant can be got into operation before long, many of the structural firms will be forced to close down.

Raw Iron.

Business in pig iron is practically suspended. Purchasers' offers can only be entertained on the condition that they are willing to wait some weeks for delivery. Under these circumstances the quotations now named for Cleveland and Scotch irons are regarded as merely nominal. On 'Change to-day Scotch foundry pig was quoted £6 10s., Cleveland No. 3 £6 12s. 9d., and Durham £5 11s. 3d. delivered Birmingham. Small lots of East Coast hematite are available at £5 6s. 3d. There is not much continental pig to be got now at less than £5 delivered into this district. A certain amount of native material has been bought for delivery after the resumption of work. The conditions leave a good deal of latitude to the seller, since he will inevitably be at the mercy of circumstances for some time to come, however soon an end is made of the coal struggle. There is a strong disinclination on the part of some producers to enter into hard and fast forward commitments. Some Derbyshire smelters have, however, made forward sales at £4 and others at £4 5s. f.o.t. Generally, however, furnace owners refuse to tie their hands in view of the big buying movement anticipated as soon as the furnaces resume production.

Bar Iron.

A few Staffordshire ironworks are still turning out material, though coal suitable for the manufacture of wrought iron is extremely difficult to get. The small amount of bar iron being produced is all reserved for special purposes, none coming on to the open market. Under these circumstances Staffordshire ironmasters hold that it is idle to attempt to fix prices which will be applicable after the coal strike. So obscure is the outlook that a groundwork for price adjustment is not easy to discover. Though the Yorkshire Association has fixed a new basis for Crown bars at £12 10s., an advance of 20s. on the price previously ruling, the Staffordshire Association has made no pronouncement, nor, it is felt, is it likely to do so until the situation clears. It is stated here that as much as £14 10s. has been paid for current production of Crown bars, and millowners say there is nothing to be made out of the business, even at that price. Fair quantities of Belgian No. 3 bars are coming into the district for use in the nut and bolt works. The price works out at something like £6 15s. delivered. Conversation with ironmasters on 'Change to-day leads one to assume that the restoration of normal production in this department is not expected much this side Christmas. The prospect is a gloomy one.

Galvanised Sheet Values.

Sheet mills continue to receive as many orders as they can handle, November or December being the delivery dates now named. South American buyers are inquiring for galvanised sheets, the supply of semi-finished material for sheet mills is rapidly being depleted, and this scarcity of material is chiefly responsible for the rise in the price of galvanised sheets of about 5s. per ton, making the quotation for 24 gauge corrugateds £17 to £17 5s. Some of the mills ask even more. There is a fair demand for thin gauges. The mills have plenty of work in front of them when production again becomes possible.

Tinned Sheet Prices.

For the first time since the summer of 1924 the Tinned Sheet Manufacturers' Association has put up its prices, the impetus coming from the upward rush of block tin. An advance of 2s. per cwt. makes best charcoal sheets £3, charcoal £2 16s., unassorted £2 14s. per cwt., 20 gauge lead-coated sheets remaining unaltered at £1 8s. There is an active demand for tin-plate wasters. Prices rule at £1 0s. 9d. upwards, Birmingham.

Scrap.

The weakest item on the market is scrap, of which only an occasional sale is made. Very large quantities are available, and some purchases to-day are on as low a basis as £2 to £2 3s. f.o.r. People who can afford to buy and have the necessary storage capacity stand to make good bargains.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Exports of Textile Machinery.

FOREIGN shipments of textile machinery last month were nearly 2000 tons less than in August and more than 3700 tons below the figures for September of last year, the reduction being accounted for almost entirely by a fall in the exports of machinery for spinning and twisting operations. The value of the textile machinery exported last month was £647,639, compared with £850,932 in the preceding month and £1,010,336 in September, 1925. The Board of Trade returns for the period under review show a number of striking changes in the destinations of the machinery shipped. In August, for example, exports to Russia were of the value of £164,417, whereas last month they were valued at only £37,312. Shipments to Germany were also rather lower, although important increases occurred in the case of France and the Netherlands, particularly the former. A decline of over £30,000—from £132,556 to £101,153—took place in the exports to "other European countries." The British East Indies continue to be the largest individual buyers, the shipments there during last month being valued at £193,215, compared with £164,898 in August and £244,629 in September, 1925. Exports to Japan were of a lower value, although greater in quantity than in August, this also being the case as regards the United States. Shipments to Australia, China and South American countries were slightly lower than in the previous month.

Wages and Production Costs.

Of the series of interesting papers read at the Manchester conference last week-end of the Institute of Cost and Works Accountants, that of Mr. R. B. Garnham on "Campaigning against Waste" merits brief reference in this column. Mr. Garnham discussed the view of Sir Lynden Macassey that wages reductions could be the only means of reducing production costs, and that improvement of management, organisation and plant, and increase of the efficiency of labour's output, whilst necessary for permanent industrial well-being, were, in so far as they resulted in reduced production costs, too slow acting for the present emergency. Mr. Garnham submitted this view to a critical analysis. The experience of recent years, he said, had shown that the attempt to reduce wages had only been partially successful. The result had been serious labour disturbances, with little effect on the mass of unemployment, and, so far as prices were concerned, they showed no remarkable tendency to fall. To-day's cost of finished engineering commodities was not much less than in 1922, and where reduction had occurred it had been mainly to meet foreign competition. Mr. Garnham held that these facts proved that a scheme for an all-round reduction of wages and profits was not swift in its results, and that it was questionable whether such a scheme had any more speed than could be obtained by a gradual revision and improvement of the means of production.

Non-ferrous Metals.

Virtually all sections of the non-ferrous metal market have moved to some extent sympathetically during the past week. All of them closed last week on a higher price level than at the opening, but all of them also were easier in the opening days of the present week, a tendency which is to be observed at the time of writing. Tin closed at the end of last week on a very firm note. The week's sales were about 500 tons more than in the previous week, and closing quotations represented a considerable advance on the opening prices. Bearish factors soon came into play, however, early this week and prices were seriously affected. Under the influence of a spell of fairly active selling, coupled with a knowledge of an increase in the available stocks of the metal in this country, the market weakened substantially, so much so that rather more was lost than was gained during the whole of last week, whilst the position at the moment cannot be described as strong. Copper has had a somewhat similar experience, in this case a particularly bullish influence being the functioning of the United States Copper Export Association. Values in this section moved upwards as a result, but a quiet demand and free selling induced an easier feeling. Both lead and spelter also moved upwards, but here, again, less so perhaps in the case of spelter, a weaker tendency has more recently made itself felt.

Iron.

In the iron market here the attitude of both buyers and sellers, generally speaking, has simply resolved itself into a question of marking time until the position is such as to afford relief to the existing famine conditions and to permit of something more akin to normal transactions. As things are now, of course, business is almost at a standstill, and the situation is clearly reflected in the prices that are now ruling. This week, for example, "subject to being unsold," up to £6 10s. per ton has been asked for delivery into the Manchester district of a small lot of Scottish No. 3 foundry iron, with a parcel of something in the neighbourhood of a No. 4 iron offered within the past few days at about £6 5s. per ton. At the end of April Scottish No. 3 was quoted here at £4 14s. per ton delivered, and the extent of the advance since then can readily be seen. Similarly, Cleveland No. 3 is at the moment about £6 12s. 6d. per ton, delivered, for delivery in about eight weeks, with a mixed lot of East Coast hematite quoted at the beginning of this week at up to £5 10s. per ton. Add to these a little foreign pig iron at about £5 5s. per ton delivered, and the current range of supplies is exhausted. There have been rumours of a probable resumption of production at some of the Derbyshire blast-furnaces, but there is little possibility of a restart under present conditions of fuel supplies. The position of manufactured iron shows no change, none being produced in Lancashire yet, and very little, apart from a certain quantity of outsized bars, being available.

Steel.

"Stagnation" is not too strong a word to apply to the steel market. There were hopes last week that plates would be available with the resumption of rolling operations on the North-East Coast at the beginning of the present week, but the expected start was not made and I cannot say at the moment when it will be. Until recently a very limited quantity of joists could be bought, at a price, of course, to cover the additional production costs; but with the closing down of the mills largely on account of the unsatisfactory results obtained with imported fuel, that source is now cut off. In the meantime, ship plates are quoted here at £8 10s. to £8 12s. 6d. per ton, and boiler plates at £11 10s. to £12, both for forward delivery. Re-rolled bars for early delivery remain very firm at £9 10s. per ton. There is little fresh to report in respect of continental steels. Prices are no lower than they were a week ago, and wire rods are 5s. to 7s. 6d. per ton dearer. The demand is only moderate, the present high prices, delivery delays—one firm of constructional engineers has just received a consignment ordered nearly four months ago—and the general uncertainty holding up a good many orders. For delivery to works in this area, for cash against shipping documents, billets are quoted at £6 5s., sheet bars, at £6 10s. to £6 12s. 6d., wire rods at £7 to £7 2s. 6d., joists and sections at £6 15s., Siemens plates at £7 10s., and light plates at about £7 5s. per ton. There is only a quiet demand for galvanised sheets, which, however, keep very firm at about £17 per ton f.o.b., for the usual 24-gauge Indian specifications, thin gauges for the Eastern markets also being in limited request.

Scrap.

Trade in non-ferrous metal scrap is very limited, but prices generally are steady, cast aluminium being lower at about £75 per ton. Brass-rod turnings are quoted at £40, selected gun-metal at £53, braziery copper also at £53, clean light copper at £57, zinc at £25 10s., lead at £31 10s., and heavy yellow brass at £45 per ton for graded materials delivered to users' works.

BARROW-IN-FURNESS.

Hematite Firmer.

As was to be expected, there has been a further rise in the price of hematite pig iron. This may be said to mean that makers are now well booked up for orders, and are asking a better price for any further contracts, so that they may be sure of a margin of profit. There are some who suggest that the increase in price is intended to meet the possibility of high fuel costs, but this many do not feel inclined to accept. Fuel, both as regards delivery and price, will have to return to normal, otherwise it would be useless securing contracts. There has been no rise up to the present in the price of either native ores or steel, and as regards the latter, it may be concluded that the number of orders for steel are not so bulky as those for ordinary

mixed Bessemer numbers. The hoop works continue to run, using Belgian billets, and there is no likelihood of there being any stoppage in this department. As regards shipbuilding, there is much important work held up owing to lack of material, and even when an end comes to the coal dispute it will be some weeks before steel plates are available for the constructors. The engineering departments at Vickers' works are busy, but it must not be inferred from this remark that there is a boom. Arrangements were made by Commander Craven, the local managing director of Vickers, with the engineers to work overtime and night shift without a break, in order that certain Admiralty work can be pushed on with. The day shift will work until eight o'clock at night, when the night shift will carry on.

SHEFFIELD.

(From our own Correspondent.)

Plenty of Steel Orders.

Although, fortunately, there has not had to be that curtailment of work on account of the fuel restrictions which was feared some weeks ago, it has only been with the greatest difficulty that activity has been maintained. Supplies of certain classes of steel have completely run out, and there is a strong feeling in manufacturing circles that more fuel could be allotted for industrial purposes without interfering with the claims of the priority services. Considerable quantities of fuel are now pouring into the Sheffield district, and on the Sheffield Iron and Steel Exchange last Friday steel makers reported that if fuel supplies were definitely assured for some few months, they would be able to restart the big plants which have been idle for five months. What is needed is an assurance that deliveries of fuel will be maintained over a period sufficiently long to make it profitable to restart the big batteries of furnaces. The finished trades are held up for supplies of high carbon basic steel, and other classes of steel largely used in the local trades are also unprocurable. There is plenty of foreign steel on offer, but it is unsuitable for the bulk of the city's requirements, and is contributing nothing towards the relief of the situation. Steel order books are overflowing with orders, and those works which can get on with their contracts are really hard at it. Many of the light foundries are managing to work full time by resorting to foreign coke and pig iron.

Engineering Orders and Inquiries.

A 1-ton Greaves Etchells electric steel furnace to be employed on the production of castings is being supplied by Watsons (Metallurgists), Ltd., of Sheffield, to the Hong Kong and Whampoa Dock Company, of Hong Kong. Although the coal dispute has restricted the chance of accepting foreign railway business, a fair amount of work has been placed during the last few months, the demand curiously enough having been larger than for several years. A large proportion of the inquiries has come from India, and further invitations to tender are now to hand. The India Store Department is seeking delivery of about 900 tons of stamped mild steel keys, 500 axle boxes for carriages and wagons, and a large quantity of cable required for railway electrification schemes. The Great Southern Railway of Ireland has inquired for 8500 tons of rails, 190 tons of fish-plates, 2700 tons of cast iron sole-plates, 150 tons of fang bolts, 600 tons of sleeper bolts, 100 tons of fish bolts, and 75,000 teak keys. Government contracts placed this week include the following :—Cast iron pipes, &c., for the Admiralty, Staveley Coal and Iron Company, Ltd. ; Pembroke Docks, pipework, Stanton Ironworks Company ; fire hearths, Darwin, Yeardley and Co., Sheffield ; W. Green and Co., Ecclesfield ; and Moorwood, Ltd., Sheffield ; pneumatic mains, Stanton Ironworks ; copper nails, &c., Cooper and Turner, Ltd., Sheffield ; steel blooms, Vickers Ltd., Sheffield ; steel billets, Industrial Steels, Ltd., Sheffield ; medium tensile steel bars, Park Gate Iron and Steel Company, Ltd., Rotherham. The Crown Agents for the Colonies have placed the following contracts :—Axles, J. Baker and Co., Ltd., Rotherham ; collars, Staveley Coal and Iron Company ; pipes, &c., Stanton Ironworks ; tipping boxes, Cammell Laird and Co., Nottingham.

The Razor Contract Protest.

Sheffield's protest against the action of the War Office in placing a contract for safety razors outside this country is being continued with vigour, and there is no intention of allowing the matter to rest where it is. A united meeting of the members of the Chamber of Commerce, the Cutlery Manufacturers' Association, and the Cutlery Workers' Council, was held on Friday. A very strongly worded resolution was passed condemning the action of the War Office in this matter, and urging that the Government should be called upon to appoint immediately an independent investigation committee to go into the whole circumstances of the case, with a view, if thought desirable, of cancelling the contract should that be found to be the only means of rectifying a serious administrative blunder. The view of many in the meeting was that there was no real need to change over from the old-fashioned razor to the safety, a strong point being made of the cheap rates at which the Army used to obtain its razors, and the inferior quality which was consequently supplied. It was contended that quite satisfactory razors of the old pattern could have been secured if the War Office had been prepared to pay a reasonable price as did the Admiralty. It was stated that the War Office price for razors before the war—no contract has been placed since—was only about 4s. 10½d. a dozen, whereas the razors bought by the Admiralty actually cost 12s. a dozen for grinding alone. Another complaint was that the change over would mean the displacement of a large number of men in the cutlery trade. Another view of this question has been put forward since by the chairman of Darwins, Ltd., the Sheffield firm which is producing safety razor blades on the mass production system. His view is that the American razor makers have adopted a policy of practically giving holders away in order to stimulate trade in blades, and in that way millions of holders are distributed annually at a considerable sacrifice to these makers, who hope subsequently to recompense themselves by increased turnover in blades. But now that Sheffield is producing a far superior type of blade to fit any of the well-known American holders, the suggestion is made that though the Army may be fitted out with American holders, British made blades will subsequently be used in them.

Cutlery and Plate.

The cutlery and plate trades continue to get busier with the arrival of seasonal orders, but there is still a good deal of uncertainty about the dimensions this trade will attain this year. A coal dispute of already six months' duration is bound to result in diminished purchasing power of the public, and the Christmas trade is certain to suffer. Already selling prices have had to come down, and the bulk of the demand is for the cheaper lines. A very good export trade is being done, and last month's shipments were of the value of £90,000, which is nearly equal to the value of the trade a year ago.

Local Fuel Position.

I have already mentioned that the supplies of fuel have greatly increased during the past few weeks. This, however, is not due so much to any development of coal getting at the Yorkshire pits as to the opening out of several new outcrop workings and to purchases in the neighbouring fields of Nottinghamshire and Derbyshire. The Yorkshire miners, and particularly their officials, have always been noted for loyalty to their Association, and no general drift back to the pits can be expected here. Mr. Joseph Jones, general secretary of the Yorkshire Miners' Association, states that there is not the slightest foundation for the suggestion that the Yorkshire representatives would be prepared to consider a district settlement. There are no district proposals before the Yorkshire Miners' Association, nor is there any disposition to consider one unless and until such a step is decided upon by National Conference. The obtaining of large quantities of coal from the filter beds at the Bradford Corporation Sewage Works at Esholt has lessened the severity of the coal shortage in that city. Some idea of the prices being charged for fuel in this district may be of use. Outcrop slack is fetching about 32s. 6d. per ton at the workings, and other qualities about 42s. 6d. The following are the quotations mentioned on the Sheffield Coal Exchange at the last meeting :—Best hand-picked house coal, 66s. 6d.; other qualities best house, 55s. to 60s. ; large nuts, 45s. to 50s. ; best hards, 50s. to 60s. ; secondary sorts, 50s. to 55s. ; rough slack, 40s. to 45s. ; all these prices being per ton at the pit. Another increase of 5s. per ton in the price of gas coke and breeze has been recorded, and large coke is now 55s. per ton and breeze 58s.

Trade Technical Societies.

Important statements regarding future co-operation between the Sheffield Trades Technical Societies and the University were made at the opening meeting of the session. Mr. Albert Senior, the deputy chairman of the Applied Science Committee of the University, stated that the men who had maintained the superiority of Sheffield for high-grade steels had received their training at the Applied Science Department. This training should be available in a suitable form for the old Sheffield trades, and the University would this year extend its facilities so as to make provision for each of these trades. There would be two distinct classes of instruction, one dealing with the materials used in the trades, and the other with the methods of production. This instruction would be given in the form of weekly lectures, which would be specially arranged to meet the requirements of the workers in each of the trades. Recognising the difficulties which the workmen had to face at the present time and realising the necessity of this instruction, the Department had fixed the cost of this instruction at the very low fee of 2s. 6d. for each of the courses of six lectures. Another important aid which the Department could render to the trade was to act as a counsellor in cases of difficulty. Manufacturers and workmen were often faced with technical problems which required expert knowledge to solve. The professors were always anxious to help in such cases, and the trades should bring their problems up for solution.

Modified Harbour Scheme.

As a result of the refusal of the Government to provide a loan of £15,000 for the improvement of Scarborough Harbour, the original scheme, which provided for the deepening of the harbour to 3ft. below the low water level has been modified. The new scheme only provides for the deepening of the harbour to low water level.

NORTH OF ENGLAND.

(From our own Correspondent.)

Miners Drifting Back.

The breakaway among the miners has been more pronounced this week in the Northern coalfields, and it is likely to continue, notwithstanding the renewed activities of the Federation "Council of War." It is not general, but the move is significant. In Northumberland the breakaway appears to be moving on definite lines, notably at Ashington, Cramlington, and elsewhere. Work was resumed at South Tyne Colliery, Haltwhistle, on Monday, with a full turn out of about 650 men and lads. The normal output at this colliery approaches 700 tons per day. All the collieries in the Haltwhistle district are now working, with the exception of Blackett Colliery, a small pit 2 miles east of Haltwhistle, and owned by the Blackett and South Tyne Collieries, Ltd., but arrangements are being made for a start there in a few days. Plenmeller Colliery, the second largest in the district, has been working for a month. Others which have been working for some time include Barcombe, Bardon Mill, Lambley, Byron-Greenhead, and Whitechapel, while the colliery at Midge, holme has worked throughout the dispute. There are also prospects of the miners at Seaton Burn, Holywell, Prudhoe, and the Ashington group of collieries resuming work at the beginning of next week. The terms of engagement in all cases are on the county basis, viz.:—Eight hours and one winding for all classes, with 80 per cent. on the basis wage and 6s. 9½d. subsistence wage. In last week's letter reference was made to the efforts of the Durham coalowners to bring about a settlement, but nothing has resulted, owing to the persistent refusal of the representatives of the Durham Miners' Association to meet the owners for the purpose of discussing a way out of the present deadlock. Nevertheless, every day sees a swelling of the stream of men back to the pits which have already opened. This week a start was made at the Bitchburn Colliery, and several other smaller pits are expected to resume in the course of a few days.

Cleveland Iron Trade.

With very little pig iron available for early delivery and a general disinclination to discuss forward business until the outlook clears considerably, transactions have shrunk to trifling dimensions on the Cleveland iron market. Of the five blast-furnaces which now represent the sum total of the pig iron producing plant in operation in Great Britain, four are situated on the North-East Coast. Thus this district is virtually the sole source of the supply for consumers of British pig iron, and famine conditions prevail. The scarcity of all descriptions of iron is most acute, and prices are being squeezed up to totally unexpected levels. As a matter of fact, the point has been reached when some consumers refuse to buy, but the ironmasters have sold all their output for weeks ahead, and, being assured of a market, are able firmly to maintain quotations or even to stiffen them. Still there is a marked difference between home and foreign prices, good foreign foundry iron being on offer, f.o.b. Antwerp, at about 76s. per ton, compared with 120s., which is the current price of No. 3 Cleveland pig iron. No. 1 foundry iron has hitherto been at a premium of 2s. 6d. per ton, but that has been increased to 5s., so that this grade is now 125s. per ton ; No. 4 foundry is 119s.; and No. 4 forge 118s. 6d.

Hematite Pig Iron.

The position in the East Coast hematite trade is now very difficult. Ordinary grades are unobtainable, the producers being so heavily booked that they refuse to quote for further business. There are a few off grades, however, on offer at 85s. to 87s. 6d. per ton, and the latter is still regarded as a nominal figure for mixed numbers.

Ironmaking Materials.

There is no indication of an early resumption of business in the foreign ore trade. Best Rubio ore is nominally at 21s. 6d. per ton c.i.f. Tees. English blast-furnace coke is almost unobtainable, but the last lot sold brought 57s. 6d. per ton at the ovens.

Manufactured Iron and Steel.

A certain amount of steel manufactures continue to be turned out in the North of England, but producers decline to disclose the realised prices. There is still a big proportion of foreign steel being used, though much of it is unsatisfactory.

The Coal Market.

Little business is possible as yet on the Northern coal market so far as export trade is concerned. There is, however, every probability that if the pits as a whole resume operations, there would be some months of brisk trade. As it is, forward contracts are still out of the question. The collieries working can sell every ton of output at good prices, and with the advent of colder weather, the demand will continue to expand. There are inquiries from abroad for fuel, and business would be placed if there was any immediate prospect of delivery. Forward values are still in the region of 25s. per ton for best steams for the early weeks of resumption, and in later months prices are expected to recede to about 18s. per ton. At the latter figure some producers are said to be offering over the whole of next year, but buyers are not moving yet. There can be no real test of values, however, until dates of delivery can be guaranteed. There is still a good inquiry for foreign coal. Prices are firmer, and it is difficult to discount 52s. 6d. c.i.f. Tyne dock, for good gas coals for November delivery. Tonnage rates from all centres are advancing, and this reacts on the c.i.f. prices, which are steadily rising for December deliveries.

SCOTLAND.

(From our own Correspondent.)

Slow Progress.

The return of the miners to work progresses slowly and the attitude of the men in certain districts does not promise any acceleration of the movement. Four-fifths of the number now employed are working in Lanarkshire mines, and while the number is steadily increasing there, the outlook in the other districts is unfavourable. Some trouble has been experienced with the safety men in certain districts, but on the whole quiet conditions prevail.

Demand for Oil Fuel, &c.

The acuteness of the coal shortage and the high price of supplies when available is reflected in an unprecedented demand for oil and oil stoves for heating and cooking. The demand exceeds the supply, and stocks are not readily replenished, as many manufacturers of stoves have been compelled either to cease or to curtail production owing to the coal shortage causing a scarcity of the necessary materials. The price of oil shows little, if any, advance, supplies being obtainable at from 1s. 2d. to 1s. 5d. per gallon, according to quality.

New Cross-Channel Steamers.

William Denny and Brothers, Dumbarton, have received an order for three steamers for the Irish service from the London, Midland and Scottish Railway. These steamers are to be fitted with twin-screw geared turbines, obtaining steam from water-tube boilers. The trial speed of the vessels will be 21 knots.

Advance in Ferro-manganese and Spiegeleisen.

Ferro-manganese has been advanced by £1 per ton, making the price now £15 per ton for 78 per cent., delivered Glasgow. Spiegeleisen is 10s. per ton dearer at £7 10s. per ton for 20 per cent., delivered Glasgow. Manufactured copper has been advanced £2 and is now £90 per ton basis for strong.

Steel and Iron.

Generally speaking, the steel and iron trades continue in a state of inactivity, and the past week has been practically without fresh feature. With one or two exceptions, the outputs are extremely meagre, and at the few works in operation great difficulty is often experienced in maintaining production, owing to the unsuitability of the fuel obtainable. Heavy steel is still practically unprocurable, as none of the works are in operation. Steel sheet makers are busy, and many are well placed so far as orders are concerned. Both black and galvanised varieties continue in steady demand. Only two of the bar iron works are engaged, and in these chief attention is centred on the output of steel bars manufactured from foreign billets. Business in pig iron is extremely quiet. Stocks of foundry qualities are very limited, and the prices quoted are as a rule outwith the ideas of consumers. A moderate turnover in hematite is reported. Prices are all nominally unchanged.

Coal.

The demand for coal has been on the increase, and owing to dwindling imports and the slow expansion of home supplies, merchants have been finding great difficulty in arranging prompt deliveries. Prices of foreign coal have not appreciably altered, despite the fact that importers have been forced to pay higher prices recently. A steamer arrived in Glasgow during the week from Spitzbergen with the first cargo of coal from that quarter, while four vessels, each carrying 7000 tons, are due from America. In view of the shortage of foreign coal, some importers of briquettes are arranging for increased deliveries. Merchants have turned their attention to collieries south of the Border, but have had little success in their endeavours to secure fuel supplies from such sources. Approximate prices are as follows:—Silesian screened, 75s. to 80s.; unscreened, 72s. 6d.; Westphalian screened, 70s. to 75s.; unscreened, 70s., all per ton f.o.t. at Glasgow, Grangemouth, Bo'ness or Leith. American unscreened, 70s. to 75s., f.o.t. Glasgow. Westphalian foundry coke, 48s. to 50s. per ton, f.o.t. Grangemouth or Bo'ness. Scottish patent fuel is dearer at 62s. 6d. per ton, f.o.b. Glasgow, Grangemouth or Bo'ness, and 63s. 6d. per ton at Leith. Scottish screened coal, 70s. to 75s.; triping, 60s. to 65s.; and dross, 50s., all per ton in truck at pit. Household fuel is selling on the average at from 4s. 6d. to 4s. 9d. per cwt. bag.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Drift Back.

THE miners in South Wales are steadily drifting back to work, and the probability is that the number reported to have been at work last week, viz., nearly 17,000, will be considerably added to by the end of this week, unless, of course, strong steps are taken by the Federation leaders to persuade them to down tools again. In various parts of the coalfield, but more especially in the Monmouthshire area, there appears to be a greater readiness to resume operations. It must not be assumed from that, however, that a general resumption is within sight. It is not possible to be anything like so optimistic, and it will be a matter for surprise if our coal troubles are over by the end of this month or the early part of November. In practically all areas where miners show any disposition to get back to work serious efforts are being made to restrain them, and the methods adopted are not always of the peaceful persuasion type. Last week there were very serious conflicts between the police and miners at Cymmer, in the Afan Valley, following upon a demonstration by the unemployed miners against the action of a few Port Talbot men who were alleged to be working at the Glyncymmer Colliery. Still the outlook is rather more promising when reports come to hand of miners numbering anything from a dozen to 120 returning to work at various pits. The Executive of the South Wales Miners' Federation met at Cardiff on Saturday last, but no reference was made in the official report of the proceedings to the question of the safety men.

Coal Export and Import.

Under the best of circumstances, assuming that the coal troubles in this country come to an end in a fortnight's time, which is doubtful, so far as South Wales is concerned, it is unlikely that there will be any real resumption of coal exports before the second half of November. It is taken as quite for granted that a measure of control will be exercised over all supplies of coal for some time after work is recommenced at collieries, so that home requirements shall be first met. This being the case no exporters are as yet seriously entertaining business. The conditions ahead are altogether too uncertain to make any definite offers, though, of course inquiries are coming in from abroad. The fact, however, that exporters cannot give any undertaking as to when cargoes can be supplied from this district has had the effect of making some buyers abroad not only purchase elsewhere the coals they may require up to the end of this year, but some consumers abroad have bought German coals for delivery over the first three months of next year. Prices of coals all round continue to advance, Westphalia large being now round about 55s. f.o.b., with unscreened qualities at about 45s. Rumours have been busy that an embargo was to be placed on the export of German coals; but while that is not altogether correct, there is some truth in the statement that the export of Silesian and Saxony qualities is being restricted. It is greatly to be feared that supplies of coal in most countries will be found to be inadequate, seeing that the extra needs of winter have to be taken into consideration. Cargoes of coal are actually being shipped from Newcastle, New South Wales to Buenos Aires, and further supplies of coal are coming from South Africa to this country, while even Spanish coals have been bought for shipment to South Wales. Rates of freight are mounting up almost daily, the call for tonnage to lift coals being very urgent. At the same time the cost of bunker coals is advancing, and this week the price quoted for supplies has been 55s. at Algiers and 65s. at Las Palmas, figures which are more than double the price of normal times. The quantity of foreign coal brought to this district last week was rather less than in the previous week, but there were good arrivals over the week-end, and on Monday seventeen steamers were engaged discharging their cargoes, the bulk of the coals to hand being from the United States. So far as prices are concerned, American run of the mine coals command about 57s. 6d. c.i.f. South Wales, while as regards any Welsh coals which may be available, the prices at pit are approximately 50s. to 52s. 6d. for large, 45s. to 47s. 6d. for through, and 30s. to 35s. for smalls, with patent fuel 50s. to 55s.

Impending Tin-plate Deal.

The report is current that negotiations are afoot and on the point of completion for the acquisition of a controlling interest in the old-established Morriston Tinplate Company, by the Briton Ferry Steel Company, both of which undertakings hold a high position in the tin-plate and steel bar industry of this district. The Morriston Tin-plate Company owns the Morriston and Midland Tinplate works, which have thirteen mills and employ 500 men.

Tin-plate Trade.

About 60 per cent. of Welsh tin-plate mills are at present operating, mainly by means of foreign coal. The Joint Standing Committee of the Tin-plate Industrial Council met at Swansea on Saturday last, when the men's representatives put forward their application for the continuance of the *ex gratia* bonus of 7½ per cent., which was originally conceded by the employers to meet the necessities of the men in 1921, when the basis of the sliding scale fell nearly to zero, and had been renewed each quarter up to the present, when the employers gave notice that they could not grant a further renewal. They, however, agreed to meet the men to hear their arguments, but on Saturday they eventually informed them that they could not alter their decision, and consequently the bonus ceases after November 6th.

German Methods.

Mr. H. H. Merrett, the managing director of D. R. Llewellyn, Merrett and Price, Ltd., of Cardiff, who has just returned from a visit to the United States, in the course of an interview, states: "I have heard of a most peculiar and extremely clever move on the part of German colliery owners. Owing to the exorbitant prices which are being charged by the German colliery companies to the British consumer during the strike, the German anthracite coalowners find themselves able to offer best German anthracite to customers to whom I have been supplying Welsh anthracite at prices which are actually shillings below the prices previously paid for Welsh coal. The apparent losses which they may be making in order to effect this introduction are being made up to them out of the enormous profits that they are making from the British consumers of industrial coals. This German anthracite is giving considerable satisfaction, and it seems a crime that we, having given the German producer an opportunity of putting his coal on our markets, should actually be called upon to pay for the cost of its introduction."

Catalogues.

THE ARORA COMPANY, Loughborough.—List of electric fires for the 1926–7 season.

LEYLAND MOTORS, Ltd., Leyland, Lancs.—Showcard illustrating the Trojan delivery van.

MACMILLAN AND CO., Ltd., St. Martin's-street, W.C. 2.—Autumn list of new Macmillan books, 1926.

HERBERT MORRIS, Ltd., Loughborough.—Illustrated folder dealing with the "Morris" gravity conveyor.

E. GREEN AND SON, Ltd., Wakefield.—Catalogue describing Green's patented tri-tube horizontal economiser.

GRIMSTONE, PRICHARD AND PLUTTE, Ltd., 83, Queen-street, London, E.C. 4.—Price list of ball and roller bearings.

HERBERT TERRY AND SONS, Ltd., Redditch.—Folder giving particulars of the "Terry" four-valve wireless receiver.

MAVOR AND COULSON, Ltd., 47, Broad-street, Glasgow, S.E.—Leaflet illustrating the M. and C. electric shaker conveyor.

HOPKINSONS, Ltd., Britannia Works, Huddersfield.—List No. 1940, dealing with Hopkinson's patented steam traps.

PHILIPS LAMPS, Ltd., 145, Charing Cross-road, W.C. 2.—Leaflet 164, illustrating Philips electric lamps for all purposes.

HIGGS MOTORS, Witton, Birmingham.—Stock list of alternating-current and direct-current electric motors for September, 1926.

STEWARTS AND LLOYDS, Ltd., 41, Oswald-street, Glasgow, C. 1.—Booklet of net prices of screwed and socketed tubes and fittings.

BRITISH PISTON RING COMPANY, Ltd., Holbrook-lane, Coventry.—Illustrated brochure entitled "Piston Ring Cast Iron and Design."

HANS RENOLD, Ltd., Didsbury, Manchester.—Publication No. 8006 on Renold chains for conveying and elevating machinery.

JONES AND LAMSON MACHINE COMPANY, Springfield, Vermont, U.S.A.—Folder dealing with the 4 by 34 J. and L. Hartness flat turret lathe.

PRIESTMAN BROTHERS, Ltd., Holderness Foundry, Hull.—Dredger catalogue No. 250, showing the range of "Priestman" grab dredgers.

J. W. SHILLAN, 150, Southampton-row, London, W.C. 1.—Folder illustrating and describing the "Basco" air-cooled petrol engine.

ASTER ENGINEERING COMPANY (1913), Ltd., Wembley, Middlesex.—Pamphlet S15, describing the Aster-Anthony feed-water regulator.

ALDRIDGE AND RANKEN, Ltd., 39, Victoria-street, S.W. 1.—Catalogues dealing with coke separating plant made under the Columbus patents.

GREENWOOD'S STANDARD GEAR CUTTING COMPANY, Ltd., New Bond-street, Halifax.—Price lists of all sizes of machine-cut gearing kept in stock.

E. BROOK, Ltd., Empress Works, Huddersfield.—Folder entitled "Sale and Service," setting forth the representatives for Brook motors.

BIRTLEY IRON COMPANY, Birtley, Co. Durham.—Pamphlet on the Birtley pneumatic separator for removing refuse from coal in a dry condition.

GEORGE CROSSLEY, Ltd., Albion Ironworks, Cleckheaton, Yorks.—Illustrated catalogue on wire rope, hemp rope, and cable-making machinery.

BURTON, GRIFFITHS AND CO., Ltd., 64, Vauxhall Bridge-road, S.W. 1.—Descriptive booklet of the Lapointe "No. 0" high-speed broaching machine.

THE BRITISH INSULATED CABLES, Ltd., Prescot, Lancs.—Publication 203, giving detailed descriptions of various types of "Prescot" mining boxes.

THE GENERAL ELECTRIC COMPANY, Ltd., Magnet House, Kingsway, W.C. 2.—Bulletin No. 22, an illustrated descriptive price list of oil circuit breakers.

JAMES KEITH AND BLACKMAN COMPANY, Ltd., 27, Farringdon-avenue, E.C. 4.—Folder describing the Keith-Blackman dust separator fan for arresting dust and smuts from chimney gases.

HENRY BUTCHER, HALL AND CO., 63-64, Chancery-lane, W.C. 2.—Register of factories, mills, wharves, warehouse sites, and other industrial properties to be let or sold in London and the provinces.

LAUNCHES AND TRIAL TRIPS.

STUARTSTAR, twin-screw steamer; built by Palmer's Shipbuilding and Iron Company, Ltd.; to the order of the Blue Star Line, Ltd.; dimensions, 494ft. overall length; 11,750 tons deadweight. Engines, twin-screw, single-reduction geared turbines; constructed by the builders; trial trip, October 7th.

VIZAGAPATAM, suction hopper dredger; built by Wm. Simons and Co., Ltd.; to the order of the Government of India. Engines, four sets of triple-expansion, surface-condensing; constructed by the builders; launch, October 7th.

PATELLA, oil tank vessel; built by Palmer's Shipbuilding and Iron Company, Ltd.; to the order of the Anglo-Saxon Petroleum Company, Ltd.; dimensions, 440ft. long; 9900 tons deadweight. Engines, single-screw, four-cycle, six-cylinder double-acting Werkspoor; constructed by the North-Eastern Marine Engineering Company, Ltd.; launch, October 8th.

PULPIT POINT, oil tank vessel; built by David Rowan and Co., Ltd.; to the order of the Vacuum Oil Company, Ltd.; dimensions, 640ft. by 62ft. 6in. by 36ft. 6in. Engines, inverted, direct-acting, triple-expansion; pressure, 220 lb.; constructed by the builders; trial trip, October 8th.

BRITISH GOVERNOR, tank steamer; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of the British Tanker Company, Ltd.; dimensions, 454ft. by 57ft. beam; 10,150 tons deadweight. Engines, triple-expansion; constructed by the builders; trial trip, October 13th.

SHERINGHAM, single-screw cargo steamer; built by Earle's Shipbuilding and Engineering Company, Ltd., Hull, to the order of the London and North-Eastern Railway Company for express goods service between Parkeston Quay and Rotterdam; dimensions, 255ft. by 36ft. moulded by 17ft. 2in moulded; capacity 92,000 cubic feet. Engines, triple-expansion, 22in., 35in. and 60in. by 39in. stroke, pressure 205 lb.; constructed by the builders; trial trip, October 19th, 14½ knots.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS: RESEARCH FUND.—The sum of £400 is allocated in each calendar year to the advancement of research in petroleum technology and its basic sciences, and the Council is prepared to receive applications for assistance from this fund. Applications from persons proposing to engage in research in any university or other teaching institution must be supported by the professor under whom the applicant will be working. Applications from associate members, students or associates of the Institution of Petroleum Technologists and non-members, not proposing to engage in research in any university or other teaching institution, must be supported by a member of the Institution or other responsible person. Applications from full members of the Institution do not require a supporter. Applications for grants from this fund will be considered in June and December of each year, and must be received by the Secretary not later than June 1st or December 1st respectively. Application forms and the conditions under which the awards are made may be obtained from the Secretary of the Institution at Aldine House, Bedford-street, Strand, London, W.C. 2.

ROYAL INSTITUTION.—The following courses of lectures have been arranged to be delivered at the Royal Institution during November and December. The Tyndall lectures will be delivered by Dr. G. W. C. Kaye, who will commence a course of three lectures on "The Acoustics of Public Buildings" on Tuesday, November 2nd, at 5.15, and on Tuesday, November 23rd, Sir William Bragg begins a course of four lectures on "The Imperfect Crystallisation of Common Things." On Thursday afternoons, beginning on November 4th, there will be two lectures by Sir Edgeworth David on "Antarctic Exploration, Past and Future;" three by Dr. R. R. Marett on "The Archæology of the Channel Islands;" and two by Sir Squire Sprigge on (1) "Early Medical Literature," and (2) "Medical Literature in Relation to Journalism." On Saturday afternoon, November 6th, at three o'clock, the Rev. E. M. Walker will deliver the first of three lectures on "The Study of History;" on succeeding Saturdays Dr. G. C. Simpson will give two lectures on "Atmospheric Electricity," and Dr. Cyril Rootham two lectures with musical illustrations on "Henry Purcell and his Contemporaries." The juvenile lectures this year, the 101st course, will be delivered by Professor A. V. Hill on "Nerves and Muscles: How We Move and Feel." (1) Nerves and the messages they carry (December 28th), (2) Muscles and how they move (December 30th), (3) The heart and some other muscles (January 1st), (4) The lungs and blood (January 4th), (5) Nerves and muscles working together (January 6th), (6) Speed, strength and endurance (January 8th).

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	21/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	—	—
No. 1 Foundry	‡4 15 0 to 5 0 0	—
No. 3 Foundry	‡4 10 0	—
‡ *For delivery after resumption of work at furnaces.*		
N.E. Coast—		
Hematite Mixed Nos.	4 7 6	4 7 6
No. 1	4 8 0	4 8 0
Cleveland—		
No. 1	6 5 0	6 5 6
Silicious Iron	6 5 0	6 5 6
No. 3 G.M.B.	6 0 0	6 0 6
No. 4 Foundry	5 19 0	5 19 6
No. 4 Forge	5 18 6	5 19 0
Mottled	5 17 6	5 18 0
White	5 17 6	5 18 0
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
„ „ Foundry	4 7 6	—
(3) Northampton—	(*None offered.*)	
Foundry No. 3	3 5 0 to 3 10 0	
„ Forge	2 16 0 to 2 17 0	
(3) Derbyshire—	(*None offered.*)	
No. 3 Foundry	3 7 6 to 3 15 0	
Forge	3 2 0 to 3 5 0	
(3) Lincolnshire—	(*None offered.*)	
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 13 0 (*a*)	—
	4 16 0 (*b*)	—
	4 19 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	12 0 0	11 0 0
Best	—	—
N.E. Coast—		
Common Bars	11 5 0	—
Lancs.—		
Crown Bars	12 0 0	—
Second Quality Bars	10 15 0	—
Hoops	14 0 0	—
S. Yorks.—		
Crown Bars	12 10 0	—
Best Bars	13 10 0	—
Hoops	14 10 0	—
Midlands—	(*Prices nominal.*)	
Crown Bars	11 5 0 to 11 10 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 5 0 to 10 10 0	
Gas Tube Strip	12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	11 0 0	—
Ship Plates, ¾in. and up	7 17 6	7 0 0
Sections	7 7 6	6 5 0
Steel Sheets, under $^3/_{16}$in. to ½in.	11 5 0 to 12 10 0	
Sheets (Gal. Cor. 24 B.G.)	— £16 10 0 to 17 10 0	

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 12 6	—
Angles	8 12 6	—
Boiler Plates	12 0 0	—
Joists	8 0 0	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 0 0†	—
Light Rails	8 5 0 to 8 10 0	
Billets	8 0 0 to 11 10 0†	
Manchester—		
Bars (Round)	9 10 0	—
„ (Small Round)	10 0 0	—
Hoops (Baling)	11 0 0	11 0 0
„ (Soft Steel)	10 15 0	10 15 0
Plates	8 5 0 to 8 12 6	
„ (Lancs. Boiler)	11 10 0 to 12 0 0	
Sheffield—		
Siemens Acid Billets	10 0 0	—
Bessemer Billets	11 0 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	7 5 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0	—
Midlands—		
Small Rolled Bars	8 12 6 to 8 15 0	
Billets and Sheet Bars	—	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 0 0 to 17 5 0	
Angles	8 12 6 to 8 17 6	
Joists	8 12 6 to 8 17 6	
Tees	9 12 6 to 10 17 6	
Bridge and Tank Plates	7 17 6 to 8 15 0	
Boiler Plates	11 0 0 to 11 15 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	21/- to 23/-
Block Tin (cash)	314 10 0
„ (three months)	305 12 6
Copper (cash)	58 15 0
„ (three months)	59 12 6
Spanish Lead (cash)	30 18 9
„ (three months)	30 17 6
Spelter (cash)	34 8 9
„ (three months)	34 6 3
Manchester—	
Copper, Best Selected Ingots	66 5 0
„ Electrolytic	67 0 0
„ Strong Sheets	92 0 0
„ Tubes (Basis Price)	0 1 1
Brass Tubes (Basis Price)	0 1 0
„ Condenser	0 1 2¼
Lead, English	32 5 0
„ Foreign	30 17 6
Spelter	34 5 0

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/9 to 1/10 per lb.	
Ferro Tungsten	1/4½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/6
„ „ 6 p.c. to 8 p.c. „	£22 0 0	7/3
„ „ 8 p.c. to 10 p.c. „	£20 15 0	6/6
„ „ Specially Refined		
„ „Max. 2 p.c. carbon	£37 0 0	12/6
„ „ „ 1 p.c. „	£43 5 0	15/-
„ „ „ 0·70 p.c. carbon	£54 0 0	17/6
„ „ „ carbon free	1/5d. per lb.	
Metallic Chromium	3/- per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
„ Silicon, 45 p.c. to 50 p.c.	£10 5 0 scale 5/- per unit	
„ „ 75 p.c.	£16 0 0 scale 6/- per unit	
„ Vanadium	14/9 per lb.	
„ Molybdenum	5/3 per lb.	
„ Titanium (carbon free)	0/11 per lb.	
Nickel (per ton)	£170	
Cobalt	10/- per lb.	
Aluminium (per ton)	£112	

FUELS.

SCOTLAND.

	(*Prices nominal.*)	Export.
Lanarkshire—		
(f.o.b. Glasgow)—	Steam	15/9
„ „	Ell	16/6
„ „	Splint	16/6 to 17/-
„ „	Trebles	15/9
„ „	Doubles	14/- to 14/6
„ „	Singles	13/9
Ayrshire—		
(f.o.b. Ports)—	Steam	16/9
„ „	Jewel	17/- to 17/6
„ „	Trebles	17/-
Fifeshire—		
(f.o.b. Methil or Burntisland)—	Steam	12/6 to 14/9
Screened Navigation		21/-
Trebles		14/- to 15/-
Doubles		14/-
Singles		13/- to 13/6
Lothians—		
(f.o.b. Leith)—	Best Steam	14/- to 14/3
Secondary Steam		13/6
Trebles		14/6 to 14/9
Doubles		13/6
Singles		13/6

ENGLAND.

(8) N.W. Coast—	
Steams	*No quotation.*
Household	„ „
Coke	„ „
Northumberland—	
Best Steams	16/-
Second Steams	14/6 to 15/-
Steam Smalls	8/- to 8/6
Unscreened	13/- to 13/6
Household	20/- to 22/-
Durham—	
Best Gas	18/6 to 19/-
Second	15/- to 15/6
Household	20/- to 22/-
Foundry Coke	18/- to 20/-

Sheffield—	Inland. (*Nominal ; none on offer.*)
Best Hand-picked Branch	31/- to 34/- —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	26/- to 28/- —
„ „ House	24/- to 25/- —
„ „ Large Nuts	17/- to 20/- —
„ „ Small	12/6 to 14/- —
Yorkshire Hards	17/- to 19/6 —
Derbyshire Hards	16/- to 19/- -
Rough Slacks	10/- to 12/6 —
Nutty Slacks	7/6 to 9/- —
Smalls	3/6 to 6/- —
Blast-furnace Coke (Inland)*	— —
„ „ (Export)	f.o.b. 16/- to 17/-

(9) SOUTH WALES.

Cardiff—	(*All prices nominal.*)
Steam Coals :	
Best Smokeless Large	26/- to 27/-
Second „ „	24/6 to 25/6
Best Dry Large	24/- to 25/-
Ordinary Dry Large	21/- to 22/-
Best Black Vein Large	25/6 to 26/-
Western Valley Large	24/6 to 25/-
Best Eastern Valley Large	24/- to 25/-
Ordinary „ „	23/6 to 24/-
Best Steam Smalls	17/- to 18/-
Ordinary „	16/- to 17/-
Washed Nuts	19/- to 26/-
No. 3 Rhondda Large	26/6 to 27/-
„ „ Smalls	18/- to 18/6
No. 2 „ Large	24/- to 25/-
„ „ Through	20/- to 21/-
„ „ Smalls	15/- to 16/-
Foundry Coke (export)	40/- to 50/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	42/6 to 45/-
Pitwood (ex ship)	32/6 to 35/-
Swansea—	
Anthracite Coals :	
Best Big Vein Large	39/- to 40/-
Seconds	32/6 to 35/-
Red Vein	27/- to 29/-
Machine-made Cobbles	47/6 to 50/-
Nuts	47/6 to 50/-
Beans	42/6 to 44/-
Peas	23/- to 25/-
Breaker Duff	7/6 to 8/-
Rubbly Culm	12/6 to 13/6
Steam Coals :	
Large	22/6 to 24/6
Seconds	20/- to 22/-
Smalls	11/- to 15/-
Cargo Through	16/6 to 17/6

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayreshire.
(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis ; open market 17/6 to 19/- at ovens. † Latest quotations available. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Steel Production.

THE immediate effect of the operations of the Steel Union is to reduce the production of those firms which have been increasing their output with a view of exporting to Great Britain during the period of the strike. This applies more particularly to Luxemburg, and also, to a great extent, to some of the Belgian steelmakers. Nothing has yet been definitely settled as regards prices, but it is understood that, until British makers join the Cartel, continental prices will be based upon the prime costs in Great Britain, which means that there will be an appreciable advance to continental consumers. It is confirmed that the Cartel can only become effective on the signing of the proposed commercial treaty between France and Germany.

Inland Navigation.

Apart from the question of providing employment to boat and engine builders, the value of the exceptionally good system of rivers and canals in this country has suggested the necessity of carrying out an active propaganda in favour of their more general utilisation. So far, despite these efforts, pleasure cruising on the inland waterways has made little or no real progress. It is doubtful whether it will ever become a popular pastime. Nevertheless, something must be done to create a vogue for pleasure cruising if new outlets are to be provided for small marine oil engines. At present the demand is not sufficiently great to allow of such engines being turned out under economical conditions. Accordingly, a further effort is being made to encourage a great national movement in favour of motor boating on the rivers and canals, and during the Paris motor car show a shipping exhibition on the banks of the Seine was organised for the first time. The show was not particularly large, and it did not indicate any notable technical development in the motor boat industry, but it certainly awakened an interest, and is likely to be the forerunner of more important exhibitions in the future. As it is desirable to provide as large a market as possible for aviation engines, Lorraine-Dietrich exhibited, amongst other things, an eight-cylinder petrol engine of 500 horse-power, while a straight eight-cylinder engine of similar power was shown by the Isotta-Fraschini firm, which also had a remarkable boat fitted with an engine of that type. Experimental boats are built for the navy with these light high-powered engines solely with a view to attaining the highest possible speeds. All the engines were of well-known types, mostly running on heavy oils. In the absence of any really suitable reversing gear, sliding pinions were employed for the purpose on some of the big engines, and reversing propellers were shown in larger numbers. One entirely new type of reversing gear which gives promise of success was shown. On one stand there was a marine engine with a suction gas plant, and a big Ford oil engine was obviously presented in competition with the hot bulb engines, which are now almost generally employed on the motor barges now running in considerable numbers of the French canals.

Railway Electrification.

The electrified line between Paris and Orleans has just been put into use, and it is expected that the extension to Vierzon will be completed before the end of next year. The energy is supplied by the Eguzon Hydro-electric Power Station, which has a capacity of 50,000 kilowatts, and is working in conjunction with the Gennevilliers Station in Paris. The current is distributed in the Paris district at 60,000 volts and 13,200 volts pressure by cables, and is transformed in two big stations, one near Paris and the other near Orleans. Altogether there will be eleven sub-stations between Paris and Vierzon. The locomotives are of 3000 to 4000 horse-power. It is estimated that the electrification of the line will mean an economy in coal consumption of 140,000 tons a year. At present the Midi is electrified over 400 kiloms.; then come the Paris-Orleans with 151 kiloms.; the State railways with 47 kiloms.; and the P.L.M. with 23 kiloms. of experimental line.

Synthetical Fuels.

The problem of obtaining ample supplies of liquid fuels is regarded as of such vital importance to the country's security and prosperity that the experimental production of oils and alcohol by synthetic processes is being continued in the national laboratories, which have been specially created for the purpose, and a great deal of publicity has lately been given to the results achieved, statements having been made to the effect that there is no reason why methylic alcohol and oils should not now be manufactured in considerable quantities on a commercial scale. Methylic alcohol is produced by the dissociation of hydrogen and carbonic oxide by projecting steam on to heated carbon. The two gases are then subjected to a high compression and a high temperature, after which they are passed through catalysers, which decompose them and cause them to combine in the form of alcohol. There are many variations which enable all kinds of alcohol, petroleum and other oils to be produced in much the same way. The secret, of course, lies in the composition of the catalysers, which have to be provided for each combination of liquids, and while one form of catalyser consists of iron fillings and nickel, there are many others which have to be experimented with in order to discover the exact constituents and proportions to produce the desired results. There is, of course, no doubt as to the possibility of obtaining these results, which have long been achieved on a laboratory scale by Professor Maihle, who developed the principle first discovered by Professor Sabatier. Everything naturally depends upon the cost. The hydrogenation of coal has failed to make headway on account of the necessity of employing high compressions, and for the catalytic production of petroleum pressures of 200 atmospheres are required, to say nothing of the consumption of coal. Still, the results are declared to be very promising, and there is a general impression in this country that we are on the eve of a considerable production of synthetic liquid fuels.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

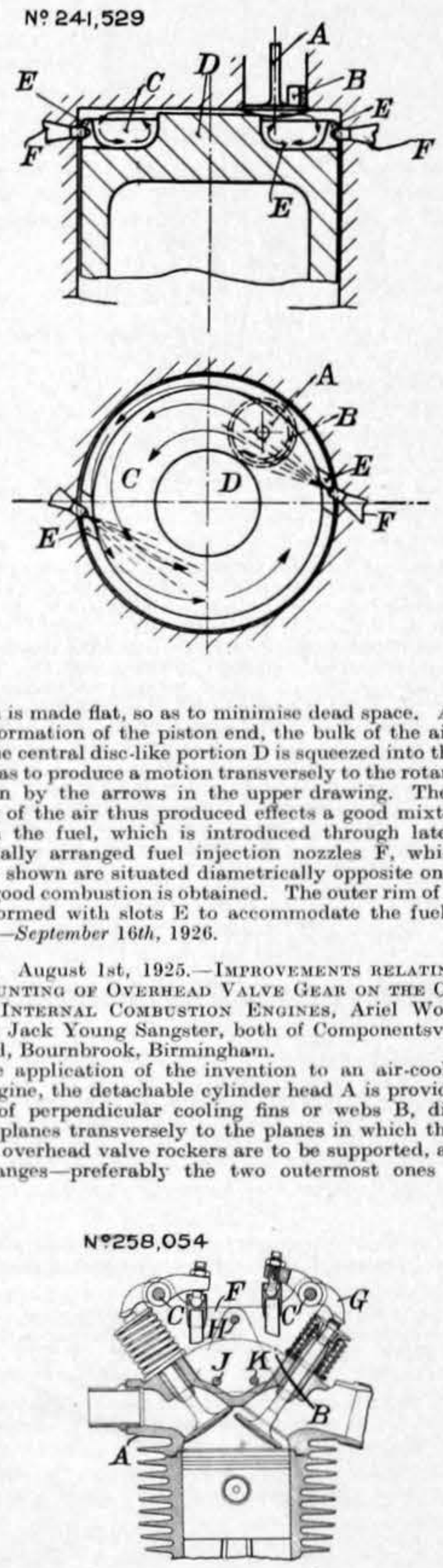
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

241,529. September 3rd, 1925.—IMPROVEMENTS IN OR RELATING TO INTERNAL COMBUSTION ENGINES, Maschinenfabrik Augsburg-Nurnberg A.G., of 7, Stadtbachstrasse, Augsburg, Germany.

This invention relates to internal combustion engines of the solid fuel injection type, having laterally arranged fuel nozzles. The air inlet valve A has a screen attachment B, which imparts a rotary motion to the inflowing air. The portion of the combustion zone C, situated at the piston end, has an annular formation, so that in the centre a flat disc-like portion D of the piston end remains, this portion, in the innermost dead position of the piston, reaching almost to the cylinder cover, the inner surface

Nº 241,529

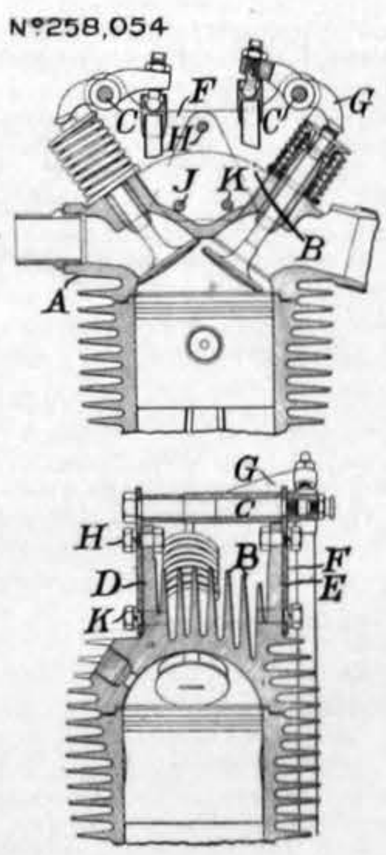


of which is made flat, so as to minimise dead space. As a result of this formation of the piston end, the bulk of the air situated above the central disc-like portion D is squeezed into the annular zone, so as to produce a motion transversely to the rotary motion, as shown by the arrows in the upper drawing. The powerful whirling of the air thus produced effects a good mixture of the air with the fuel, which is introduced through laterally and tangentially arranged fuel injection nozzles F, which in the example shown are situated diametrically opposite one another, so that good combustion is obtained. The outer rim of the piston end is formed with slots E to accommodate the fuel injection nozzles.—*September 16th*, 1926.

258,054. August 1st, 1925.—IMPROVEMENTS RELATING TO THE MOUNTING OF OVERHEAD VALVE GEAR ON THE CYLINDERS OF INTERNAL COMBUSTION ENGINES, Ariel Works, Ltd., and Jack Young Sangster, both of Componentsville, Dale-road, Bournbrook, Birmingham.

In the application of the invention to an air-cooled motor cycle engine, the detachable cylinder head A is provided with a system of perpendicular cooling fins or webs B, disposed in parallel planes transversely to the planes in which the spindles C of the overhead valve rockers are to be supported, and two of these flanges—preferably the two outermost ones D E—are

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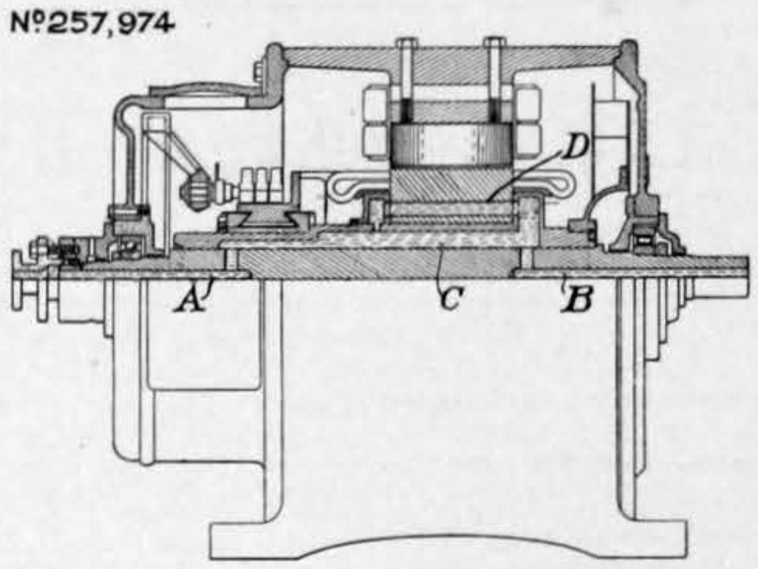
extended a distance above the other webs and are shaped and dimensioned, substantially as shown, so that they constitute a pair of rigid primary or main brackets for the rocker spindles. To the outer sides of these extended webs, which may be machined with flat outer faces, bracket plates F are bolted to serve as the carriers of the fixed spindles C, on which the push rod operated rockers G are mounted. The extended webs D E may be substantially triangular in shape, as shown, to enable each of the bracket plates F to be attached at three points by three bolts H J K, two being near the base and the other near the apex of the web, whilst the bracket plates themselves are so shaped that when bolted to the cylinder webs they will rigidly support the two rocker spindles across the cylinder head in parallel relationship to one another, at such a distance apart, and at such a height above the intermediate cooling webs, as will permit of the rockers working on the spindles without fouling any part of the cooling-web system. When applied to a detachable cylinder head in which inclined overhead exhaust and inlet valves are housed, the invention admits of the whole of the parts of the valve mechanism—less only the tappet-actuating rods—being removed bodily from the cylinder, without disturbing any part of the mechanism, when the head is unbolted from its seating.—*September 16th*, 1926.

DYNAMOS AND MOTORS.

257,974. May 12th, 1925.—IMPROVEMENTS RELATING TO THE COOLING OF DYNAMO-ELECTRIC AND OTHER MACHINES Enclosed Motor Company, Ltd., Neville Wallace Gilbert, Henry Charles Edward Jacoby, and Arthur Edward Jabet, all of Perseverance Works, King's-road, Hay Mills, Birmingham.

Central cooling of the rotating parts of the enclosed motor described in this specification is provided for by forming the

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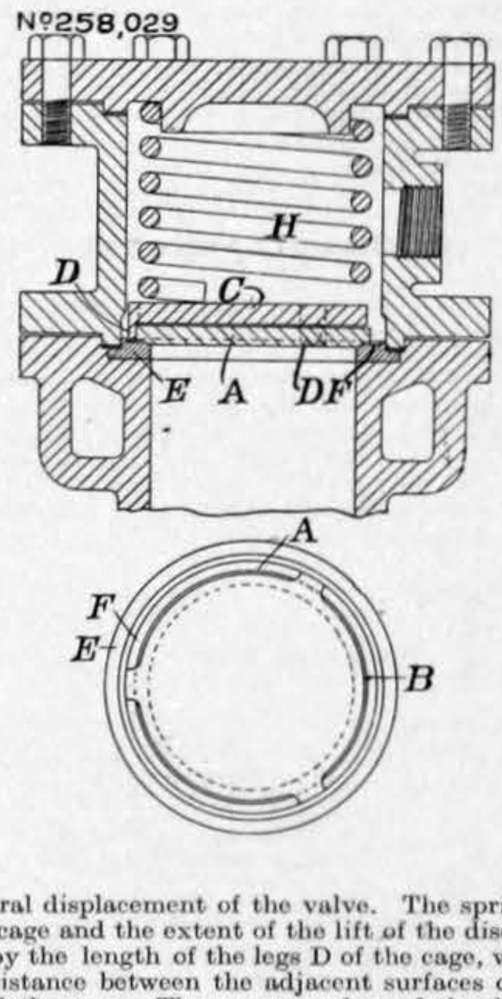
shaft with intake and delivery passages A and B for cooling fluid, and connecting them with a pump or impeller. The spider or like member that carries the rotating parts is also provided with an annular cooling chamber connected with the intake and delivery passages in the shaft. Direct cooling of the armature laminations may be obtained by passing pipes or ducts D through these laminations. A detailed description of the construction of the machine is given.—*September 13th*, 1926.

PUMPING AND BLOWING MACHINERY.

258,029. June 29th, 1925.—IMPROVED VALVE CONSTRUCTION FOR USE IN COMPRESSORS, PUMPS AND THE LIKE, Ian McCulloch, of 33, Beach-parade, Druncondra, Geelong, and Alexander Hastie Wilson, of Upper Skeno-street, Geelong, Australia.

The disc valve A is retained in a metal container or cage B, comprising a circular plate C with a number of lugs or legs D projecting from the inner face of the plate and offset from its periphery. The legs rest upon the valve seat E and preferably engage an annular groove F, formed in the seat, the legs pre-

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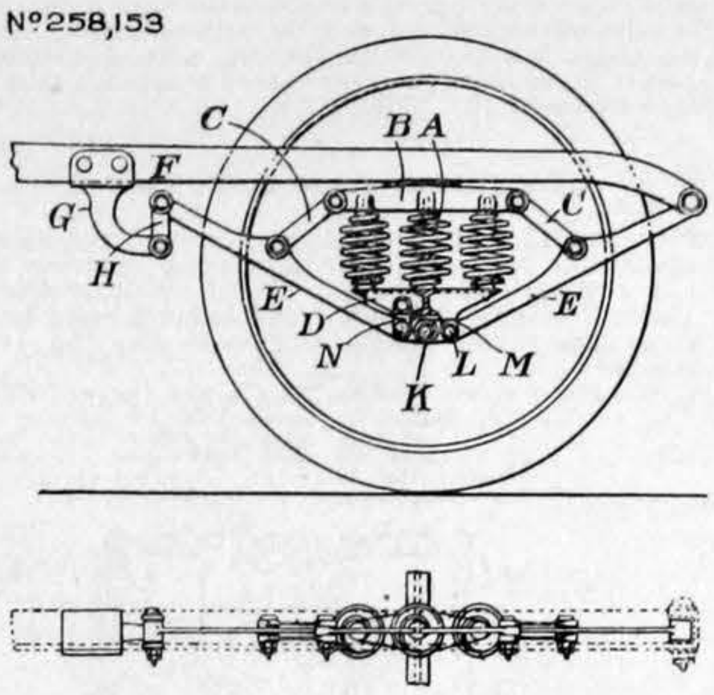
venting lateral displacement of the valve. The spring H bears against the cage and the extent of the lift of the disc valve A is controlled by the length of the legs D of the cage, which determines the distance between the adjacent surfaces of the valve and plate of the cage. The upper surface of the disc valve A is parallel with the underneath surface of the guard plate, both surfaces being plane surfaces. In operation the plate of the cage allows the disc valve a predetermined rise, and air, gas or liquid entering between the plate and the top of the disc valve act as a cushion.—*September 16th*, 1926.

MOTOR CARS AND ROAD TRAFFIC.

258,153. August 24th, 1925.—IMPROVEMENTS IN OR RELATING TO SPRING SUSPENSIONS FOR MOTOR AND OTHER VEHICLES, Thomas Summerson and Sons, Ltd., of Albert Hill Foundry, York-street, Darlington, and Albert Vincent Boothroyd, of "Ravenstone," West-crescent, Darlington.

Helical compression springs A are placed between the upper bearer B and the spring plate D, which is firmly attached to or formed integral with the non-rotating axle. C C are upper links which are pivotally connected at one end to the upper bearer B and at the other end to lower links E at points between the ends of the latter links. The outer end of the front lower link is pivoted to the dumb iron on the vehicle frame F and the outer end of the rear lower link is connected to a bracket G on the frame by means of a swinging link H. The inner ends of the lower links are connected to each other by a pivot pin K, which is situated below the wheel axle, and is not connected to any other part. The spring seat D carries lugs M for the attachment of one of the lower links E E at a point between its ends by means of a pivot

pin L, and at the rear of the pivot pin K is a short swinging link N interposed between the spring seat D and the other lower link at a point between its ends. Although in the construction shown the lower links E E and the upper bearer B are each formed of a



single member, these parts may be composed of double side members with distance pieces between them.—*September 16th*, 1926.

WELDING.

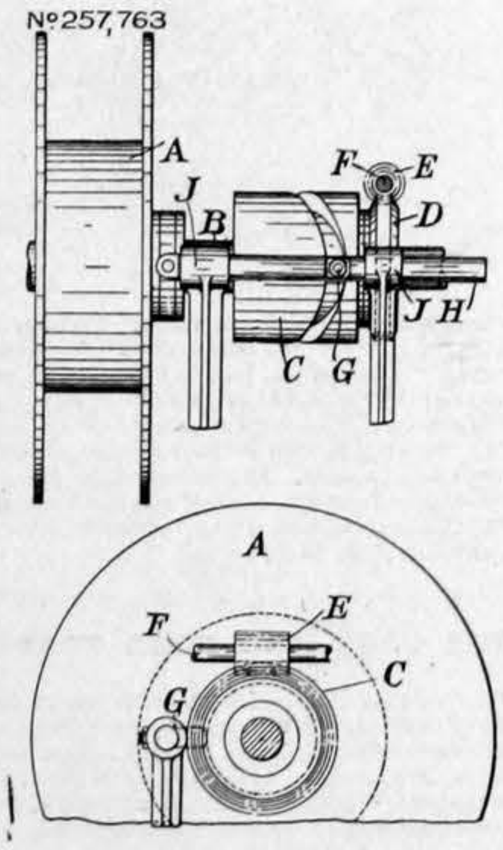
258,036. July 6th, 1925.—Improvements relating to Flux Materials for use in Arc Welding and Methods of Coating Electrodes therewith, Hume Steel, Ltd., of 301, Flinders-lane, Melbourne, and Walter Reginald Hume, of Kinnear House, corner of King and Little Collins-street, Melbourne.

In automatic arc welding machines, the arc length is subject to continual fluctuations, due to vibration and other causes, which are liable to cause repeated extinction of the arc and consequently an irregular and defective joint. The object of the present invention is to remove these objections and to provide means for producing a longer arc length to enable the molten metal to spread more evenly and freely over a wider zone along the work. The electrode is coated with bichromate of potash, which, when acted upon by the heat of the arc, produces a protective gaseous film surrounding and enclosing the molten metal passing from the arc to the work and prevents contact of the molten metal with the air. It has been found that bichromate of potash (potassium dichromate), particularly when used in combination with a suitable refractory material, such as ground asbestos or other refractory earth or mineral, gives excellent results in the direction of eliminating the objections referred to. The bichromate of potash and asbestos or other refractory earth or mineral may be employed in any desired relative proportions which may vary considerably according to circumstances. As a practical example, highly satisfactory results may be obtained be using the bichromate of potash and the refractory material in approximately equal proportions. Various methods may be adopted in applying the improved coating material to the electrode. For example, in the case of long coiled wire electrodes or thinly coated electrodes, where flexibility or great economy is desired, the rod or electrode may be immersed or placed in a heated solution of the bichromate of potash with or without a suitable refractory material. The solution is then allowed to dry upon the electrode, forming a highly efficient flux coating. By heating the solution it is caused to dry more quickly and evenly on the electrode. Alternatively, the electrode may be heated instead of the solution to ensure rapid and even drying. —*September 16th*, 1926.

MISCELLANEOUS.

257,763. October 6th, 1925.—Improvements in or relating to Coiling Gear for Windlasses and the like Cable-winding Apparatus, John Fowler and Co. (Leeds), Ltd., and Charles Henry Fowler, both of Steam Plough and Locomotive Works, Hunslet, Leeds.

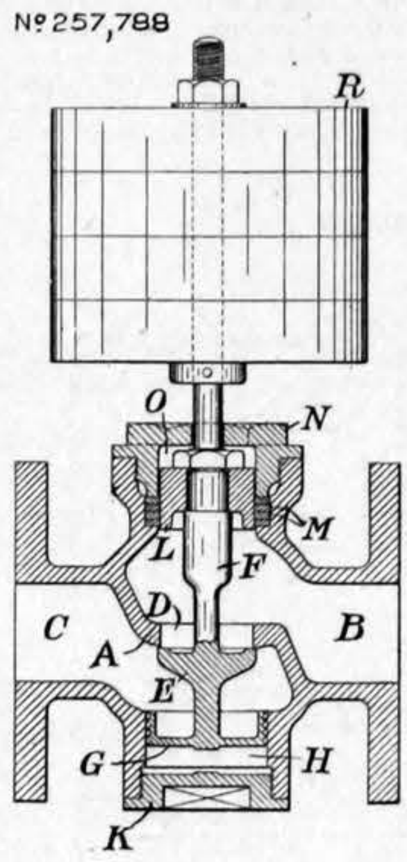
According to this invention, the winding reel or drum is so mounted on its shaft that whilst being capable of being rotated or driven it will, during the winding operation, be reciprocated laterally by cam mechanism and thereby ensure of the cable



being wound on in uniform successive layers. A represents a winding reel or drum which is slidably mounted on and adapted to be driven by the shaft B on which is also loosely mounted a cylindrical cam C adapted to be rotated by a worm wheel D meshing with a worm E mounted on a shaft F, the arrangement being such that the cylindrical cam C is adapted to be rotated by the attached worm wheel D independently of the reel or drum shaft B. The positive reciprocation or lateral sliding movement of the drum or reel A is effected through the engagement with the groove of the cylindrical cam C of a pin G mounted on a side rod H slidably mounted in bearings J, one end of the rod H being attached to a loose collar on the winding reel or drum A, which thus reciprocates laterally with the rod H as the cylindrical cam C is rotated. The speed of rotation of the shaft F and the ratio of the gearing D E are such that the lateral sliding movement of the drum A will be gradual or in accordance with the amount of cable being wound.—*September 9th*, 1926.

257,788. November 19th, 1925.—Improvements in Pressure-reducing Valves, Robert Arnold Blakeborough and Sydney Warrington Mosby, both of Woodhouse Works, Brighouse, York.

The reducing valve described, which is for use particularly with steam or air, is of simplified construction, and the use of diaphragms is dispensed with. It comprises a casing having a horizontal bridge piece A dividing the inlet side B from the outlet or reduced pressure side C. An opening D in the bridge piece is adapted to be closed from the under, or reduced pressure side, by a valve disc or stopper E. The spindle F of this stopper has a piston G of larger area than the stopper, and it slides freely in a cylinder H. A screwed plug K closes the lower end of the cylinder. Sufficient clearance is provided around the piston G to permit of the reduced pressure having unrestricted access to the space below the piston. Above the stopper is a second



piston L working through a stuffing-box containing a suitable packing M, preferably a frictionless metallic packing. The gland N of the stuffing-box is formed as a cap or cover, and provides an enclosed air space O above the piston L. A small clearance is provided between the spindle and the wall of the opening in the cap or cover through which it passes. The piston L corresponds, or substantially corresponds, in diameter with the passage opening D, so that the inlet pressure acting on the upper side of the stopper is balanced. The spindle F is so loaded that the designed reduced pressure acting beneath the piston D will cause the stopper to maintain the opening D closed. The loading of the spindle is shown as being effected by supporting deadweights R on its projecting upper end. The space below the piston G and the space above the piston L constitute dashpots which act to damp movements of the valve stopper in both the opening and closing directions, thus preventing or reducing hunting or chattering of the valve.—*September 9th*, 1926.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

TO-DAY.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Presidential address by Mr. W. Reavell. 6 p.m.

Institute of Metals: Sheffield Local Section.—Applied Science Department of the University, St. George's-square, Sheffield. Sorby Lecture, by Professor H. C. H. Carpenter. 7.30 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "Boiler Accidents," by Mr. R. H. Kenyon. 7.30 p.m.

Manchester Association of Engineers.—The Engineers' Club, Manchester. Presidential address, by Sir B. Longbottom. 7.15 p.m.

Physical Society of London.—Imperial College of Science, South Kensington, London, S.W. 7. Papers: "The Corrosion Products and Mechanical Properties of Certain Light Aluminium Alloys, as Affected by Atmospheric Exposure," by Professor Ernest Wilson; and "The Distribution of Intensity in a Positive Ray Spectral Line," by Mr. M. C. Johnson. 5 p.m.

TO-DAY TO SATURDAY, OCTOBER 30th.

Motor Show.—At Olympia, London, W. 6. 10 a.m. each day.

SATURDAY, OCTOBER 23rd.

Institute of British Foundrymen: Lancashire Branch, Junior Section.—College of Technology, Manchester. Address, "The Story of Foundry Metals," by Mr. T. Makemson. 7 p.m.

North of England Institute of Mining and Mechanical Engineers.—Newcastle-upon-Tyne. Papers, "Thin Seam Mining," by Mr. T. S. Durham, and "Description of an Old Windmill," by Mr. J. J. Stout. 2.30 p.m.

Institution of Municipal and County Engineers.—East Midland District meeting at Nottingham. 10.15 a.m.

MONDAY TO WEDNESDAY, OCTOBER 25th TO 27th.

British Commercial Gas Association.—Fifteenth annual Conference at Newcastle-upon-Tyne.

MONDAY, OCTOBER 25th.

Bradford Engineering Society.—Midland Hotel, Bradford. —Joint meeting with the Bradford Textile Society. Paper, "The Conversion of Textile Mills from Steam to Electric Driving," by Mr. B. C. Johnson. 7.30 p.m.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Graduates' Section meeting. "An Investigation into the Cylinder Losses of Locomotive Engines," by Mr. E. L. Diamond. 7 p.m.

TUESDAY, OCTOBER 26th.

Illuminating Engineering Society.—E.L.M.A. Lighting Service Bureau, 15, Savoy-street, Strand, London, W.C. 2. Opening meeting of new session. 6.30 p.m.

Institution of Civil Engineers.—Great George-street, Westminster, London, S.W. 1. James Forrest Lecture. "Radio Communications," by Senator G. Marconi. 6 p.m.

WEDNESDAY, OCTOBER 27th.

Belfast Association of Engineers.—Central Hall, Municipal College of Technology, Belfast. Presidential address, "Coal and its Influence on Shipping and Shipbuilding," by Mr. W. J. Eves. 7.30 p.m.

Faraday Society.—Chemical Society's Rooms, Burlington House, Piccadilly, London, W. 1. Papers:—"Beryllium, by Mr. A. C. Vivian; "The Chemical Constants of the Halogen Hybrides," by Mr. F. I. G. Rawlins; "The Decomposition of Nitrosotriacetonamine in Presence of Hydroxyl Ion: Part 1., The Region of Small Concentration of Alkali," by Mr. J. Colvin; "Latent Heat of Dilution of Sugar Cane Solutions," by Miss Freda M. Hunter; "The Adsorption of Water by Colloidal Fibres," by Mr. J. J. Hedges; "The Anodic Behaviour of Ferro-manganese," by Mr. A. N. Campbell; "Abnormal Absorption of Gases by Steel," by Mr. T. Carlton Sutton; "The Observation of Cataphoresis in Colourless Sols: I., Rubber in Benzene," by Messrs. R. H. Humphry and R. S. Jane; "A Simple Kinetic Theory of Viscosity," by Mr. J. S. Dunn; "Condition of Silver Chromate in Gelatin from Electric Conductivity and Diffusive Experiments," by Messrs. A. C. Chatterji and N. R. Dhar. 8 p.m.

Institution of Automobile Engineers: North of England Centre.—The Engineers' Club, Albert-square, Manchester. Presidential address, "The Debt of the Community to the Automobile," by Mr. H. Kerr Thomas. 7 p.m.

Institution of Engineers-in-Charge.—General Electric Company's Office, Magnet House, Kingsway, London, W.C. 2. Paper, "Small Refrigeration Plants and their Application," by Mr. N. E. Barber. 7.30 p.m.

THURSDAY, OCTOBER 28th.

Institute of Metals: Birmingham Local Section.—The Engineers' Club, Waterloo-street, Birmingham. Paper, "Fatigue," by Dr. D. Hanson. 7 p.m.

Institution of Automobile Engineers.—Watergate House, Adelphi, London, W.C. 2. London Graduates' meeting. Discussion on the Motor Show. 7.30 p.m.

Institution of Automobile Engineers.—Training School, Vauxhall Motors, Ltd., Luton. Luton Graduates' meeting. Paper, "Hydraulic Transmission as Applied to Automobiles," by Mr. W. S. Bull. 7.30 p.m.

Institution of Locomotive Engineers.—The Engineers' Club, Coventry-street, London, W. 1. Paper, "Braking of Trains on Electrically-operated Railways," by Mr. R. C. Bond. 7 p.m.

FRIDAY, OCTOBER 29th.

Institution of Locomotive Engineers: Manchester Centre.—College of Technology, Manchester. Paper, "The Application of the Compound Principle to Locomotives," by Mr. E. M. Gass. 7 p.m.

Institution of Mechanical Engineers.—Storey's Gate, Westminster, London, S.W. 1. Informal meeting. Discussion on "Steel Castings in Mechanical Engineering," introduced by Mr. Robert Lowe. 7 p.m.

Institution of Production Engineers.—The Engineers' Club, Coventry-street, London, W. 1. Third annual dinner. 7.30 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "Distortion in Wireless Reception," by Mr. A. V. Ballhatchet. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Newcastle-upon-Tyne. Annual general meeting. "How should an Engineer be Trained?" by Sir Theodore Morison. 6 p.m.

Society of Technical Engineers.—Queen's Hotel, Birmingham. Address on "The Engineers Bill," by Mr. R. Hazleton. 7.30 p.m.

SATURDAY, OCTOBER 30th.

Finsbury Technical College: Old Students' Association.—The Engineers' Club, Coventry-street, London, W. 1. Fifteenth Annual Dinner.

Institution of Municipal and County Engineers.—South Midland District Meeting at Aylesbury. 10 a.m.

THURSDAY, NOVEMBER 4th.

Institution of Automobile Engineers.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Joint meeting with the Royal Aeronautical Society. Paper, "The Effect of Reduced Intake Air Pressure and of Hydrogen on the Performance of the Slow-speed Solid-injection Engine," by Mr. G. F. Mucklow. 7 p.m.

Institution of Civil Engineers: Birmingham and District Association.—Chamber of Commerce, New-street, Birmingham. Address by the chairman, Mr. H. H. Humphries. 6 p.m.

FRIDAY, NOVEMBER 5th.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Thomas Hawksley Lecture "Elasticity and Plasticity," by Professor E. G. Coker. 6 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

The name of the De Laval Chadburn Company, Ltd., late of Wellington House, Buckingham-gate, London, S.W. 1, has been changed to the Alfa-Laval Company, Ltd., the address of which is Alfa-Laval House, 34, Grosvenor-road, London, S.W. 1. Telegrams, "Alfa-Laval, Sowest, London;" telephone numbers, Victoria 3618 and 3619.

CONTRACTS.

The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C. 2, has received from the Port of London Authority an order for six months' supply of Osram gas-filled electric lamps.

Crankless Engines, Ltd., of 20, Grosvenor-gardens, London, S.W. 1, informs us that its licensees, Geo. Waller and Son, Ltd., of Stroud, have received an order to manufacture seven gas engine-gas booster plants for the Australian Gas Light Company, of Sydney. Both gas engines and boosters are to be of the Michell crankless type. The gas engines are each to be of 280 horse-power and the boosters of 500,000 cubic feet capacity.