A Seven-Day Journal

The Battersea and Fulham Power Stations.

IN an article in the *British Medical Journal* on "Atmospheric Pollution and Fogs," Professor J. S. Haldane discusses the deaths which occurred last December near Liége in Belgium, and goes on to deal with the proposed methods of dealing with chimney emissions at the new Fulham and Battersea generating stations. The scrubbing process suggested, he points out, would involve cooling down the effluent gas to near the air temperature, and, owing to its high percentage of carbon dioxide, during periods of air stagnation and fog, this cooled gas would at once drop with only a comparatively small dilution on a small area round the generating station. The representatives of the undertaking, the article goes on to explain, agreed to the necessity of the gas being sufficiently heated to make it rise high above the tops of the chimneys in still weather, but the Commissioners decided that it was not necessary for the effluent gas to be warm, and it appeared that the basis of this decision was a memorandum from the chief representative of another Government department. This memorandum was not brought up at the inquiry, but if it had been, it would, Professor Haldane states, have been torn to pieces in the course of cross-examination and rebutting evidence. To pour down cold and heavy gas in immense volumes on the people round the station and at the mouths of the furnaces would, he continues, be an invitation to a great disaster. The result would probably be, for one thing, a wholesale emission of carbon monoxide, owing to imperfect combustion, and hundreds of people might be poisoned in consequence.

Draft Regulations for Jib Cranes.

IN a communication from the Home Secretary attention is drawn to the number of serious accidents occurring in connection with the use of jib cranes, and reported annually by the Chief Inspector of Factories. In particular the Chief Inspector has found it necessary to make special comment upon the number of jib crane failures, a high proportion of which causes death or serious injury. The gravity of these occurrences is indicated by the following figures :—

		Jib crane failures.	Killed.	Injured.
Construction of buildings	1928	11	7	16
	1929	7	3	9
Other premises under the Factory and Workshops Act	1928	48	7	32
	1929	55	12	34

It is stated that where cranes are properly tested and adequately examined and maintained the failures reported have been comparatively few. It has therefore been decided that steps shall be taken by means of regulations to ensure that the proper precautions are observed, and in accordance with the Factory and Workshops Act of 1901 draft regulations have been issued. Agreement has already been reached as far as the building trade is concerned, and these draft regulations contain requirements similar to but less elaborate than those already applied in that trade. The main requirements are that jib cranes shall be properly tested and examined at regular intervals, and that a certificate of such tests specifying the safe working load, &c., shall be obtained; that the crane shall not be loaded beyond the safe working load except for test purposes; and that an automatic indicator shall be provided to show when the safe working load is reached or exceeded. Other provisions with regard to rail tracks and anchoring are also included.

Pulverised Coal.

SPEAKING at the inaugural meeting of the Midland Section of the Institute of Fuel in Birmingham on Thursday, February 26th, Mr. E. C. Loundes pointed out that, apart from agriculture, the coal trade was our most important industry, but that production was rapidly decreasing. In Great Britain coal consumption in 1929 was 174½ million tons, which was 14½ millions less than in 1913, or a drop in consumption of 7·6 per cent. Nevertheless, in 1929 the world actually produced 10·2 per cent. more coal than it did in 1913, while Germany increased her consumption in the same period by 13·6 per cent. At sea the number of coal fired steamers was falling rapidly; the percentage of tonnage afloat in 1914 using coal as a fuel was 88·84 per cent,, but in 1930 that figure had been reduced to 57·57 per cent. He then sought to show that the economy of coal in burning reached its maximum when used in the pulverised form, and, quoting the authority of the head of the Fuel Conservation Section of the United States Shipping Board, said that without taking into consideration the difference in first cost of the installation which was in favour of the pulverised fuel plant and in spite of the higher thermal efficiency of the oil engine, the pulverised fuel plant showed the lower operating cost. Mr. Loundes considered that if the advantages of pulverised fuel were to be used to their fullest extent the coal must be marketed in the pulverised form. There was no more unsuitable place for the processing of the coal than in a ship at sea, and small fuel users in Great Britain were unable to enjoy the economies of pulverised fuel because it was not marketed as such. The methods used by the oil trade should be applied to pulverised coal. Economies would then be made in consumption and labour, increased output would be obtained, while further advantages would be found in smokeless combustion, ease of handling, and automatic control.

The New British Steel Mark.

ATTENTION is again focussed upon the importation of foreign steel into this country by the action which is now being taken by the British steel industry. British manufacturers are now adopting a "National Mark," which will be embossed or stencilled on their principal products and proclaim their British origin. Continental steel is frequently used in this country under the misapprehension that it is British, owing to the absence of any marks which can be easily identified with the country of origin. Moreover, it frequently bears marks which, to the uninitiated, convey the impression that, far from being foreign, the material is indeed British. In order to remove any ambiguity on the subject, British manufacturers in 1927, acting through the National Federation of Iron and Steel Manufacturers, made application under the Merchandise Marks Act for an order requiring imported foreign steel to be marked with the country of origin. The application was unsuccessful because of technical difficulties. The new mark, of which we give an illustration herewith, will attain the same end—the differentiation between the home and foreign product.

Steel so marked will be certified to have been rolled from steel ingots manufactured in the United Kingdom, and to be to the finish and quality laid down by a British Standard Specification. The mark will therefore be not merely a mark of identification, but a guarantee of sound quality. The bulk of imported foreign steel does not comply with the requirements of the British Standard Specification for Structural Steel.

New P. and O. Liners for Eastern Service.

SOME particulars are now available with regard to the two new liners which are under construction at the Linthouse shipyard of Alexander Stephen and Sons, Ltd., for the P. and O. Company's London-Straits-Japan service. The two ships, to which the names of the "Corfu" and the "Carthage" have been given, have each a gross measurement of 14,500 tons, with a length of 520ft. and a beam of 71ft. The ships are to be propelled by twin-screw, geared steam turbines, which will be supplied with steam from the latest type of Yarrow oil-fuel-fired water-tube boilers, working at a pressure of 400 lb. per square inch. The boilers are being built at the Scotstoun works of Yarrow and Co., Ltd. Both the engine-room and the deck machinery will be largely electrically operated, and about 1000 tons of the 8500 tons measurement of cargo-carrying space will be insulated for the carriage of refrigerated cargoes. The passenger accommodation is to be designed for 178 first-class and 200 second-class passengers, and in the first-class state rooms there are to be 46 single-berth cabins and 66 two-berth cabins, while the second-class rooms will include 44 two-berth cabins, 16 three-berth cabins and 16 four-berth cabins. The "Corfu" is expected to be ready for sea in September, while the "Carthage" will probably be ready for service in November.

Charing Cross Bridge.

ALTHOUGH the Charing Cross Bridge Advisory Committee has not yet issued its report, certain facts with regard to its decision were reported by Sir Leslie Scott, Chairman, at a meeting of the London County Council last Tuesday, March 3rd. The Committee consisted of sixteen members and was formed with the intention that it should put forward an agreed scheme for a road bridge and approaches at Charing Cross. A very large number of proposals were considered, and as many as twenty-two full meetings were held, besides numerous sittings of sub-committees. After much labour the number of schemes was reduced to six. Agreement, however, could not be reached completely as to which of them was the most suitable. Numbering the schemes from 1 to 6, an analysis of the voting shows that No. 1 was supported by two members, who gave scheme No. 6 as their second choice, and by two other members who gave scheme No. 2 as second choice; No. 2 was supported by one member whose second choice was No. 1; Nos. 3 and 4 received no votes; and scheme No. 5 was supported by one member, who gave No. 6 as his second choice; No. 6 received nine votes, which included those of the Chairman and Vice-chairman; and one member abstained. This scheme—No. 6—received the votes of a majority of the Committee, and was also supported by the second preferences of several members. It is similar to that rejected by a Select Committee of the House of Commons in April last year. Many improvements, however, are incorporated in it with the object of reducing the bridging over of the Waterloo-road, to which so much objection was brought forward. This bridging is now transferred to the neighbourhood of a traffic circus site, included in the scheme, where on account of the openness of the position it is believed that it will be less objectionable.

Television.

NEGOTIATIONS between the Baird interests, the organisation responsible for the experimental television transmissions from the B.B.C. transmitters, and the Pathé-Natan group, have resulted in the formation of a new company in France under the title of "Television Baird-Natan." The objects of the company are to develop and exploit the inventions of Baird Television, Ltd., in France, Belgium, Luxemburg, and in the French and Belgian Colonies. The first step has been to arrange for a daily broadcast of television from the Radio-Vitus broadcasting station in the suburbs of Paris. At the outset these transmissions will occupy two hours each day, but after certain preliminary experiments have been carried out the programmes will be extended to four hours daily. Experiments will be made in order to determine the most desirable wave lengths. At first a wave length of 313 m. will be used, and subsequently all other available wave lengths will be tested in turn. The service from the Radio-Vitus station, which is equipped with a standard Baird transmitter, will begin at an early date.

Further Trent Navigation Improvements.

IT has now been decided by the Corporation of Nottingham, subject to the approval of the Unemployment Grants Committee, to construct a new river dock on the Trent, together with a warehouse, the cost of the scheme being estimated at about £60,000. In our issue of November 14th, 1924, we described, it may be recalled, the measures, which were taken later by the Corporation of Nottingham, in conjunction with the Trent Navigation Company, to render the river navigable for commercial barges from Nottingham right up to the Humber ports. New locks were built, which had the effect of converting the fast-running river into a series of dead water pools, and since the scheme was completed, the river traffic has steadily increased. Heavily laden barges now make the journey at all seasons of the year from the Humber to Nottingham without, as formerly, having to tranship their cargoes into smaller vessels at Newark. The success of the scheme has been directly responsible for bringing into being one of the largest oil-distributing centres in the country, the oil being brought by water from the northern ports up to the terminal distribution station at Nottingham.

The England-African Air Mail.

AT 8.45 a.m. last Saturday, February 28th, an air liner of Imperial Airways left the London air port, Croydon, carrying the first air mail from England to Central Africa. From London the route lies across Europe and above the Mediterranean to Cairo. Thence the mails will be flown by landplane to Khartoum and on by flying boat to Mwanza, on Lake Victoria in Tanganyika Territory, the temporary terminus of the Central Africa section of the Cape air route. The flight of 5114 miles from London to Mwanza will be made in nine days, as compared with more than twenty by surface transport. The cost for a ½-oz. letter by air from England to Tanganyika Territory, including the aerial surcharge as well as the ordinary postage, is only 7d. From now onwards there is to be a weekly air mail in each direction between England and East and Central Africa. When, this summer, the air mail is continued on from East Africa to South Africa, completing the trans-African route, passengers, mails, and urgent merchandise will be air-borne from London to Cape Town, a total of approximately 8000 miles, in not more than eleven days, as compared with seventeen days by surface transport. The passenger air fare from London to Cape Town will be £130. The main halting points on the route southward from Tanganyika will be at Nairobi, Broken Hill, Salisbury, Bulawayo, Johannesburg, Kimberley, and Victoria West. The organisation of the 5700 miles Cairo–Cape Town air line has necessitated the provision along the route of twenty-seven main aerodromes and thirty subsidiary alighting points. Many intermediate landing grounds have had to be cleared in the heart of virgin bush, while at a number of stations hotels and rest houses have been built by the company for the accommodation of aerial travellers. The ground organisation also includes hangars, workshops, wireless and meteorological departments, and quarters for the airway staff. At seventeen of the aerodromes along the route, there are wireless stations. In flight aircraft will always be in touch with ground stations.

Vector Methods of Studying Mechanical Vibrations.

By PROFESSOR DAVID ROBERTSON, D.Sc.

No. II.*

6. Simple Harmonic Vibration.

When the vector has a constant length X and a constant phase velocity ω, the projection of its end performs a simple harmonic motion or sine vibration.

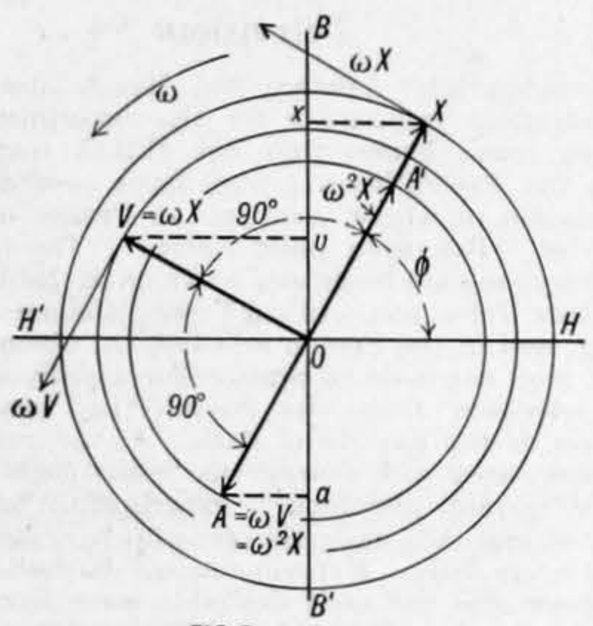

FIG. 5. S.H. MOTION.

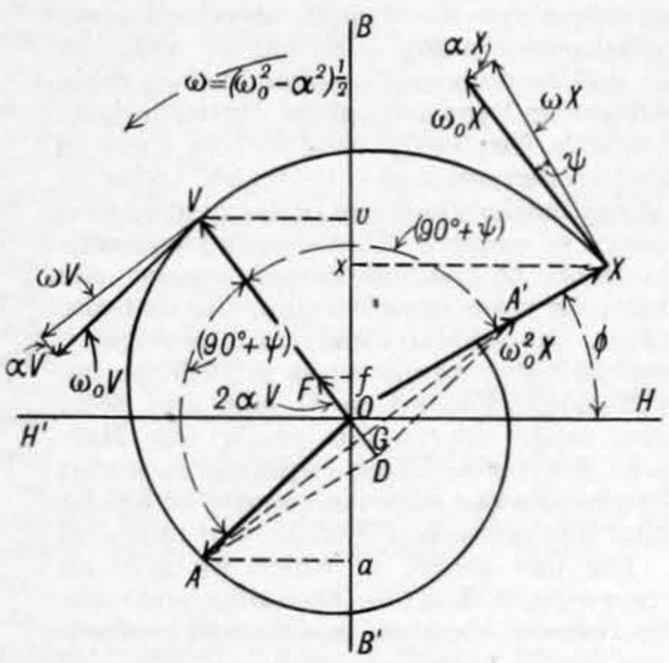

FIG. 6. SHRINKING SINE VIBRATION.

"THE ENGINEER"

The velocity vector then has an amplitude ω times that of the displacement vector and is a quarter cycle, or 90 deg., ahead of it.

Similarly, the acceleration vector has an amplitude ω times that of the velocity and is a further 90 deg. ahead. Thus the acceleration vector is exactly opposite to the displacement vector and has ω^2 times the amplitude—see Fig. 5. In other words,

$\omega^2 X + A = 0$, vectorially for the amplitudes 6·01

and consequently

$\omega^2 x + a = 0$, algebraically for the instantaneous values . . . . . 6·02

This is the characteristic differential equation for a simple harmonic vibration. Conversely, when such an equation is obtained from the conditions of motion of a given body, we know that the vibration is a simple harmonic one.

The last equation gives us for the phase velocity :—

$\omega = \sqrt{}$ [acceleration (reversed) ÷ displacement] 6·03,

and the restoring force is

$F = M a = -(M \omega^2) x = -k x$ . . . . . 6·04

where k is the controlling constant, or restoring force per unit displacement.

The equation for the phase velocity may also be written

$\omega = \sqrt{(k/M)}$ . . . . . 6·05

$= \sqrt{}$(controlling constant ÷ inertia) . . 6·06

The period, or frequency, can, of course, be obtained from ω by remembering that $\omega = 2\pi f = 2\pi/T_o$.

It should be noted that the amplitude does not appear in the expression for the phase velocity of a sine vibration, and that consequently the frequency is the same for small and for large vibrations.

The complete equations for the simple harmonic vibration are :—

$x = X \sin(\omega t + \varphi_o)$ . . . . . 6·07

$v = \omega X \cos(\omega t + \varphi_o)$ . . . . . 6·08

$a = -\omega^2 X \sin(\omega t + \varphi_o)$ . . . . . 6·09

A certain amount of energy is associated with the vibration, and oscillates between the potential and kinetic forms. At the ends of the swing, where the velocity is zero, the energy is wholly potential, and at the centre of the swing it is wholly kinetic. Its amount is—

$W_v = \frac{1}{2} M V^2 = \frac{1}{2} M \omega^2 X^2 = \frac{1}{2} k X^2$ . . . 6·10

Equation 6·04 shows that the essential for a true sine vibration is that the restoring force shall be exactly proportional to the displacement, or that the ratio (restoring force ÷ displacement) shall be exactly constant. That is almost, but not quite, true for a pendulum swinging with a small amplitude, and for a mass vibrating under the action of a spring whose own inertia is negligible, provided the friction be also negligible.

Most vibrations approach to the simple harmonic type, and as a rule can be best dealt with on the supposition that they are sine vibrations upon which certain disturbing forces have been superimposed.

The equations given above have been written in the form applicable to vibrations in a straight line ; but they are equally good for vibrations about an axis if the symbols be properly interpreted. X, V, and A then represent angular displacement, angular velocity, and angular acceleration ; F becomes an "angular force," or torque, and M the "angular mass" or moment of inertia.

7. Shrinking Sine Vibration.

Instead of moving in a concentric circle, let the free end of the vector trace out the spiral determined by the equation

$X = X_o \varepsilon^{-\alpha t}$ . . . . . 7·01

where X is the radius, or amplitude, at any instant, X_o is that at zero time, and α is a constant—see Fig. 6. This particular spiral is known as the equiangular or logarithmic spiral, and is characterised by the constant angle ψ between it and any concentric circle intersecting it. As may be seen from Fig. 4, $\tan\psi = \alpha/\omega$. The natural logarithm of the ratio of two consecutive crests on opposite sides of zero is termed the "logarithmic decrement ;" it is

$\lambda = \pi\ (\alpha/\omega) = \pi \tan\psi$ . . . . . 7·02

Since $(dX/dt)/X = (-\alpha X_o \varepsilon^{-\alpha t})/X = -\alpha$. 7·03

we see that α is the proportional rate of decay of the initial value. In the time $1/\alpha$ the vector revolves through ω/α, or cot ψ, radians. The corresponding number of cycles is $\omega/2\pi\alpha$, or $(1/2\pi)$ cot ψ. After ω/α, or cot ψ, cycles, the amplitude has fallen to 0·195 per cent., and for most purposes the vibration may be regarded as having ceased.

The amplitude of the velocity vector is given by equation 5·01, but as it is convenient to have a single symbol for the quantity under the square root, we shall write

$V = (\omega^2 + \alpha^2)^{\frac{1}{2}} X = \omega_o X$ . . . . . 7·04

$\omega_o = (\omega^2 + \alpha^2)^{\frac{1}{2}}$ . . . . . 7·05

$\sin\psi = \alpha/\omega_o$, $\cos\psi = \omega/\omega_o$, $\tan\psi = \alpha/\omega$ . . 7·06

As we have already seen in section 5, the velocity is $(90° + \psi)$ ahead of the displacement.

Since ω, α and ω_o are all constant, ψ is also constant ; thus the velocity vector rotates at the same rate as the displacement vector and is always proportional to it. It consequently shrinks at the same fractional rate and has the same ω and α.

Exactly the same relationship holds between the acceleration and velocity vectors as between the latter and the displacement vector ; the acceleration vector is thus a further $(90° + \psi)$ ahead and its amplitude is

$A = \omega_o V = \omega_o^2 X$ . . . . . 7·07

Thus all three vectors shrink at the same proportional rate and the same spiral will serve for all if a suitable choice of scales be made.

In Fig. 6, since the angles X O V and V O A are equal, the velocity vector bisects the angle between the displacement and acceleration vectors. Along O X mark off $OA' = OA = \omega_o^2 X$, and complete the parallelogram O A D A'. Since the four sides of this parallelogram are equal, A A' is perpendicular to O D, and G, the crossing point of the diagonals, is also their mid-point. Further, O D bisects the angle A O A' and is consequently in line with O V.

Hence, O G and G A are the components of the acceleration in phase and in quadrature with the velocity, due, respectively, to the shrinkage and rotation of O V. O G is the in-phase component, and is equal to αV.

Along O V set off $OF = OD = 2 \times OG = 2\alpha V$. O F now balances O D, which is itself the resultant of A and $\omega_o^2 X$. Hence the following equation is true vectorially for the amplitudes

$\omega_o^2 X + 2\alpha V + A = O$ . . . . . 7·08

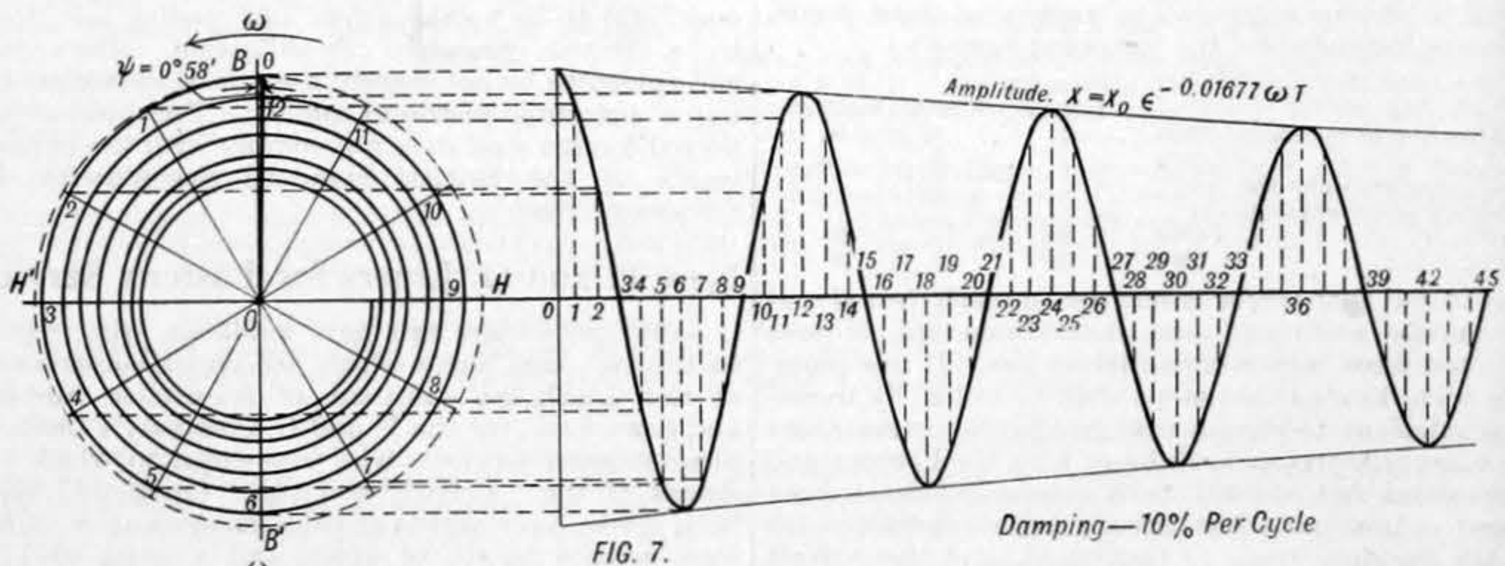

FIG. 7.

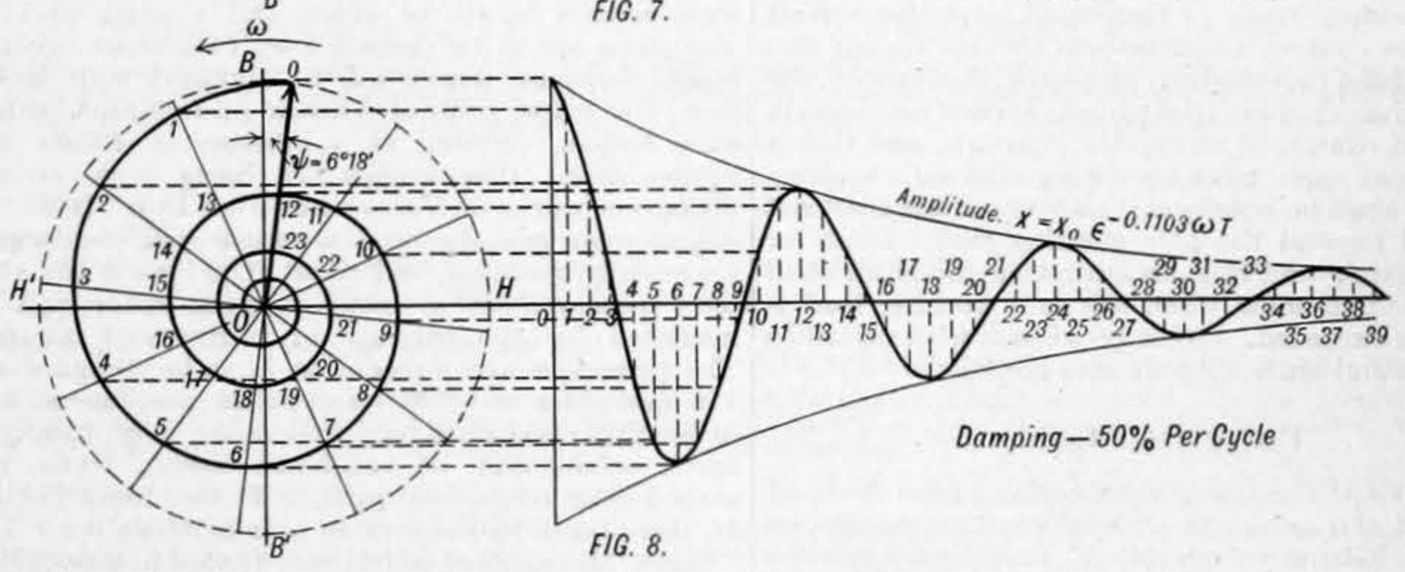

FIG. 8.

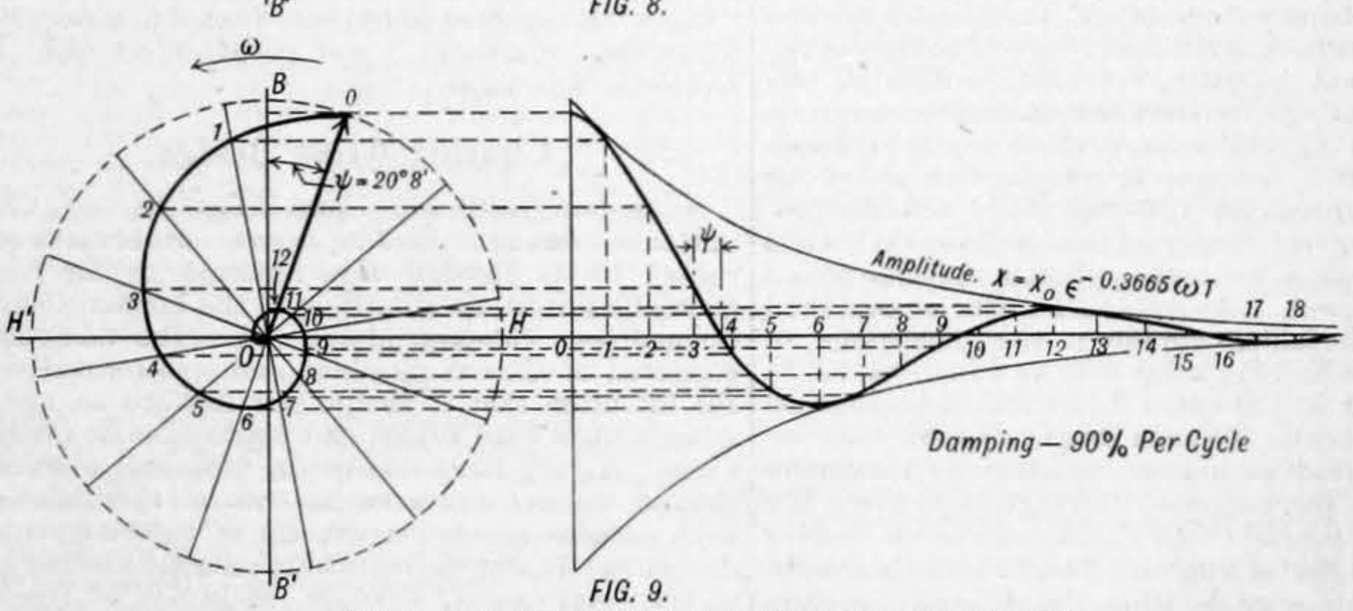

FIG. 9.

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FIGS. 7 - 9 OSCILLATIONS WITH DIFFERENT AMOUNTS OF DAMPING

amplitude. Its reciprocal is the damping time-constant, being the time taken to die away to $1/\varepsilon$, or 36·8 per cent. of its original value. After intervals of two, three, four, or five times $1/\alpha$, the amplitude has decayed to 13·5, 5·0, 1·8 and 0·67 per cent. of its and, consequently, the same equation must, at every instant, be true algebraically for the instantaneous values.

This is the characteristic differential equation for this type of vibration, which may be termed a

* No. I. appeared February 27th.

"shrinking sine vibration." Conversely, the shrinking sine vibration is the required solution when the conditions of motion give rise to an equation of this form.

The force causing the acceleration O D is

$$F_f = -M \times 2\alpha V \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 7{\cdot}09$$

which is a frictional force opposite to the velocity and proportional to it. Thus a shrinking sine function requires a restoring force proportional to the displacement and a frictional force proportional to the velocity.

When dealing with decaying vibrations it is usual to assume that the friction is proportional to the velocity, even when we know that such is not the case, for the simple reason that the mathematics applicable to any other law becomes too difficult, or impossible, for us to solve; the approximate solution obtained by this assumption is generally near enough for practical purposes.

At very low velocities air friction does follow the assumed law, but at higher velocities the square law would be nearer the truth. An exact solution for a vibration with damping proportional to the square of the velocity has been given by van Zandt,* but it is far too complicated for general use.

A comparison of equations 7·08 and 6·01 will show that the phase velocity represented by ω_o is that which would apply if the friction were removed without other change. Consequently a damping force proportional to the velocity not only dissipates the energy of the vibration, but it also reduces the frequency in the ratio of $(\omega_o^2 - \alpha^2)^{\frac{1}{2}} : \omega_o$, which is the same thing as cos ψ. With moderate amounts of damping this reduction of frequency is slight.

With just sufficient friction to make $\alpha = \omega_o$, we have "critical damping," for which the frequency is zero. With still greater friction, ω becomes imaginary, and there are no oscillations but just a gradual return to zero.†

With critical damping the vibrator comes practically to rest at zero, more quickly than with either more damping or less. With greater damping it takes longer, because the inward movement is slower, whereas, with less damping, time is lost by the oscillations. In all cases an infinite time must elapse before the vibrator has come absolutely to rest.

With decaying vibrations the crest values do not occur when the vector is vertical, but at a point where the increase of the projection due to the rotation of the vector is balanced by the decrease caused by the shrinkage. The vector is then at an angle ψ before the vertical, and the amplitude at that instant is greater than the crest in the ratio of 1 : cos ψ. Further, the crests do not come midway between the zero points, but at a phase interval of $(90° - \psi)$ after the preceding zero and of $(90° + \psi)$ before the following zero.

The ratios V/X, A/V and A/X are exactly the same as they would be if the friction were absent, but the phase step from X to V and from V to A is $(90° + \psi)$ instead of 90°.

Graphs of shrinking sine vibrations with different rates of decay are given in Figs. 7–9.‡ It will be observed that ψ is very small until the decay becomes very rapid; it then quickly increases to 90° with critical damping.

With the help of the vector diagram, the complete equations for the shrinking sine vibration can at once be written down. Counting time from the instant at which O X lies along O H, they are

$$x = X_o \varepsilon^{-\alpha t} \sin \omega t \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 7{\cdot}10$$

$$v = \omega_o X_o \varepsilon^{-\alpha t} \cos (\omega t + \psi) \quad . \quad . \quad . \quad . \quad . \quad 7{\cdot}11$$

$$a = -\omega_o^2 X_o \varepsilon^{-\alpha t} \sin (\omega t + 2\psi) \quad . \quad . \quad . \quad 7{\cdot}12$$

$$\omega = (\omega_o^2 - \alpha^2)^{\frac{1}{2}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 7{\cdot}13$$

$$\sin \psi = \alpha / \omega_o \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 7{\cdot}14$$

* J. Parker van Zandt, "Oscillating Systems Damped by Resistance Proportional to the Square of the Velocity" (*Phys. Rev.*, X., pp. 413–431, November, 1917).

† A much fuller discussion of the shrinking sine vibration, and a meaning for this imaginary rotation of the vectors, is given in the author's paper "A Mode of Studying Damped Vibrations by the Aid of Shrinking Vectors" (*Journ.* I.E.E., 54, pp. 24–34, 1915). Figs. 7–9 have been taken from that paper.

‡ *Loc. cit.*

8. INITIAL CONDITIONS OF DAMPED VIBRATION.

Let the vibrator be drawn aside and then released without giving it any velocity in the act of release. The resulting vibration starts with the displacement x_o, which has just been given; at the initial instant the displacement vector must therefore have a projection of this amount, represented by O x_o in Fig. 10, and its extremity must lie on the horizontal line through the point x_o. At the same instant the velocity vector is horizontal because the velocity is zero, and lies to the left because the velocity is about to become negative, if we take the direction of x_o as positive.

Remembering that O X is $(90° + \psi)$ behind O V, and that X is on the same level as x_o, the displacement vector can easily be drawn in.

The initial displacement amplitude is

$$X_o = x_o \sec \psi \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 8{\cdot}01$$

and the equations of the motion are

$$x = x_o \sec \psi \, \varepsilon^{-\alpha t} \cos (\omega t - \psi) \quad . \quad . \quad . \quad . \quad 8{\cdot}02$$

$$v = -\omega_o x_o \sec \psi \, \varepsilon^{-\alpha t} \sin \omega t \quad . \quad . \quad . \quad . \quad 8{\cdot}03$$

$$a = -\omega_o^2 x_o \sec \psi \, \varepsilon^{-\alpha t} \cos (\omega t - \psi) \quad . \quad . \quad 8{\cdot}04$$

Now suppose that the vibrator, when released, is given a kick which sends it off with a velocity v_o. The velocity vector is no longer horizontal, but has its extremity level with v_o in Fig. 11. We must fit in the vectors O X and O V, so that their extremities lie on the required levels, that O V is $(90° + \psi)$ ahead of OX, and that O V $= \omega_o \times$ O X.

Make O D $= \omega_o \times$ O x_o and $(90° + \psi)$ ahead of it. Then draw D V perpendicular to O D to cut the horizontal through v_o in V. O V is the required velocity vector. The corresponding displacement vector is O X $(90° + \psi)$ behind O V, with X level with x_o.

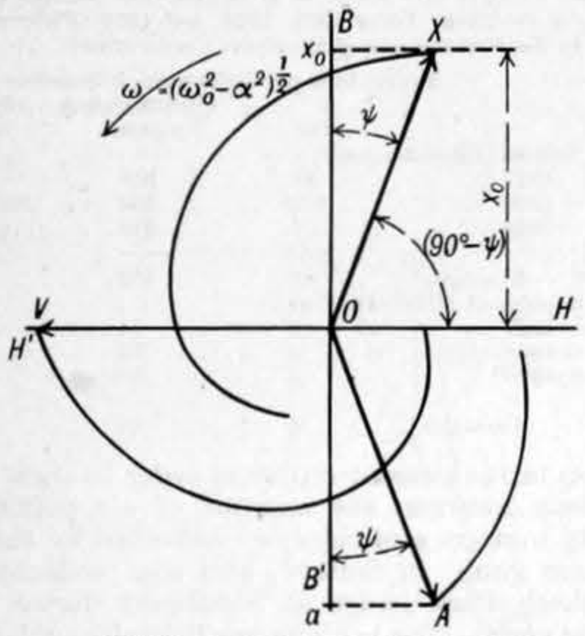


FIG. 10. VECTOR DIAGRAM FOR INITIAL INSTANT OF VIBRATION STARTING WITH $X = X_0$ & $U = 0$.

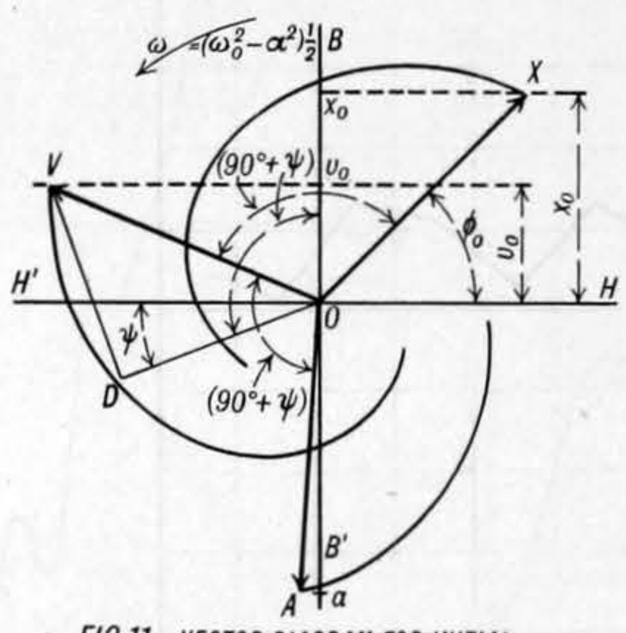


FIG. 11. VECTOR DIAGRAM FOR INITIAL INSTANT OF VIBRATION STARTING WITH $X = X_0$ & $U = U_0$.

Since we made them so, these vectors fulfil the first two conditions mentioned above. They also meet the third, for the two triangles O x_oX and O D V are similar, and therefore O V/O X = O D/O $x_o = \omega_o$.

Let φ_o be the initial phase angle of the displacement vector. That of the velocity is $(90° + \varphi_o + \psi)$, and the initial amplitude is X_o. Then

$$x_o = X_o \sin \varphi_o \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 8{\cdot}05$$

$$v_o = \omega_o X_o \cos (\varphi_o + \psi) \quad . \quad . \quad . \quad . \quad . \quad 8{\cdot}06$$

Hence

$$v_o / \omega_o x_o = \cos (\varphi_o + \psi) \div \sin \varphi_o \quad . \quad . \quad . \quad . \quad 8{\cdot}07$$

$$= \cot \varphi_o \cos \psi - \sin \psi \quad . \quad . \quad . \quad . \quad 8{\cdot}08$$

$$\text{or } \cot \varphi_o = v_o / (\omega_o x_o \cos \psi) + \tan \psi \quad . \quad . \quad . \quad 8{\cdot}09$$

$$= v_o / \omega x_o + \tan \psi \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 8{\cdot}10$$

$$\text{Also } X_o = x_o \operatorname{cosec} \varphi_o \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 8{\cdot}11$$

$$x = x_o \operatorname{cosec} \varphi_o \, \varepsilon^{-\alpha t} \sin (\omega t + \varphi_o) \quad . \quad . \quad 8{\cdot}12$$

$$v = \omega_o x_o \operatorname{cosec} \varphi_o \, \varepsilon^{-\alpha t} \cos (\omega t + \varphi_o + \psi) \quad 8{\cdot}13$$

$$a = -\omega_o^2 x_o \operatorname{cosec} \varphi_o \, \varepsilon^{-\alpha t} \sin (\omega t + \varphi_o + 2\psi) \quad . \quad . \quad . \quad 8{\cdot}14$$

(To be continued.)

Atmospheric Pollution in 1929-30.

By JOHN B. C. KERSHAW, F.I.C.

THE facts and figures given below relating to the atmospheric pollution in cities and towns of this country, and to the efforts which are being made to abate smoke in Hamburg and other places in Germany, have been taken from three recently published reports, namely, that of the Hamburg Verein für Feuerungsbetrieb und Rauchbekampfung, the report of the Fernley Observatory of Southport, and the report of the Medical Officer of Health for Salford in Lancashire. These reports are for the year 1929, and contain interesting figures and data relating to atmospheric pollution, and to methods for its prevention. The Southport report contains the more important figures for the year ending March 31st, 1930, relating to air pollution in twenty-eight of the thirty-eight towns and cities of the United Kingdom in which the observations are being carried on by the Committee for the Investigation of Atmospheric Pollution. The official report of these investigations is now compiled and published annually by the Department of Scientific and Industrial Research, and, like many other Government Blue Books, it has been very belated in its annual appearance. The sixteenth report, containing the results of the investigations for the year ending March 31st last, is not yet available,* but during the past twelve months some of the leeway in the publication of these reports has been recovered, and it may be hoped that in another year or two the reports will appear within six months of the close of the year to which they relate.

As in previous years, the writer is making use in this article of the figures for air pollution in the United Kingdom which appear in the report of the Southport Corporation Meteorologist, and his thanks are due to Mr. Baxendell for his kindness in sending an advance copy of the 1929 report. The figures contained in it may be regarded as semi-official, since they have been supplied and verified by Dr. John S. Owens, the Superintendent of the Air Pollution Observations in this country.

NUMBER OF GAUGES IN USE.

At the date of the last article, which appeared in THE ENGINEER of February 14th, 1930, there were eighty-one deposit gauges in operation, maintained by thirty-three public authorities. These numbers have undergone some change during the past year, and there are now eighty-four deposit gauges in use, and the number of authorities making the observations is increased to thirty-eight. During the year ending March 31st, 1930, new gauges were set up at Blackstone Edge near Rochdale, Burnley, Liverpool, Oldham, Walsall, Wallsend, and Wolverhampton; and the observations were discontinued at the following stations:—Cottingham, Kingston-on-Hull, at the City-road, Newcastle-on-Tyne, and at the Cenotaph and Technical School, at Rochdale.

THE LONDON RESULTS.

It is disappointing to have to report that after showing a steady decrease for some years. London's average deposit of solid impurities for the year 1929–30 is on the increase, and in view of the larger amount of fog which has been experienced in the Thames Valley during the present winter it seems probable that the figures for 1930–31, when completed, will show a still further increase of solid impurities. The opponents of the erection and operation of super-power stations within the metropolitan area will no doubt consider that this increase of atmospheric pollution gives support to their contention that no large power stations ought to be allowed within 20 or 30 miles of St. Paul's. The writer's plan, on the contrary, is not to banish the super-power stations outside the Greater London area, but to insist that every large power generating plant should be provided with cleaning and washing apparatus, adequate for removing the greater portion of solid and gaseous impurities from the waste gases, before these gases are discharged into the atmosphere. It is with these conditions that the Electricity Commissioners have sanctioned the erection of the new power station at Battersea Park, and the extension of the existing power station at Fulham. The advantages of proceeding on these lines are:—(1) That a lead will be given to other large fuel consumers, both for power and other purposes, concerning the practicability of cleaning and washing the waste gases from boilers and furnaces; and (2) that Londoners will be supplied with electric current at the lowest possible price without any of the heavy extra charges which would have been required if the current had been generated at power stations situated well outside the Greater London area, and had been transmitted in bulk by insulated cables laid underground.

It is quite time, however, that the use of raw bituminous coal for domestic purposes should be prohibited in London and in many of our larger provincial cities. London certainly ought to copy Paris and New York by prohibiting the use of any smoke-producing solid fuel within its precincts, especially as the supplies of smokeless fuels, such as anthracite nuts and beans, low-temperature coke, and coalite, and ordinary gas coke are now quite adequate for meeting the demands of domestic consumers.

In view of the controversy which is likely to arise in the near future concerning the effects upon the atmosphere of London when the Battersea Park station has begun operations, the details of the amount of solid matter collected in each of the eleven London gauges during the past three years are given in tabular form below, the stations being grouped according as they fall east or west of a north-and-south line drawn through the centre of the Metropolis.

Examining the figures in Table I., it will be seen that although the average solid deposit from all the eleven stations in 1929–30 is higher than in the previous year, five of these stations show considerable reductions in the amount of solid matter collected in the gauges, and it is chiefly owing to the increase in the amounts collected by the gauges in Ravenscourt Park, Victoria Park, and Westminster that the average deposit for 1929–30 is considerably higher than that

* This Report was published on February 27th (after this article was completed) and is obtainable from any of the branches of H.M. Stationery Office at the price of 4s. 0d.

for the previous year, the respective totals being 254 tons and 238 tons per square mile per annum. Had the first of the new super-power stations been operating during the year under review, there is no doubt that this sudden increase in the amount of solid impurities in the gauges situated at Westminster and at Ravenscourt Park would have been attributed to this cause. Since the Battersea Park station is not yet completed one must attribute the increased air pollution of these two districts of London to other causes, and it would be well for the health authorities to inquire into the matter, and to take any steps possible for removing the causes of the increase.

TABLE I.—*The Total Deposit of Solid Matters Collected in the London Gauges during the Three Years Ending March 31st, 1930, Expressed as Tons per Square Mile per Annum.*

Locality.	1927/28.	1928/29.	1929/30.
East and Central Districts:			
Golden-lane	593	395	391
Finsbury Park	284	240	284
Southwark Park	332	304	279
Victoria Park	209	184	238
Archbishop's Park	339	268	233
Average for East and Central	351	278	285
West and S.W. Districts:			
Ravenscourt Park	221	201	344
Westminster	—	251	299
South Kensington	295	260	228
Kew Observatory (B)	199	174	180
Wandsworth Common	243	179	169
Kew Observatory (A)	175	159	151
Average for W. and S.W.	227	204	228
Average for all stations	289	238	254

Examining the earlier figures in the table, it may be pointed out that the high average solid deposit in 1927–28, namely, 289 tons, was due chiefly to the increased deposit of solids in the Golden-lane gauge in that year, for whereas the deposit in that gauge in the two previous years was only 440 tons and 476 tons respectively, in 1927–28 it jumped up to 593 tons. If this sudden increase had not occurred the general average of the eleven London stations in 1927–28 would have been 277 tons in place of the 289 tons recorded.

The largest reduction in the amounts of solid deposit collected in the London gauges in recent years is shown by those installed at Archbishop's Park, Golden-lane, Southwark Park, South Kensington, and Wandsworth Common. It is noteworthy that the air on Wandsworth Common shows less solid impurity than that of the B station at Kew Observatory.

Considering next the relative positions of the London stations, as regards sulphur impurities, Table II. contains the figures for the last three years, expressed as tons SO_3 per square mile per annum.

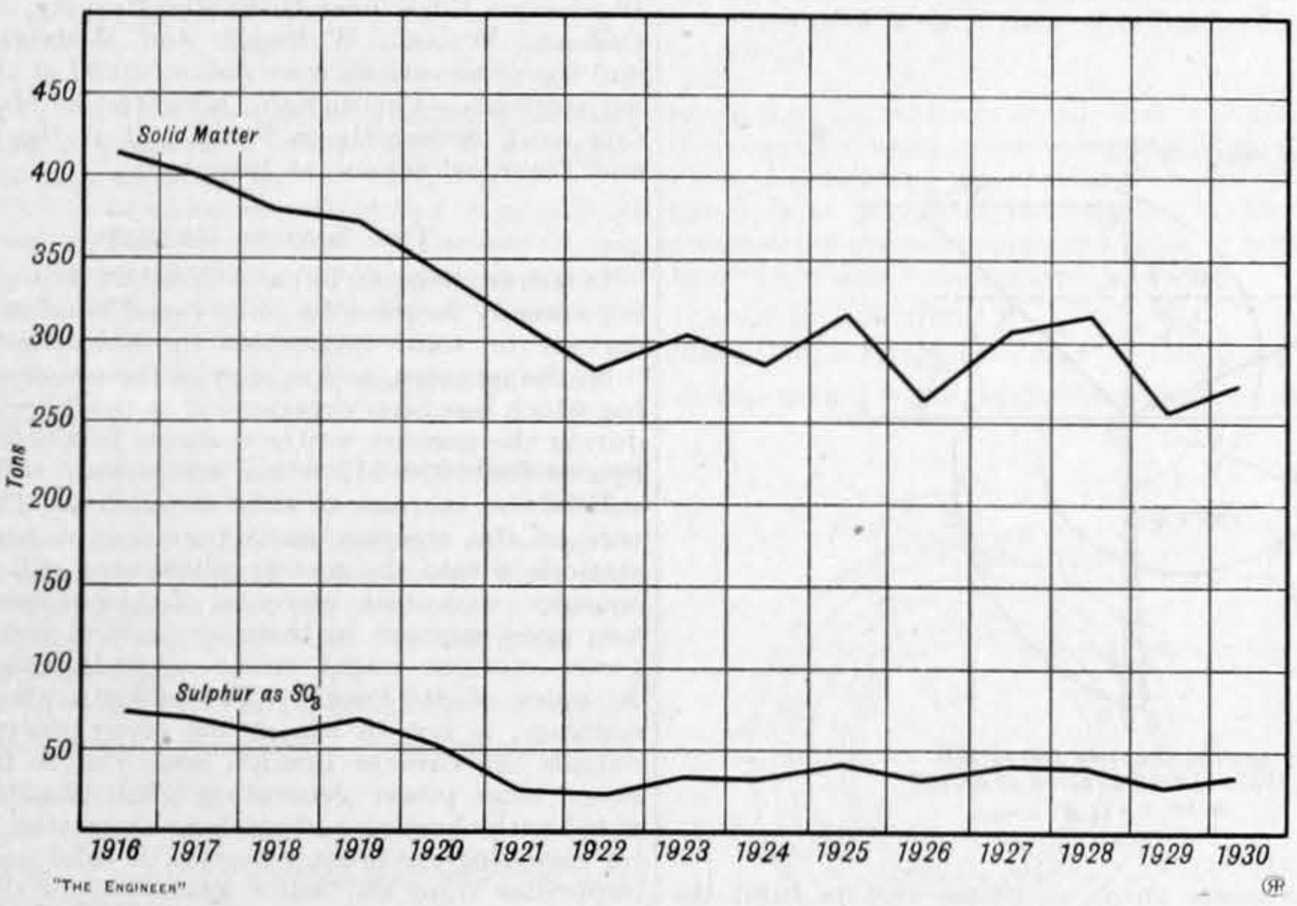
TABLE II.—*The Total Amount of Sulphur, Expressed as Tons SO_3 per Square Mile per Annum, Collected in the London Gauges during the Three Years Ending March 31st, 1930.*

	1927/28.	1928/29.	1929/30.
East and Central Districts:			
Golden-lane	75	39	42
Finsbury Park	32	26	32
Southwark Park	38	32	32
Victoria Park	28	24	26
Archbishop's Park	51	39	36
Averages	45	32	34
West and S.W. Districts:			
Ravenscourt Park	29	24	69
Westminster	—	27	28
South Kensington	36	28	25
Kew Observatory (B)	34	27	28
Wandsworth Common	27	22	20
Kew Observatory (A)	30	26	22
Averages	31	26	32
Averages for all stations	38·0	28·5	32·7

Studying the figures of this table more closely, we find that the average amount of sulphur collected in the gauges has increased in the year ending March 31st, 1930, to 32·7 tons per square mile per annum, as compared with 28·5 tons in the previous year. The increase is chiefly due to the enormous rise in the sulphur deposit collected by the Ravenscourt Park gauge, the figures of which for the past three years have been 29 tons, 24 tons, and 69 tons respectively. Compared with this latter total, the increase in the deposits of sulphur collected in the Golden-lane, Finsbury Park, and Victoria Park gauges are comparatively negligible, and as in the case of the solid deposit increase, the Ravenscourt Park district is chiefly to blame for the upward trend of London's average of sulphur air pollution in the year 1929–30.

Wandsworth Common again stands well in the comparative table as regards sulphur air pollution, and its records for the three years under review are better than those of the two stations at Kew. It may be noted here that the figure for sulphur impurity at the newly started Westminster station is rather below the average for the whole of the London stations, and it will be of considerable interest to see whether this position is altered when the new power station at Battersea Park comes into operation.

Comparing, now, the progress made in cleansing London air during the past fifteen years, the accompanying diagram gives the figures for the solid impurity and for the sulphur in the form of two curves. In order to bring the later averages into line with the earlier figures only eight stations have been taken instead of eleven for the construction of this diagram. The steady inclination downwards of both curves is a measure of the gradual improvement of London's atmosphere, and had it not been for the disturbing effect of the Ravenscourt Park figures for the year ending March 31st last, both curves would have been still continuing their downward course.



SOLID IMPURITY AND SULPHUR IN LONDON AIR

Since the question of sulphur impurity is certain to occupy a prominent place in all future discussions relating to the operation of super-power stations in city areas, the figures showing the comparative amounts of sulphur collected by the gauges in various towns and cities of the United Kingdom during the past three years are given in Table III., the totals,

TABLE III.—*Comparative Amount of Sulphur Collected by the Gauges in Various Cities and Towns in the United Kingdom for the Three Years Ending March 31st, 1930, Expressed as Tons of SO_3 per Square Mile per Annum.*

Town or city.	1927/28.	1928/29.	1929/30.
Bourneville	16·9	11·3	13·3
Southport	19·9	17·2	17·4
London (av. eight stations)	39·5	29·2	35·2
Leeds (Park-square)	43·0	36·8	36·9
Glasgow (av. nine stations)	50·2	38·0	41·2
London (Golden-lane)	74·9	39·0	42·2
St. Helens	82·6	62·1	56·0
Liverpool (Netherfield-road)	72·2	66·3	65·2
Huddersfield	70·3	65·1	66·9
Newcastle-on-Tyne (City-road)	77·6	77·1	77·4

as before, representing the tons of SO_3 deposited per square mile per annum. London, it will be seen, occupies quite a good position in this table, and only Bourneville and Southport can show lower deposits of sulphur. The Golden-lane gauge in London in 1929–30 showed less sulphur than many of the cities in the North. Whether the relative positions in this table will be altered when the new super-power stations are in operation remains to be seen.

Table IV. gives the comparative figures for the soot

TABLE IV.—*Comparative Figures for the Soot and Dust Fall during the Year Ending March 31st, 1930, in Twenty-eight English and Scottish Towns and Cities.*

Place.	Tons per square mile per annum.	No. of gauges in use.
Marple	119	1
Gloucester	120	1
Rothamsted	129	1
Bourneville	133	2
Southport	144	2
Watford	167	1
Wakefield	192	2
Cheltenham	195	1
Wrexham	202	1
Cardiff	218	1
Edinburgh	219	2
Leeds	240	5
Leicester	246	3
Birmingham	251	2
London	254	11
Stoke-on-Trent	255	2
Glasgow	280	9
Loughborough	293	1
Sheffield	302	3
Rotherham	304	2
Salford	310	2
Kingston-upon-Hull	320	1
Rochdale	356	5
Newcastle-on-Tyne	367	3
Huddersfield	370	2
St. Helens	399	1
Liverpool	438	2
Burnley	531	1

and dust fall during the year ending March 31st, 1930, in twenty-eight of the thirty-eight cities and towns making the observations; the total deposit of solid matter ranging from 119 tons at Marple up to 531 tons at Burnley. London, it will be seen, occupies a fairly central place in this table.

THE SALFORD REPORT.

The Medical Officer of Health for Salford, in his report for the year 1929, refers to the fact that for the past seven years a separate section of his annual report has been devoted to the subject of "Atmospheric Pollution." A special investigation carried out by his Department in 1923 proved that, so far as Salford was concerned, the domestic chimney was chiefly responsible for the large amounts of tar and carbonaceous matter found in the atmosphere of the borough. The following figures—see Table V.—are

TABLE V.—*The Air Pollution of Salford and Southport Compared for the Three Years 1927, 1928, and 1929 (Figures Compiled by the Meteorologist of Southport Corporation).*

Metric tons per 100 square kilometres per annum.

	Tar.	Carbonaceous matter.	Sulphur as SO_3.
Salford (Regent-square):			
1927	84	648	175
1928	102	366	300
1929	57	345	149
Averages	81	453	208
Southport (Hesketh Park):			
1927	4	74	49
1928	5	76	76
1929	4	57	48
Averages	4	69	58

given in the present report in order to show the comparison between the amount of air pollution—tar, sooty matters and sulphur—collected by the Regent-square gauge in Salford, and that collected by the Hesketh Park gauge at Southport during the past three years. The table shows that although some progress has been made in cleansing the atmosphere of Salford, the amount of tar and carbonaceous impurity is still from six to twelve times as great as that of Southport. The difference is due chiefly to the badly designed and cheap grates, which are found in the working-class houses in Salford, and to the use of cheap bituminous fuel. The activities of the Health Department of Salford, therefore, have been directed latterly to improvements in the design of grate employed for the newly constructed Council houses and to attempts to popularise the use of vertical retort coke for domestic heating purposes. The special type of grate designed by the Department for burning coke has been used in the Health Department of the municipal offices in Salford for some years, and the 1929 report contains further figures to show the efficiency and economy of this grate when burning ordinary gas coke for domestic heating purposes. The following extract from the report may be quoted here, since it is along these lines that the smoke abatement movement is likely to develop in working-class neighbourhoods:—

> "It is abundantly clear that in dry gas coke as obtained from vertical retorts by a process which obviates water quenching we have an ideal smokeless fuel for the open domestic grate, which should be preferably of the all fire-brick type, without bottom draught. Vertical coke fires give out a tremendous amount of radiant heat, are pleasant and bright to sit by, give rise to no objectionable fumes in the room, require little attention, and are exceedingly economical. Above all, they are absolutely smokeless. . . .
>
> "Low-temperature cokes, such as 'Coalite,' give excellent smokeless fires also, and are even more easily ignited than vertical retort dry coke, but the price is considerably higher. Throughout the Health Department (of the Salford Corporation) some 56 rooms have been heated for years by open coke fires. They have proved quite easy to light and to maintain, and the fuel bill is relatively low."

REPORT OF THE HAMBURG SMOKE ABATEMENT SOCIETY FOR 1929.

The Society during the year lost by death its President, Herr Dr.-Ing. Blohm, who had contributed greatly to its success during the years that he was in office. Herr Heye, has been elected in his place, with Herr Dr.-Ing. Bannworth as Vice-president. The former is head of the Hermann Heye Glas-Fabriken, in Hamburg, and the latter is managing director of

the Hamburg Electricity Works. Dipl. Ing. W. Burgdorff continues as Chief Engineer of the Society, with Dipl. Ing. W. Stagemann as Assistant Engineer; and the staff consists of one fully qualified engineer with three engineer fitters and three assistants in the office. The Chief Engineer in his report refers to the serious position into which the once-flourishing coal industry of the mining district of the Ruhr fell during the year 1929 and to the closing down of pits owing to the bad state of trade and industry. The industrial depression was also making itself felt in the work of the Hamburg Smoke Abatement Society, for although this work was not reduced the Society was called upon much more frequently than formerly to achieve economies, and any alterations of plant which were undertaken by its clients were not, as formerly based upon the scrapping of old plant and the substitution of new and up-to-date units, but were generally based upon alterations and adaptations of the existing plant to meet the altered conditions of manufacture and industry. It was reassuring to find that the Society's work was extending in a new direction, for shipowners and engineers were taking more interest in the work and many investigations were carried out by the Society's staff on ships sailing from Hamburg, Danzig, and Emden. In some cases the engineers in charge of these tests accompanied the ships on their voyages to Holland and England. The other investigations and tests of the Society have been carried out on the usual lines, but in order to reduce expenses the steam-raising tests are now conducted with less elaboration and more on the lines of trial tests.

The investigations of mechanical stokers and their efficiency were continued during the past year, but the results obtained are not yet ready for publication. In the beet sugar industry the work of the Society was concerned chiefly with the operation and efficiency of the drying machines for raw beets and the use of this type of machine is extending. One section of the report is therefore devoted to this subject, and will be of special interest to those engaged in the English beet sugar industry.

In ordinary steam-raising investigations the year was marked by the desire of manufacturers to employ fuels, either of very low or very high thermal value; and the whole question of fuel economy and efficiency has therefore been investigated anew. The American Taylor type of travelling grate, in which the grate is divided into different zones, and the air pressure regulated according to the depth and combustion stage of the fuel being burnt, is receiving great attention in Germany, and it is now recognised that aerodynamic forces must be taken into account, when this type of grate is intended for use with different classes of fuel. The reduction of the amount of free grate surface, and the accompanying increased speed of the draught, influences favourably the kindling of the coal and the cooling of the grate bars, but, on the other hand, the subdivision of the air currents increases the danger of carrying unburnt particles of coke into the flues. The heavier particles of coke, however, can be caused to travel backwards by alteration of the angles of the air ducts, and they thus pass again through the combustion space over the grate, after they have assisted in kindling the newly added fuel. It is considered by the engineers of the German Society that the Taylor type of grate requires some alterations in design in order to render it suitable for use with German fuels, and that the depth of the fuel on the bed of the grate in the original design is greater than is desirable, and leads to loss of heat by the formation of carbon monoxide gas.

The second part of the report deals with the actual test results and a series of examples is given of the results obtained during the year 1929. The best tests were obtained from a Büttner, and from a Babcock sectional boiler with travelling grates and with boiler heating surfaces of 5375 and 3762 square feet respectively. The relative proportions of the grate area to that of the boiler heating surface in the first case was 1 to 25·9, and in the second case 1 to 25·4. The economiser heating surface for the Büttner boiler was 10,836 square feet and for the Babcock boiler only 3225 square feet. Westphalian coal was used for both boilers, and in the case of the Büttner boiler 22·7 lb. were consumed per square foot per grate area per hour, as compared with 13·7 lb. for the Babcock boiler. The steam pressures were 255 lb. for the Büttner boiler and 138 lb. for the Babcock boiler, while the temperature of the superheated steam was 383 deg. Cent. in the one case and 346 deg. Cent. in the other. The waste gases passed away with a temperature of 176 deg. Cent. from the Büttner boiler and at 111 deg. Cent. from the Babcock boiler, while the CO_2 contents were 11·8 and 9·6 per cent. respectively. The following table gives the heat balances for the two boilers, and from it, it will be seen that the efficiencies were both considerably over 80 per cent., the Babcock boiler showing a heat loss of only 15 per cent., as compared with 16·9 per cent. for the Büttner boiler.

Heat utilised.	Büttner boiler. Per cent.	Babcock boiler. Per cent.
Steam formation	63·0	71·3
Superheating	12·5	5·8
Preheating air and water	7·6	7·9
Totals	83·1	85·0
Heat losses.		
Sensible heat of waste gases	9·8	7·5
Unburnt gases	0·5	Nil
Unburnt fuel	3·6	2·5
Radiation and other losses	3·0	5·0
Totals	16·9	15·0

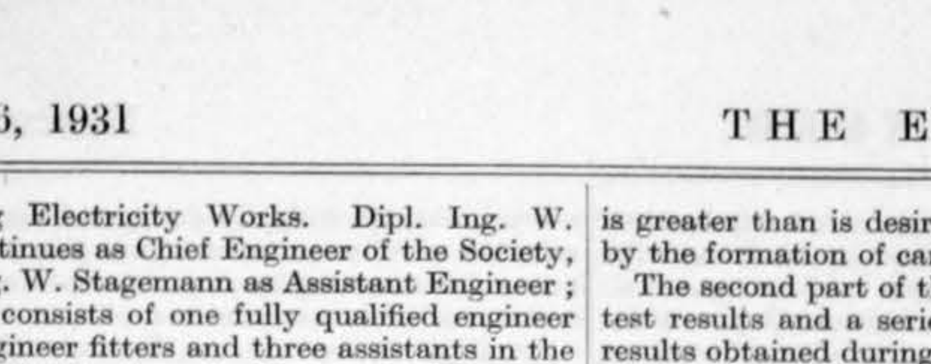


FIG. 1

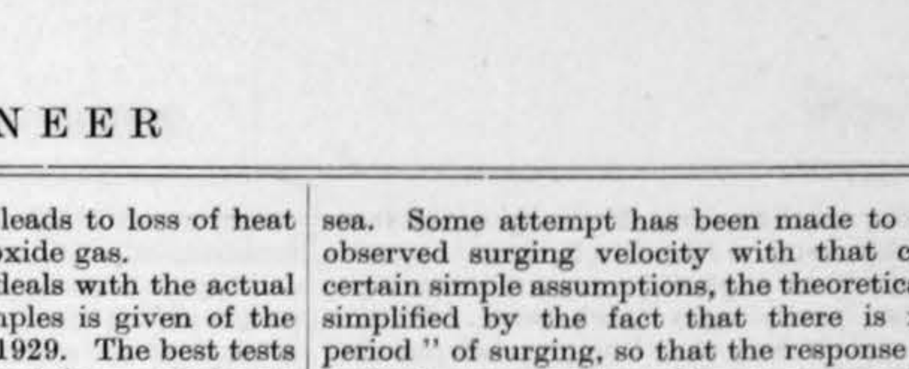


FIG. 3

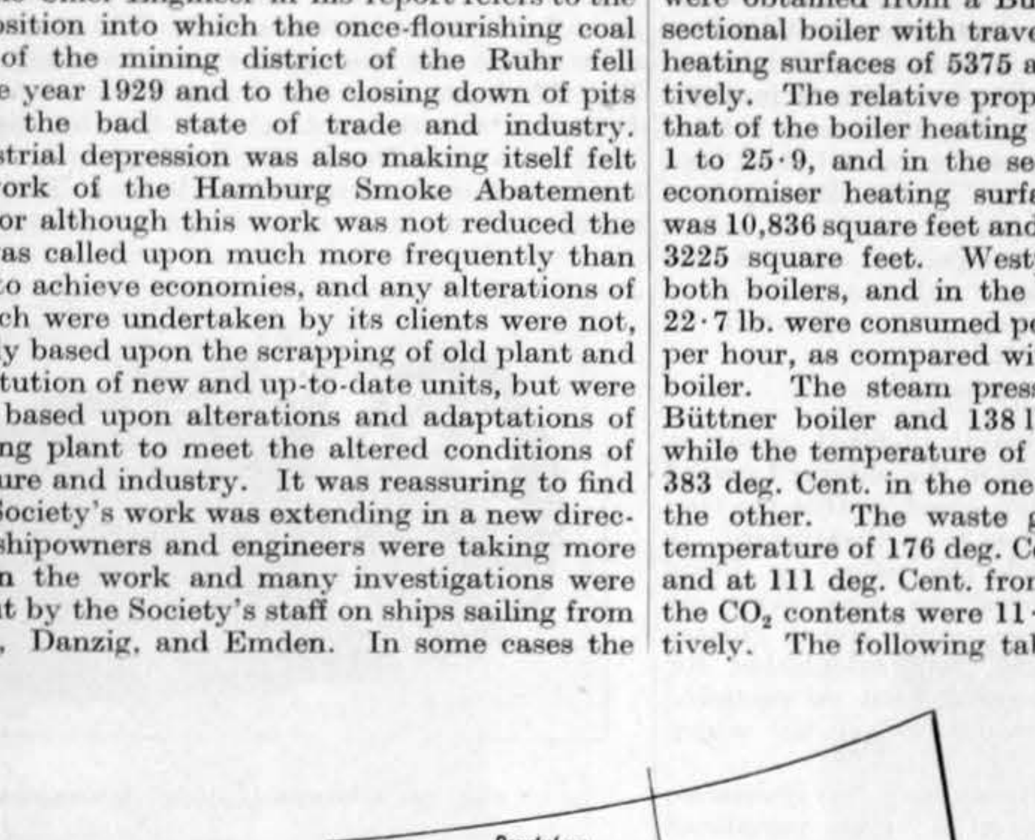


FIG. 2 SURGING IN BOW SEA.

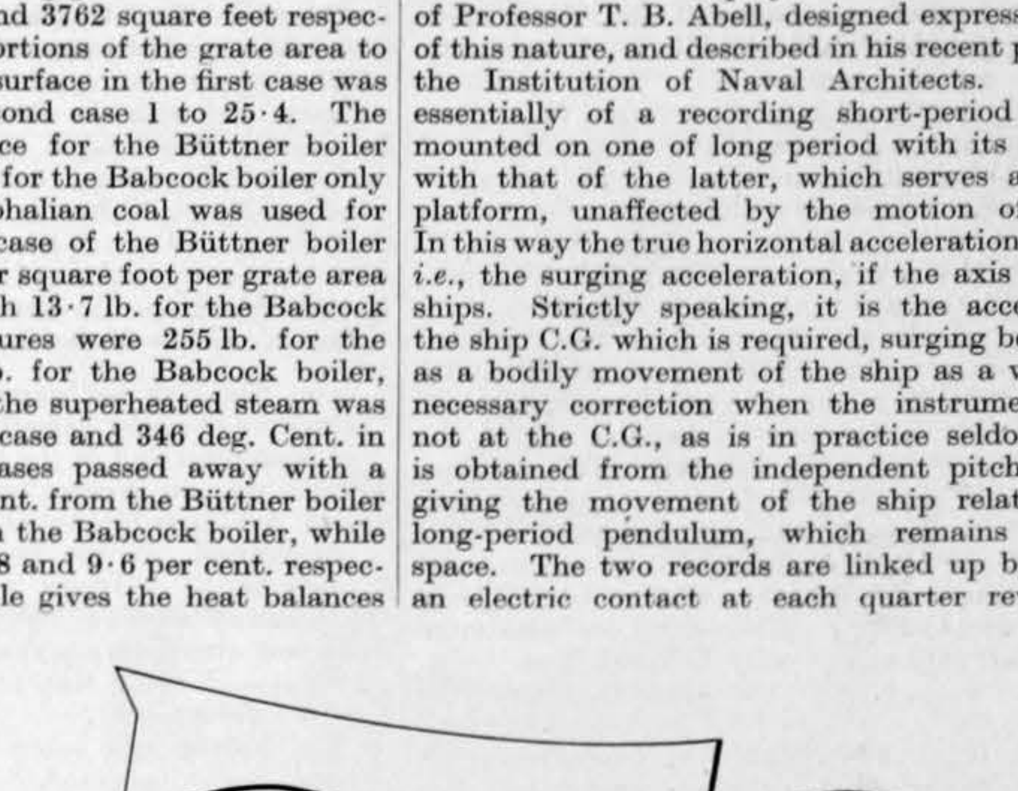


FIG. 4 SURGING IN FOLLOWING SEA.

Surging of Ships.

By J. LOCKWOOD TAYLOR, D.Sc.

OF the various motions of a ship in a seaway, attention so far as experimental and mathematical research is concerned has been concentrated principally on those which are essentially of oscillatory type. Of these, rolling and pitching have been investigated experimentally, as well as theoretically, while heaving has received mathematical treatment. The remaining types of motion—surging, yawing and broadside motion, or drift—are, perhaps, of less practical importance and have not received much attention, partly, no doubt, from the fact that they are rather difficult to measure, and that the forces producing them are not readily calculable.

Surging, however, defined as the variation in speed of—forward—translation through the water, is of a certain practical interest, first, from the influence which it has on the mean resistance of the ship in a seaway, and on the propeller efficiency, and, secondarily, on account of its bearing on the question of ocean towing. The experiments to be described may, accordingly, be of interest as being, probably, the first of their kind, and for the sake of the light which they throw on the forces acting on a ship at sea. Some attempt has been made to correlate the observed surging velocity with that calculated on certain simple assumptions, the theoretical work being simplified by the fact that there is no "natural period" of surging, so that the response to the forces acting is not complicated by resonance phenomena.

The instrument employed is the co-axial pendulum of Professor T. B. Abell, designed expressly for work of this nature, and described in his recent paper before the Institution of Naval Architects. It consists essentially of a recording short-period pendulum, mounted on one of long period with its axis in line with that of the latter, which serves as a steady platform, unaffected by the motion of the ship. In this way the true horizontal acceleration is recorded, *i.e.*, the surging acceleration, if the axis is athwartships. Strictly speaking, it is the acceleration at the ship C.G. which is required, surging being defined as a bodily movement of the ship as a whole. The necessary correction when the instrument itself is not at the C.G., as is in practice seldom possible, is obtained from the independent pitching record, giving the movement of the ship relative to the long-period pendulum, which remains steady in space. The two records are linked up by means of an electric contact at each quarter revolution of the short-period recording drum, which operates an electro-magnetic pen on the long-period drum. The two drums are started and stopped simultaneously, and one revolution, *i.e.*, one single record takes about 2 minutes. The time scale is obtained from the long-period drum, which is driven by clockwork with an escapement, the other drum having an ordinary-governed spring motor drive. The scale of the pitching record is $\frac{1}{2}$in.=1 deg., and that of the acceleration record 1in.=0·28ft./sec.^{2}. This scale proved rather large, as the accelerations sometimes exceeded the maximum of $\pm$0·8ft./sec.^{2}, which could be recorded. In practice it is not possible to maintain the long-period pendulum absolutely steady, but as its period of 50 secs. is so much greater than that of the velocity fluctuations being measured, this does not vitiate the results, provided the swing is not excessive.

The vessel on which the observations were made had the following dimensions:—L.B.P., 518ft.; breadth, extreme, 63ft. 9in.; draughts, forward 16ft. 9in., 21ft. 10in. aft; mean draught, 19ft. 3$\frac{1}{2}$in.; displacement, corresponding, 13,200 tons. The height of V.C.G. above keel was estimated at 16ft., and the axis of the instrument being 30ft. above the keel is 14ft. above the C.G. This height is required for the correction for pitching mentioned above. The most interesting records were obtained in a fairly long following sea, when the surge velocity proved surprisingly large, but reference will first be made to the results with a moderate bow sea. With a beam sea or heavy bow sea the rolling of the ship makes it impossible to use the instrument, and such records would, in any case, be of minor interest and difficult to interpret.

The actual records of acceleration differ materially in character, according as the period of encounter of the waves is greater or less than the ship's natural pitching period, which emphasises the necessity for making an allowance for the fore and aft movement due to pitching. In the former case the pitching angle is in phase with the effective wave-slope, so that, for instance, when amidships is at the point of maximum forward slope of the wave—Fig. 1—the bow is up, and it is readily seen that the fore and aft acceleration due to pitching, at a point above the

C.G., is in a forward direction. The surging acceleration, on the other hand, is found to be in the opposite direction, as would be expected from the wave-slope, so that the two partly cancel each other. With a period of encounter less than the natural pitching period, the pitching is opposite in phase, and the two accelerations are in the same direction. This would be a complete statement if the waves were perfectly regular, but the actual lack of regularity involves a certain amount of "free" pitching in addition to the forced pitching referred to, so that the correspondence of phase between pitching and surging, while broadly as described, is not complete. The natural pitching period deduced from the records in accordance with the above, is in agreement with that obtained from those taken in a following sea, as mentioned later, and is about 5·9 seconds.

The actual maximum correction to the recorded acceleration on account of pitching is $(2\pi/T)^2 \times \theta \times h$ (ft./sec.^{2}), where T is the (forced) pitching period, θ the amplitude of pitching in radians, and h the height above C.G.—in this case 14ft. This assumes simple harmonic motion, which is very nearly correct for any individual oscillation. Correcting the surge acceleration record from point to point by this amount, and integrating to obtain the velocity curve, gives a diagram such as Fig. 2. This shows the maximum velocity fluctuation actually experienced, viz., 0·63ft./sec., or, say, ±0·31ft./sec., the period of encounter being about 5 to 6 seconds, and the estimated wave length 300ft. The long-period variation shown is due to the swing of the instrument, and does not represent actual movement of the ship.

The records taken in a following sea, when the period of encounter of the overtaking waves is much longer, are of a very different character. The vessel tends to pitch in accordance with the wave slope at all times, so that the pitching is essentially of what may be termed the "equilibrium" type, with a slight exaggeration due to the fact that the period of encounter is not infinitely long compared with the natural pitching period. The value of the latter can be deduced from the record, since a small amount of "free" pitching is occasionally superposed on the long-period motion corresponding to the period of encounter. The value in the present instance was found to be 5·9 seconds, as previously mentioned. The effect of this motion on the acceleration record is relatively small, and practically disappears on integrating to obtain the velocity, so that no correction need be applied to the recorded accelerations on this account. The correction for the long-period pitching acceleration is also small.

Comparing the phase of the surging with that of the effective wave-slope, which is the same as that of the pitching, it is found, as might be anticipated, that the acceleration is a maximum when the steepest part of the wave is passing under the ship amidships, the maximum forward acceleration occurring on the forward wave-slope—Fig. 3—and *vice versâ*. From this it follows that the maximum forward velocity occurs one-quarter of a period later, *i.e.*, at the wave crest, so that the surging of the ship may be described as a copy, on a somewhat reduced scale, of the orbital motion of the water. The actual ratio of the surge velocity to the orbital velocity appears to be surprisingly large in the present instance, as will be seen, the total velocity fluctuation being about 3ft./sec. in waves of moderate height, Fig. 4.

Deducing the effective wave-slope from the recorded pitching angle, with a small correction for dynamic magnification, and the wave length from the period of encounter in conjunction with the speed of the ship, the wave-height may be estimated, and, hence, the orbital velocities and accelerations of the water. Making the tentative assumption that the forces acting on the hull of the ship are precisely those which would act on the displaced water if the ship were not there—*i.e.*, extending Archimedes' principle to the wave-borne condition—it is obvious that the resultant horizontal force acting at any moment will be such as to give an acceleration equal to the mean acceleration of the displaced water. This can be calculated, and, hence, the theoretical surging velocity may be deduced, and compared with the figure obtained from the observations. The assumption as regards forces acting is the exact equivalent of that normally made in strength calculation, the use of the actual pressure and acceleration in the wave, according to the trochoidal theory, corresponding to the "Smith" correction.

The observed data were as follows :—

Pitching angle (θ), 10·17.
Period of encounter, 17–18 seconds.
Surge velocity, ±1·45ft./sec.
Ship speed, 12·5 knots, or 21·1ft./sec.
The corresponding calculated figures are :

(1) Wave length (λ), 600ft.
(2) Wave speed (ft./sec.) $= 2 \cdot 26 \sqrt{\lambda} = 55 \cdot 3$ft./sec.
(3) Wave speed, relative $= (55 \cdot 3 - 21 \cdot 1) = 34 \cdot 2$ft./sec.
(4) Period of encounter $= (600 \div 34 \cdot 2) = 17 \cdot 5$ secs.
(5) Equilibrium pitching angle $= \theta \times (T^2_1 - T^2)/T^2_1 = 1° \cdot 04$ (T, T_1 are the periods of free and forced pitching respectively).
(6) Wave height = 6·4ft.
(7) Calculated ship acceleration = ±0·36ft./sec.^{2} (maximum).
(8) Calculated ship velocity $= (T_1/2\pi) \times 0 \cdot 36 = \pm 1 \cdot 00$ft./sec.
(9) Maximum orbital velocity = ±1·85ft./sec.

The wave height—line (6)—is that required to maintain the ship in momentary equilibrium, with amidships midway between crest and trough—*i.e.*, practically at the position of maximum slope—when pitched at an angle of 1°·04—line (5). The mean horizontal acceleration of the displaced water—line (7)—is calculated for the same position on the wave, and since the variation with time is practically sinusoidal, this leads to the velocity as given in line (8), which may be compared with the maximum orbital velocity, and with the observed figure of 1·45ft./sec. In view of the simple nature of the assumptions made, close agreement between observed and calculated results could hardly be expected, and the fact that the figures are of the same order seems to show that the explanation of surging put forward is, broadly speaking, the correct one.

Possible causes of the discrepancy are :

(*a*) The deduced wave length of 600ft. is rather sensitive to slight variations in the observed period of encounter and in the ship speed, so that the true value may be greater or less than that given. It was not possible to check the value by direct observation, as the observations were taken at night time. A longer wave would give a greater calculated surging velocity, but calculation for several alternative waves shows that no probable increase in wave length would remove the whole of the discrepancy.

(*b*) Variation in screw thrust and ship resistance have been neglected. Even if these variations amounted to an appreciable fraction of the mean thrust necessary to propel the vessel—about 40 tons—they would be small compared with the acceleration force corresponding to the records, which is about 200 tons. So far as the thrust is concerned, the amount of variation may be estimated from the variation in speed of advance. Thus, when the vessel is on the crest, its velocity is 1·45ft./sec. greater than the mean, while the screw being in the trough, where the orbital velocity is 1·85ft./sec.—astern—has its speed of advance increased by 3·3ft./sec. in all. The change in thrust due to this will not exceed about 5 per cent. of the mean value, while the phase differs from that of the resultant wave thrust by a quarter of a period. A similar phase relation holds for the variation in resistance, so that if these effects were important, some change in the observed phase would be anticipated.

(*c*) No account has been taken of the possible "piling-up" of the wave around the ship. Some disturbance of the wave-structure is bound to occur, and this may increase the resultant force on the ship. This is, to some extent, bound up with the question of the virtual inertia of the hull, since it is a question of the reaction of the added water mass, which is also periodically accelerated during the passage of the wave, upon the hull. If, as has been suggested, the mass to be taken for acceleration purposes is the "perfect fluid" mass, *i.e.*, ignoring any change in the mass of water dragged along by friction, theoretical results show that the added mass for a body of the appropriate fineness ratio will not exceed about 5 per cent. of the displacement.

In conclusion, the writer is greatly indebted to Professor T. B. Abell, at whose suggestion the observations were carried out, as part of the work in connection with the Munitions Committee Research Fellowship of the University of Liverpool. Grateful acknowledgment must also be given of the facilities afforded by the owners of the vessel, and of the data supplied to enable calculations to be made.

The British Industries Fair.

No. IV.*

WE continue below our description of the exhibits at the Birmingham section of the British Industries Fair. It must not, of course, be taken that the notices which we have published exhaust the whole of the engineering exhibits, as their description would occupy an inordinate amount of space. We have, however, chosen such as seem to us to be of special interest to our readers.

The official figures, which have just been published, show that from the point of view of attendance the Fair has been more successful than ever, the total number of visitors amounting to over one hundred thousand.

H. R. MARSDEN, LTD.

A varied and interesting exhibit of stonebreaking and roadmaking machinery was shown on the stand of H. R. Marsden, Ltd., of Soho Foundry, Meadow-road, Leeds. The largest machine was the Blake-Marsden "X" type lever motion stonebreaker with a mouth opening of 20in. by 12in., which is designed to reduce the hardest rock to road metal size at the rate of approximately 15 tons per hour. The crank shaft is made of high-tensile steel with a marine type of connecting-rod and specially designed lever, which transmits the motion to the swinging jaw stock. A very heavy frame is employed and a feature of the design is the renewable manganese steel jaws and side plates.

In Figs. 36 and 37 we illustrate the new "H" type excentric motion stonebreaker, which has only recently been put on the market. The general appearance of the machine will be seen from Fig. 36, while Fig. 37 shows a section through the moving parts. It has a mouth opening of 15in. by 9in. and is built on a rigid frame, the bearings and methods of lubrication being of improved design. The pitman is made of steel, and a special high-tensile steel is used

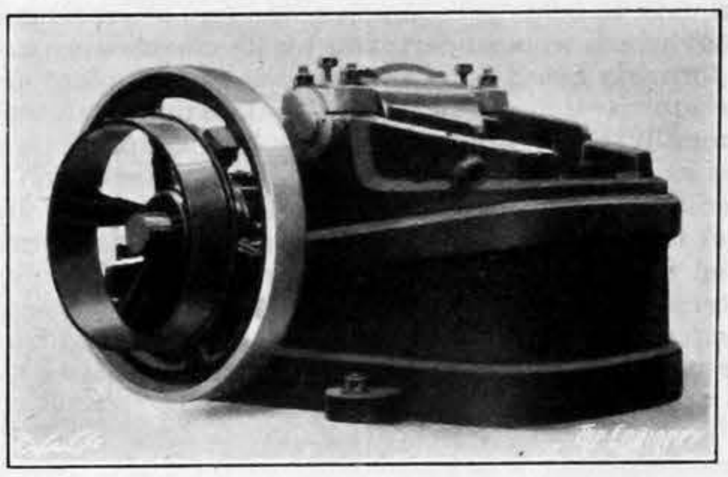


FIG. 36—STONEBREAKER—MARSDEN

for the excentric shaft, while the deeply ribbed jaw stock is furnished with renewable jaws and side plates of manganese steel.

Another exhibit on the stand was the Blake-Marsden granulator for the production of small crushed stone or chippings for ferro-concrete work or for the crushing of pyrites and similar ores. The example exhibited had a mouth opening of 30in. by 6in., which, it is claimed, gives ample room for direct feeding in addition to chute feeding of oversize rock or ore from the main crushers. The bearings of the excentric are white metal lined and, like the bronze main bearing, are furnished with Stauffer grease cap lubrication. As

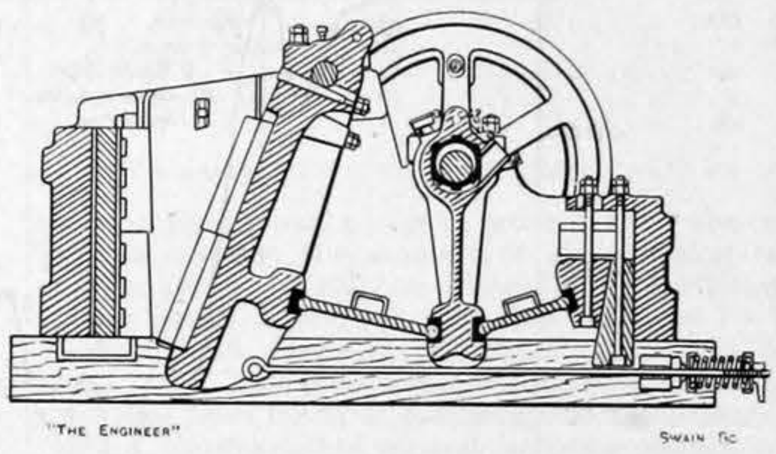


FIG. 37—SECTION OF STONEBREAKER—MARSDEN

in the machines previously referred to, renewable jaws and side plates are fitted. The firm also showed one of its vertical elevators, which has been designed to collect and deliver material without overflow or spilling. No skid bars are used and, it is claimed, that friction is thereby reduced and jamming obviated, while a very simple and positive method of adjustment is arranged, the drive being made to suit the requirements of the user.

COVENTRY MACHINE TOOL WORKS, LTD.

The two principal exhibits on the stand of the Coventry Machine Tool Works, Ltd., St. George's-road, Coventry, were the press illustrated by Fig. 38 and the forging machine shown in Fig. 39.

The press is suitable for stamping, finning, forming, bending, and drawing operations, and for general press work. The body is cast in one piece with solid crank shaft bearings, and has transverse slots just above the table to allow strip material to be fed in from the side. The main table is cast on the body and provided with tee slots, as well as a circular hole in the centre, which can be altered to any size or shape, if desired, for special work. A loose table—not shown in the illustration—can also be used to reduce the height below the tools for shallow work. The drive is effected by fast and loose pulleys and gearing, in conjunction with a large fly-wheel. The crank shaft is of special alloy steel and of larger diameter in the excentric than the bearings. It runs in solid sleeves and carries, at one end, the main driving gear, with which it is coupled only during the working stroke. The driving clutch consists of two rotary keys, one for taking up the drive and the other for absorbing the reactionary stresses. The hardened steel clutch fixed to the driving gear has four keyways, and the driving keys, after the foot rod has been depressed, find the nearest keyway, so that the engagement may be instantaneous or at most after one-quarter of a revolution. The connecting-rod is of cast steel and is made in two parts with a safety arrangement, which takes the form of a bolt, coupling the two parts together, and of such dimensions that it breaks should the machine be overloaded. The thrust is taken on solid kunckles, thus relieving the pins from all strain. The machine illustrated is made with a fixed stroke, but it can be provided with a varying stroke if

* No. III. appeared February 27th.

desired. The carriage has long and wide guiding surfaces. It can be adjusted vertically, irrespective of the stroke and arranged either to carry a tool holder with a dovetail groove, or with a tool holder of the quick-adjusting self-centring type. The vertical adjustment is done by a tommy bar, but a worm and wheel is adopted for the larger sizes. The brake is placed on the opposite side of the crank shaft to the driving gear, and holds the carriage in the top position after the driving key has been disengaged. It is automatic in its action.

The machine shown has belt drive, but all machines of this type are provided with a planed seating at the back of the body, to which a bracket for carrying

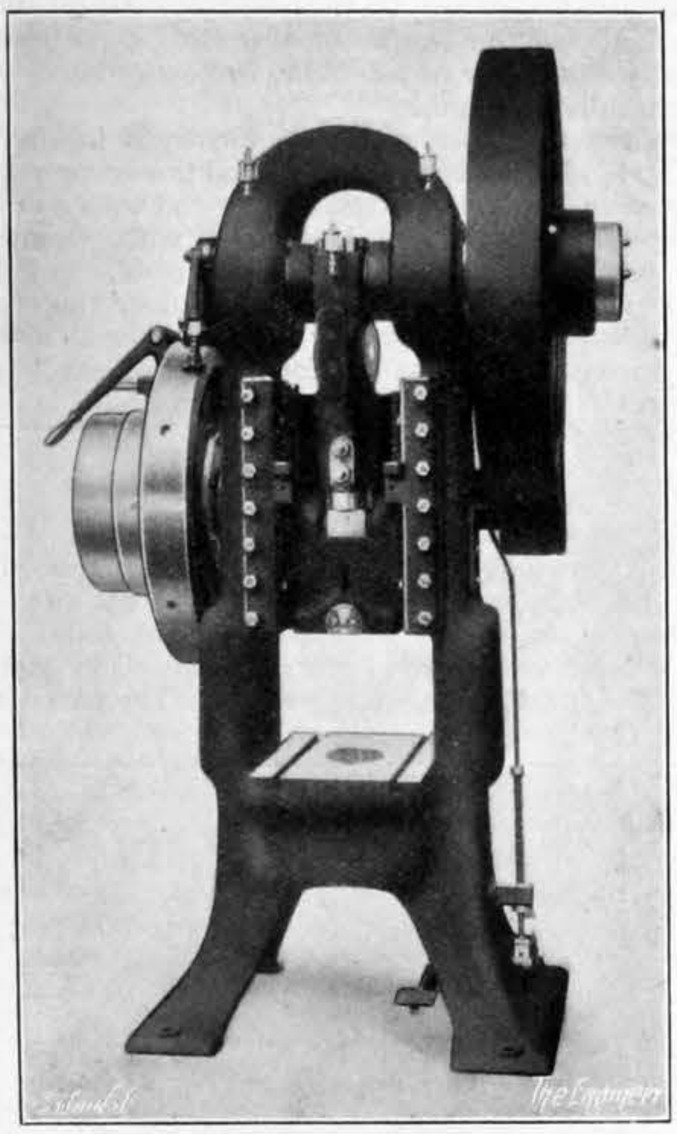


FIG. 38—PRESS—COVENTRY M.T. WORKS

an electric motor may be attached, so that a standard machine may easily be changed from belt to motor drive. Either single or double ejectors can be fitted. These machines are made in several sizes with pressures varying from 80 to 400 tons.

The body of the forging machine illustrated in Fig. 39 is a heavy casting of box form, strongly ribbed and provided with steel tie bars, which assist in resisting the heavy strains to which the machine is subjected. The crank shaft bearings are bored through the solid body. The pressure of the crank shaft is, therefore, taken by the solid body casting and the use of bearing caps is avoided. The heading slide is of the top-hung type, so as to protect the bearing surfaces from falling grit and scale. In

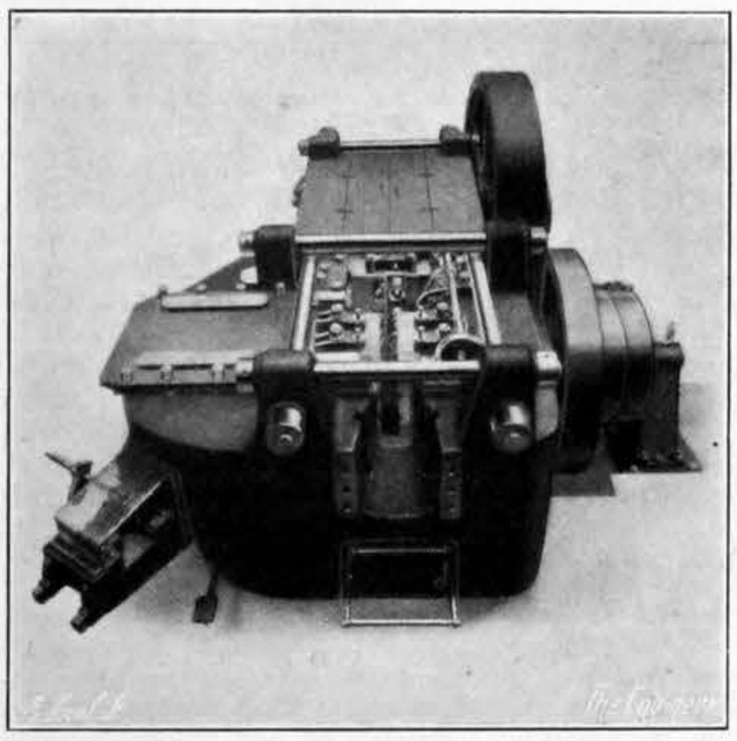


FIG. 39—FORGING MACHINE—COVENTRY M.T. WORKS

order to eliminate the tendency to tilt under heavy pressure, the guiding surfaces are made exceptionally long, and in the case of the larger machines are extended underneath the crank shaft. The die slide, like the heading slide, is of the top-hung type, with long guiding surfaces running on phopshor bronze liners. In the standard form, the right-hand die is stationary and rests on a solid bearing in the bed, but for special classes of work which require additional die opening, it is mounted on a slide in the same manner as the left die, and is operated by hand. The closing of the dies is completed before the beginning of the heading operation. Therefore, during the actual upsetting period, the toggles serve merely to maintain the grip of the dies. The thrust is taken on the solid part of the bed, toggles, and die slide, thus relieving the pins from all strain. The crank shaft is made of 3 per cent. nickel steel and is larger in the excentric than in the bearings. The tool holder consists of three or four separate pieces—the number varying according to the size of the machine—which may be adjusted independently to enable the centres of the tools to be varied to suit the nature of the work. Fine adjustment to and from the dies is provided for. The work

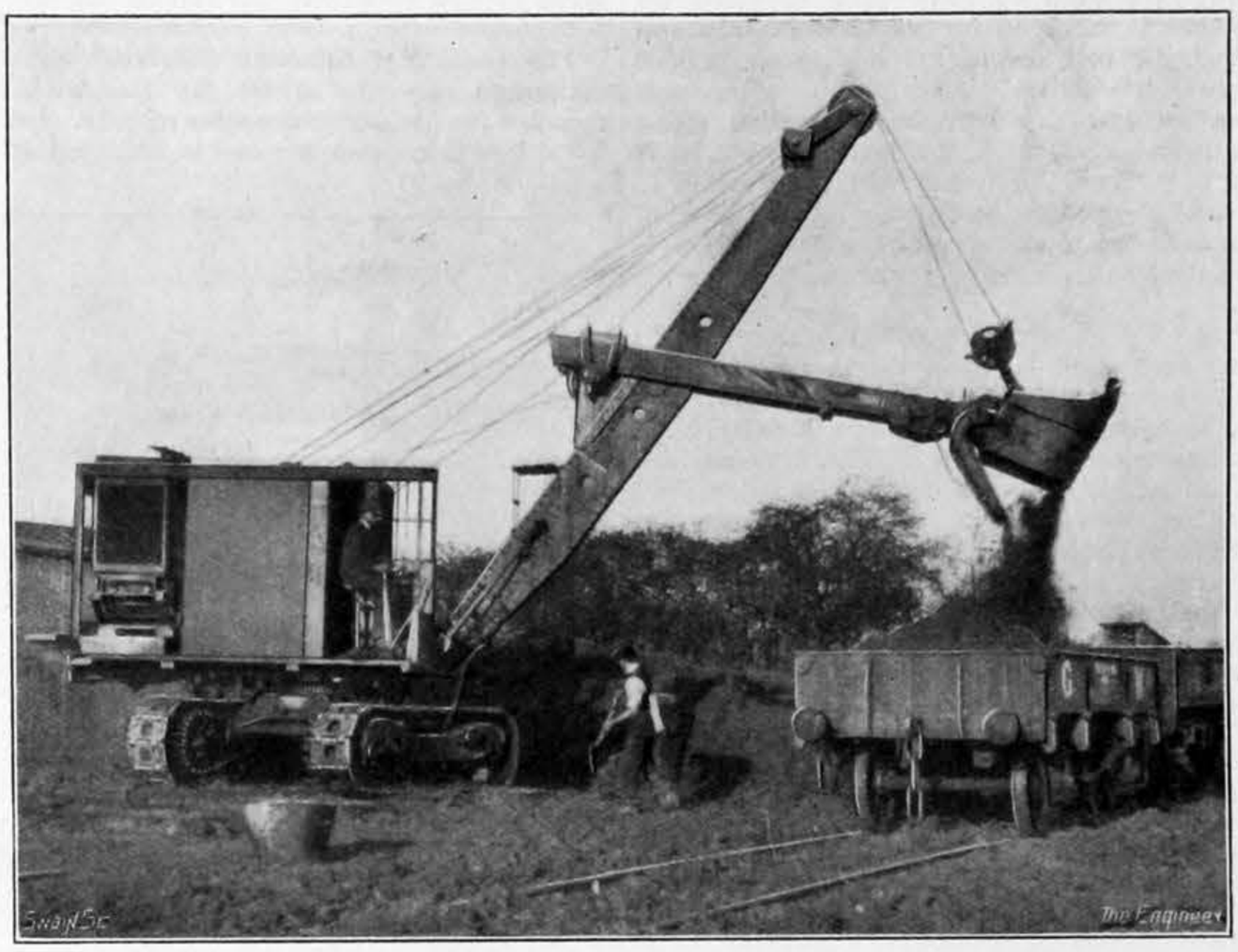


FIG. 40—THREE-QUARTER CUBIC YARD EXCAVATOR—RUSTON-BUCYRUS

stop is used to determine the length of the stock to be headed, and is arranged automatically to swing clear of the tools as they approach their forward position. In the larger machines it may be adjusted from the operating position by means of an indexed hand wheel. The index is graduated to give adjustment to $^1/_{64}$in. Shears for cutting off forgings to length are provided when required. They are placed at the front of the machine in a convenient position for the operator and are well guarded. The lubrication of the constantly moving parts is effected by means of large sight-feed and centrifugal lubricators. The intermittently moving parts, such as the heading slide and crank shaft, are, in the larger machines, lubricated from a centralised system controlled from three positions on the machine.

RUSTON-BUCYRUS, LTD.

The principal exhibit on the stand of Ruston-Bucyrus, Ltd., of Lincoln, was the firm's new "1030" type $\frac{3}{4}$ cubic yard excavator, which has been specially designed to meet modern excavating demands, and was first put into production at Lincoln last year. By dispensing with a counterweight and arranging all the machinery behind the centre post, an increased speed of working has been attained. The photograph we reproduce in Fig. 40 illustrates the general character of the excavator, which can be arranged to work as a shovel, a drag-line excavator, a drag shovel, a grab crane, or a lifting crane. The example exhibited at Castle Bromwich, was for convenience, electrically driven, and a general plan of the machinery is reproduced in Fig. 41. The four separate motions for hoisting or dredging, rocking, slewing and travelling, and derricking, are neatly combined in one power unit, with the main spur gears running in an oil bath. For racking, a second motor can be mounted on the jib if required. By arranging the drums and clutches on a single shaft, much space has been saved, while the various control levers are all placed within easy reach of the operator.

A very simple arrangement of caterpillar mounting has been embodied in the new excavator, which is easily accessible and gives improved manœuvring and turning facilities. The machine is so designed that it can be easily transported on rail with very little alteration, while for road transport no dismantling whatever is required. Although the model shown at Birmingham is electrically driven, it can also be supplied with a four-cylinder petrol engine, or with a four-cylinder high-speed heavy-oil engine, instead of the motor drive. Under average digging conditions, when working with the heavy-oil engine drive, not more than 1 gallon of fuel oil per hour is, we understand, required.

Another exhibit on the Ruston-Bucyrus stand was an example of the "Robuston" centrifugal pump for liquid-borne solids. The pump shown was

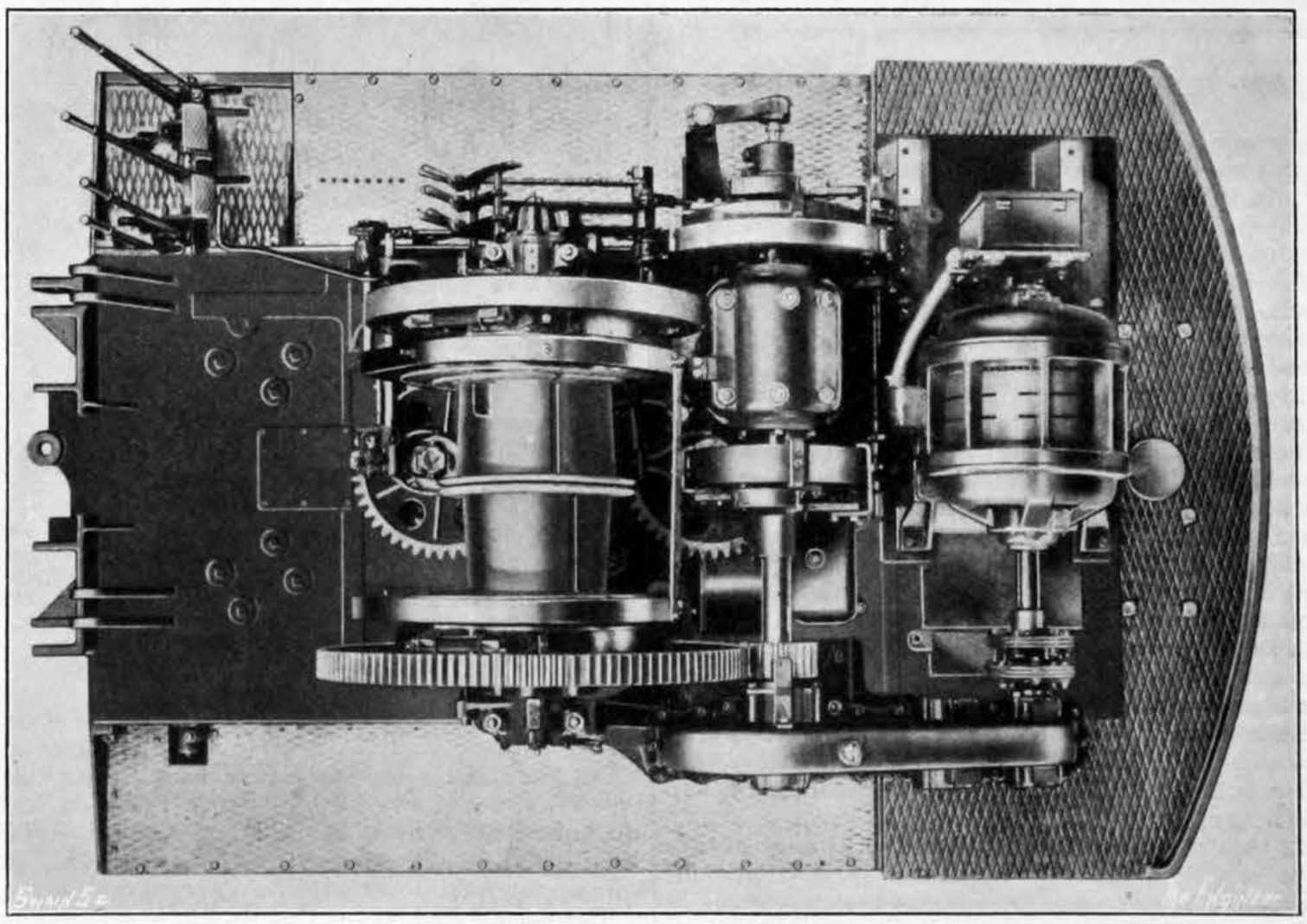


FIG. 41—PLAN OF ELECTRICALLY-DRIVEN EXCAVATOR MACHINERY—RUSTON-BUCYRUS

designed to meet modern excavating demands, and was first put into production at Lincoln last year. By dispensing with a counterweight and arranging all the machinery behind the centre post, an increased speed of working has been attained. The photograph we reproduce in Fig. 40 illustrates the general character of the excavator, which can be an 8in. bore model, and is one of a series which is manufactured in sizes from 4in. up to 12in. The impeller is made of manganese cast steel, and it is screwed, giving an easy attachment to the spindle, which runs in enclosed roller bearings. For the purpose of taking any thrust developed, a special ball bearing is fitted. The pump casing is made of cast

iron and it is split, while the pump liner is a heavy manganese steel casting with a door on the suction side of the pump for the inspection and removal of the impeller. The pump shaft is furnished with a specially hard renewable sleeve of steel at the parts at which wear usually takes place, thereby lengthening the life of the main shaft. The pumps and bearings are bolted down to a very stiff and robust bed-plate, and for the larger pumps a friction clutch, as well as a pulley, forms part of the equipment. Several of the pumps referred to have been supplied for floating pontoons engaged in gravel pumping, and are arranged for belt driving. Such an equipment can quite well be looked after by one attendant. Other uses include the pumping of sand, china clay, or alluvial ores, and for heavy solids it is worthy of note that the pump will take solids in sizes practically right up to the actual diameter of the pump delivery pipe. Thus, the 8in. pump is designed to deal with solids up to 7in. in diameter.

TILGHMAN'S PATENT SAND BLAST COMPANY, LTD.

The most important item on the stand of Tilghman's Patent Sand Blast Company, Ltd., Broadheath, near Manchester, was the rotary table sand blast apparatus illustrated by Fig. 42. The general idea of these machines is not, of course, altogether novel, but several improvements have been added recently.

The work to be cleaned by the sand blast is arranged on a circular table of heavy cast iron, which is slowly rotated. One half of the area of the table is covered with a sheet steel hood, and the other half is exposed, so that the articles to be cleaned can be placed thereon. At the front of the hood there is a double curtain of strips of rubber, that depend right down to the table. The articles push this curtain aside as the table rotates, and go into the hood, where they are

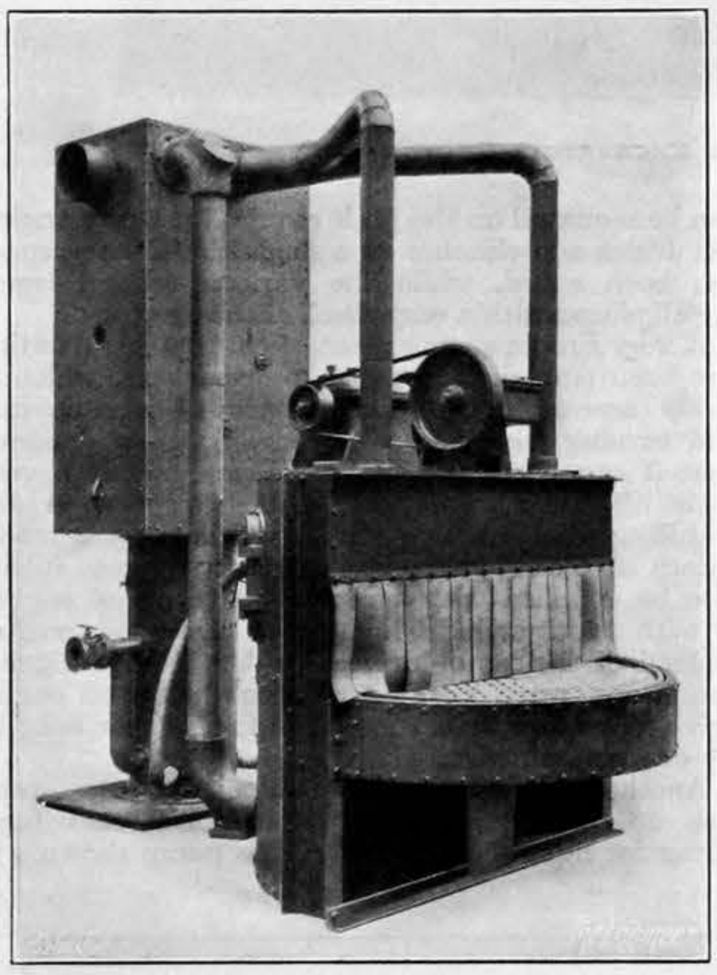


FIG. 42—SAND BLAST MACHINE—TILGHMAN

subjected to the sand blast. The blast of sand or chilled shot is projected downwards from a number of jets using air at a pressure ranging from 30 lb. to 80 lb. per square inch, according to the work in hand. These jets are at the ends of pivoted pipes, which are swung back and forth so as to cover the whole area of the table. This swinging action is so arranged that the swing is quicker towards the centre of the table, and the whole area is consequently evenly treated. The abrasive, and the dirt it has removed, drop through slots in the table into a hopper below, and are sucked out by a fan. This fan delivers into a separator which extracts the dust and leaves only the sharp abrasive, which is returned for use in the jets again. Without this precaution the dust, if returned to the circuit, would have cushioning effect on the sand blast, and reduce its efficiency. The top of the hood is also connected with the suction system, so that there must always be an inwards draught of air through any crevices, which ensures a dust-free atmosphere outside. All the bearings are dustproof, and the gearing is protected from being damaged by grit. The machine exhibited has a table 7ft. in diameter, but they are made in sizes ranging from 3ft. 6in. to 9ft.

On this stand there were also several more simple types of sand-blasting apparatus and some air compressors.

BROOKES (OLDBURY), LTD.

There was a novel machine on the stand of Brookes (Oldbury), Ltd., of Oldbury, near Birmingham, which is the direct outcome of a display at the previous Fair. It is the guillotine shearing machine shown in Fig. 67, page 268, which has been supplied by the makers to the Austin Motor Company, Ltd., for use in the metal stores at the Longbridge Works, Birmingham. The peculiarity of the machine lines in the fact that it is equipped with a two-speed geared drive.

The advantage of such an arrangement is obvious where a single machine is employed to cope with a wide range of different thicknesses of metal, and there is not sufficient work to justify the installation of two machines. The alternative high speed for working on the lighter gauges is particularly of service where such a machine is to be principally engaged in cutting light work, but is used occasionally for cutting up to the maximum thickness. Under such conditions the installation of one of these twin-speed shears not only saves capital cost, but has the advantage of saving floor space.

The particular machine exhibited has a normal maximum capacity of 4ft. by ¼in. with a cutting speed of twenty-six strokes per minute. On the twin-speed machine the low speed is arranged at the usual

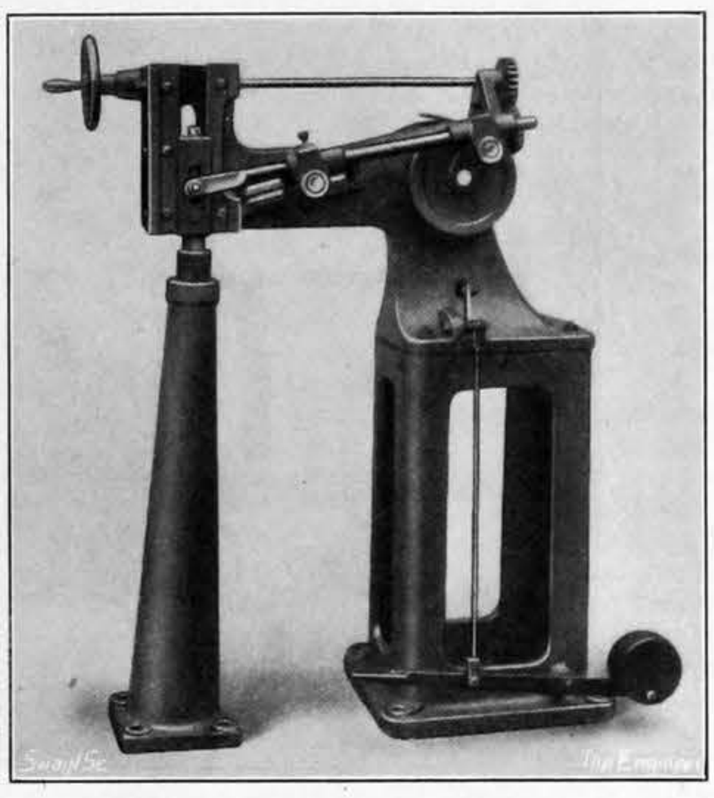


FIG. 43—PLANISHING HAMMER—BROOKES

standard of twenty-six strokes per minute, but the alternative high speed is eighty cuts per minute. The high speed is suitable for dealing with sheets up to 14 gauge thick and the low speed above 14 gauge up to ¼in. thick. The two-speed drive consists of twin spur wheels working in conjunction with a sliding twin steel pinion, which are plainly shown in Fig. 67. The countershaft works at constant speed and carries a heavy fly-wheel to deal with a maximum thickness of material. The sliding pinion works on splines cut on the countershaft, which is made from heat-treated toughened nickel chrome steel. The machine on the stand was driven by a direct gear-coupled electric motor arranged with a fabroil pinion on the motor spindle and a cast iron machine-cut spur wheel on the countershaft. The machine is provided with

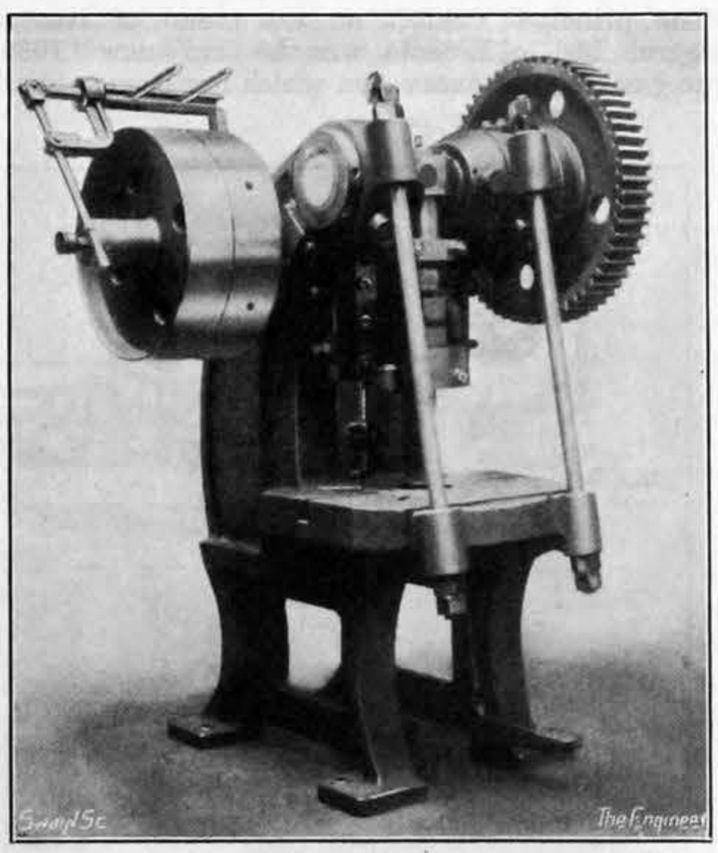


FIG. 44—POWER PRESS—BROOKES

a cam-operated hold-down for retaining the sheet in position, while it is being cut, the hold-down gate being provided with steel pins fitted with rubber buffers, which compensate for the variation in the thickness of materials being cut. There is also provided a main screw adjustment that permits the pressure of the hold-down gate being regulated.

The back gauge fittings on all the shears made by this company have now been standardised on the clamp principle, which not only gives rigidity, but also ensures that when tightening up after "setting" there is no risk of shifting the gauge as the pull is vertical and does not impose any side strains. A further point of interest in connection with this show model is the vertical adjustment to the bottom blade, in addition to the standard horizontal adjustment, which saves the necessity of packing up the blades after regrinding and permits of the bottom blade always being maintained in a position flush with the top of the table. Oil ring type bearings are employed for the countershaft, and the main bearings for the crank shaft are lubricated by sight-feed lubricators placed in a prominent position, so that they may be under easy observation of the attendant.

In view of the steady increase in the employment of welding in metal plate work, the pneumatic planishing hammer, shown in Fig. 43, which was also exhibited, is of interest. This machine has a 10 lb. head, arranged with an anvil having a long arm suitable for cylindrical work and special shapes, such as motor cycle tanks. This same anvil can also be used for flat work and work of a general nature. The hammer is provided with an air cushion and the motion is transmitted through an adjustable fulcrumed rod which allows the length of the stroke, and consequently the power of the blow, to be regulated while the machine is running.

The third exhibit, which we illustrate in Fig. 44, was a standard open-fronted geared power press. It is fitted with an all-steel connecting-rod with a double screw adjustment, and is bushed with gunmetal. The bearings are unusually substantial, and give support to the crank shaft right up near the crank. The clutch is of the roller key type, and has an operating mechanism suitable for "non-repeat" and "repeat" strokes. This type of machine is built in four sizes.

WALTER FROST.

The most novel machine on the stand of Walter Frost, Crawford-street, Rochdale, was the angle iron bending machine, illustrated in Fig. 45. It is unusual in that it has four sets of rolls. The two outside sets, in the lower tier, are idlers and act as guides to keep the angle straight. The two centre

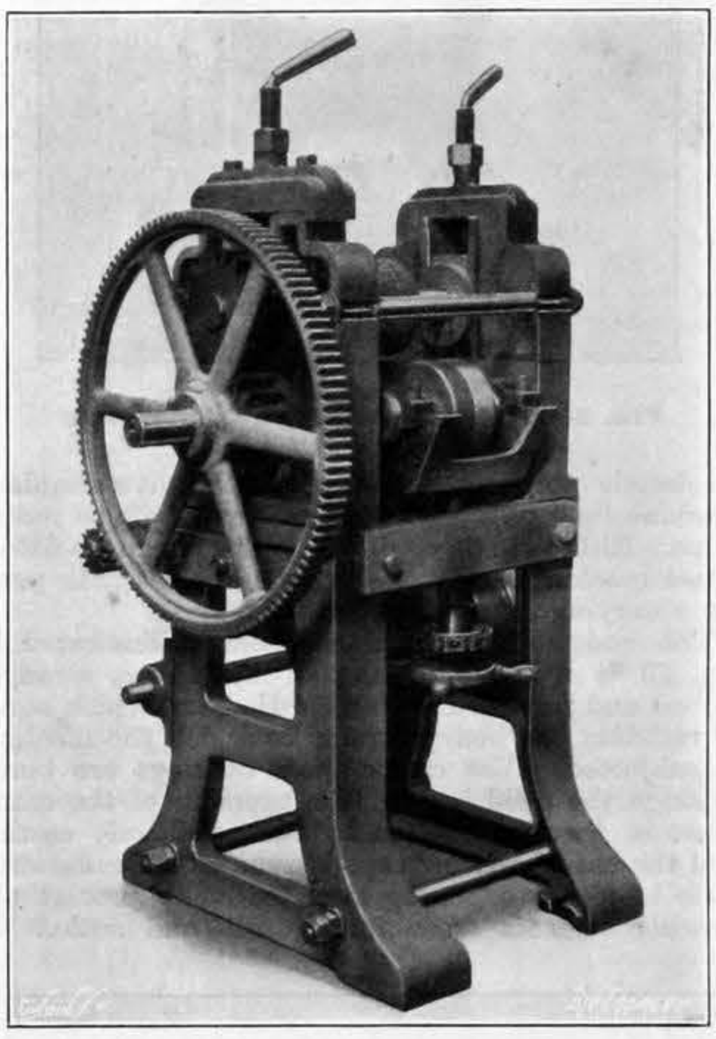


FIG. 45—ANGLE IRON BENDING MACHINE—FROST

rolls are driven by the gearing shown and act to bend the angle. The degree of bending is, of course, dependent on the relative height of the rolls, which is varied by a hand wheel and screw gears coupled together by a chain and sprockets. The rolls are made in halves, axially, so as to provide accommodation for the flange of the angle being bent, and an adjustment is provided to meet various thicknesses of flange. In the event of a complete circle being bent, the housing of the top roll can be dismantled to release the ring. The machine will bend angles up to 2½in. by 2½in. There were several other machines on this stand, such as benders for sheet metal, rolls and riveting machines.

T. S. HARRISON AND SONS, LTD.

There were several machine tools on the stand of T. S. Harrison and Sons, Ltd., of Heckmondwike, including the lathe illustrated by Fig. 64, page 268, and the wet grinding machine shown in Fig. 66.

The lathe is of 5½in. centres and has a box section bed with a removable gap piece. It is 5ft. long and will admit work pieces 31½in. long between the centres. The width across the face of the bed is 7⅝in. The gap is deep enough to swing 18in., and 7½in. diameter can be taken over the saddle. The mandrel is bored 1in. clear in diameter and is bushed at the nose to carry a No. 3 Morse taper centre. The loose headstock has a cross adjustment, by means of a screw, for taper turning. On the saddle the sliding and surfacing motions are driven independently of the screw-cutting feed from the lead screw, and no two motions can be engaged together. There is a positive feed gear-box, giving three speeds for the sliding, surfacing and screw-cutting motions. The lead screw acts in conjunction with a double nut

in the apron and is held at one end only, while the other end runs in a floating bearing, so that temperature changes do not affect its running.

The grinder, shown in Fig. 66, is chiefly noteworthy on account of the arrangements made for cooling the wheel and the work. The base of the machine is utilised as a water tank and into it the wheel dips. Within this tank there is a large float, which may be depressed by the treadle shown. The depression of the treadle naturally raises the level of the water surface and wets the wheel, but so soon as the workman leaves the machine, the water recedes and the wheel cannot be left with one side immersed and the other side dry. Adjustments are provided for following up the wear of the wheel. This machine is made in two sizes, with wheels 14in. in diameter by 2in. and 20in. by 3in.

A novel feature on this stand was an arrangement of starting handle for motor car engines, which embodies a throw-out gear that prevents any shock on the handle should the engine back-fire. The action is effected by means of a steep-pitch screw thread and a dog clutch between the handle and the crank shaft.

THE MIDLAND SAW AND TOOL COMPANY, LTD.

The universal woodworking machine which was exhibited by the Midland Saw and Tool Company, Ltd., of Summer-lane, Birmingham, is so familiar to our readers in general principle that there is no necessity to enlarge upon it here, but it may be pointed out that several minor refinements in its arrangement have been recently introduced. It is capable of planing, thicknessing, boring, tenoning, moulding, and may be used as a plain saw bench, while a new fitment provides for dovetailing work.

One of the more interesting machines on this

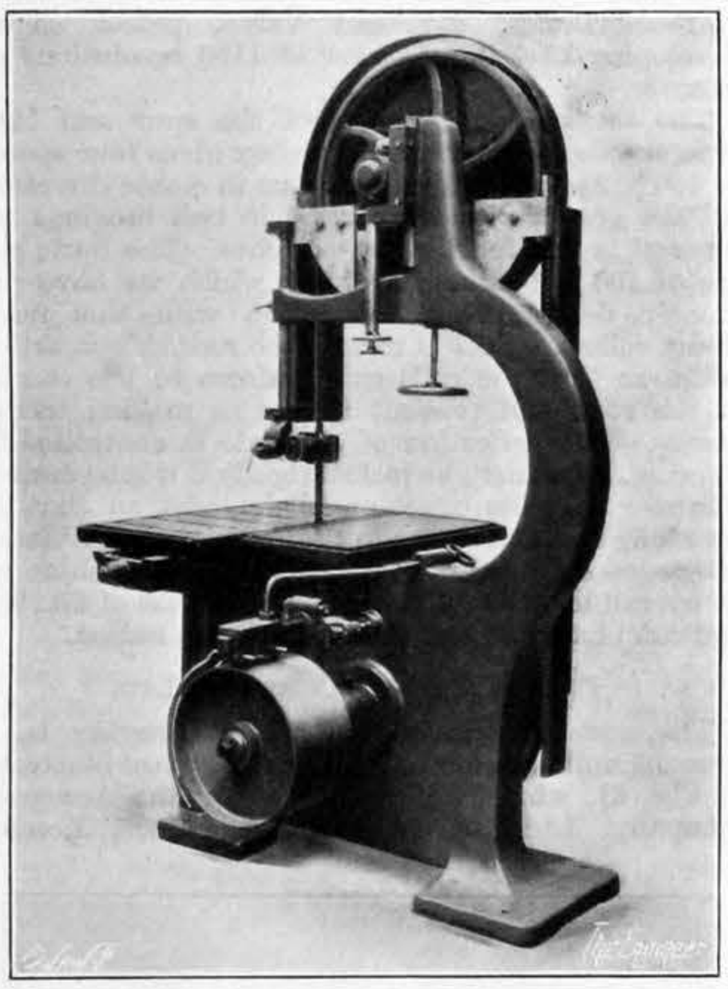


FIG. 46—BAND SAW FOR METALS—MIDLAND

stand was, however, the band saw, illustrated in Fig. 46, which has been produced specially for cutting off non-ferrous metals, such as aluminium. It was remarked by the representative of the firm, on the occasion of our visit to the stand, that, hitherto, there have been band saws for cutting wood and others for cutting steel, and that each was quite specialised in its sphere. In this we quite agree, but that the band saw is very adaptable we have experienced, in that once, in an emergency, we cut up a large amount of hard steel plate in the pattern shop on a band saw and the machine went back to its normal service on wood without any apparent detriment. It thus appears that the band saw should be applicable to the sawing of a great variety of materials, and the Midland Company has devoted attention itself to its application in the sawing of soft metals. At the Fair, the machine was only just out of "the shops," and no final decision as to the style of the tooth had been arrived at; but we inferred that a tooth swaged to give clearance was favoured, rather than one set as for wood cutting. It was also noticeable that in all the styles of saw there is a very sharp cutting angle.

In general design, the machine closely resembles an orthodox wood band saw, but it is provided with a pump for supplying a coolant to the cut. The pulleys are rubber-covered and the lower one is protected with a guard, which prevents the swarf from the cut from piling up on the wheel and spoiling the running of the saw. The top pulley is mounted in bearings, which can be canted while the machine is running to get the saw properly tracked. The guide for the saw blade is made of lignum vitæ, as the makers consider that, at the high speed at which the saw works, steel guides are not suitable. The guide is so arranged that it can be turned round to a new surface as it wears. There are also two pads of lignum vitæ, which are adjustable to suit various widths of saw, so as to make it possible to support a very wide saw close up to the teeth.

The machine has pulleys 30in. in diameter, and a saw 17ft. 6in. long, with a maximum depth of cut under the saw guide of 17in. Its capacity may be gauged from the fact that a 4in. diameter bar of aluminium alloy can be parted in 15 seconds, with a straight clean cut.

CLIFTON AND BAIRD, LTD.

One of the principal exhibits on the stand of Clifton and Baird, Ltd., of Johnstone, was a heavy duty cold

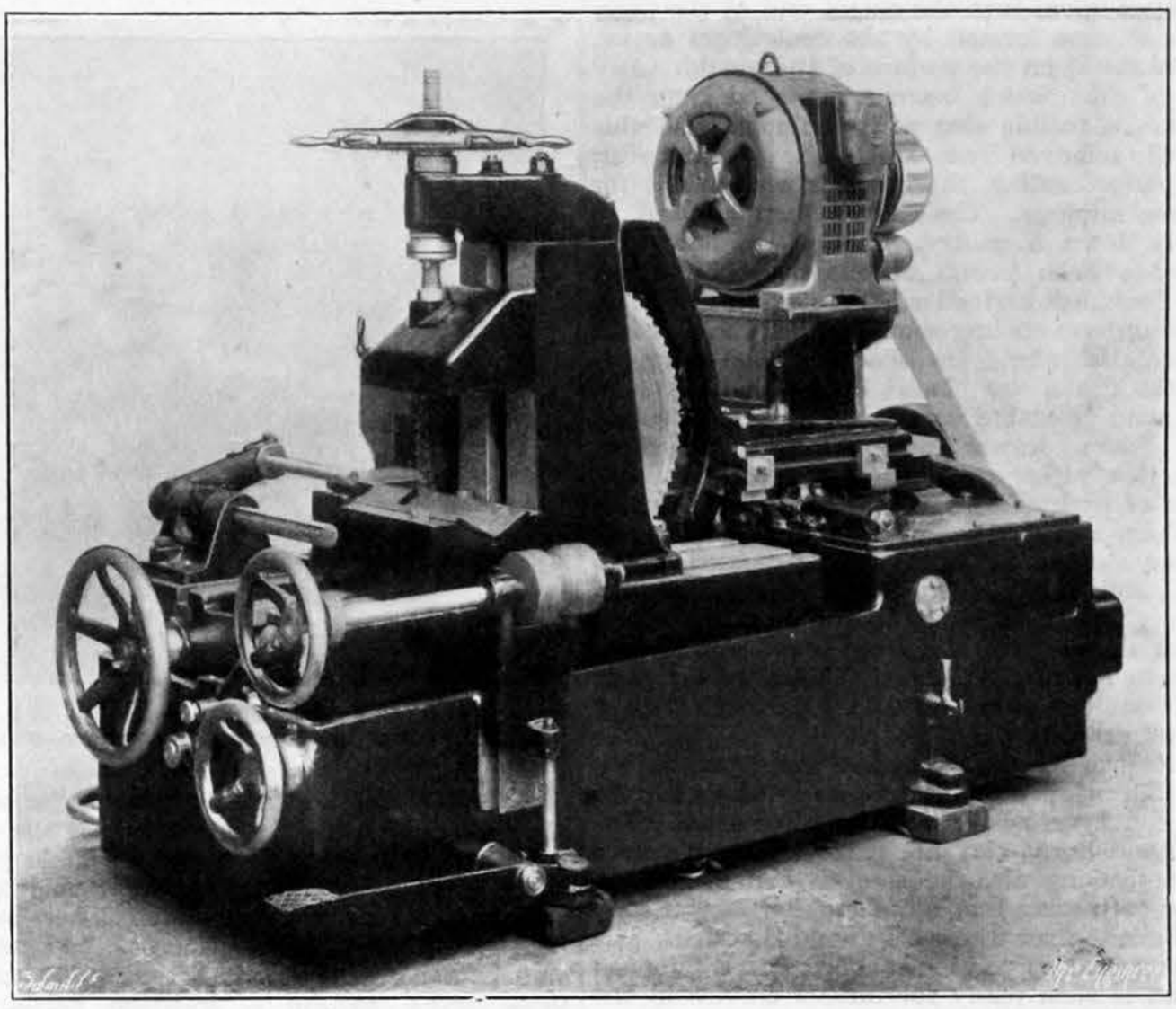


FIG. 47—HIGH-SPEED COLD SAWING MACHINE—CLIFTON AND BAIRD

sawing machine with a 26in. diameter saw. As will be seen from Fig. 47, the machine is substantially proportioned throughout with large sliding and bearing surfaces. The work table is made integral with the bed and carries tee slots for holding the vice, vee blocks, and measuring stop. There are four cutting speeds from 40ft. to 90ft. per minute, and the automatic feed has five changes with an automatic quick-return motion on completion of the cut. The

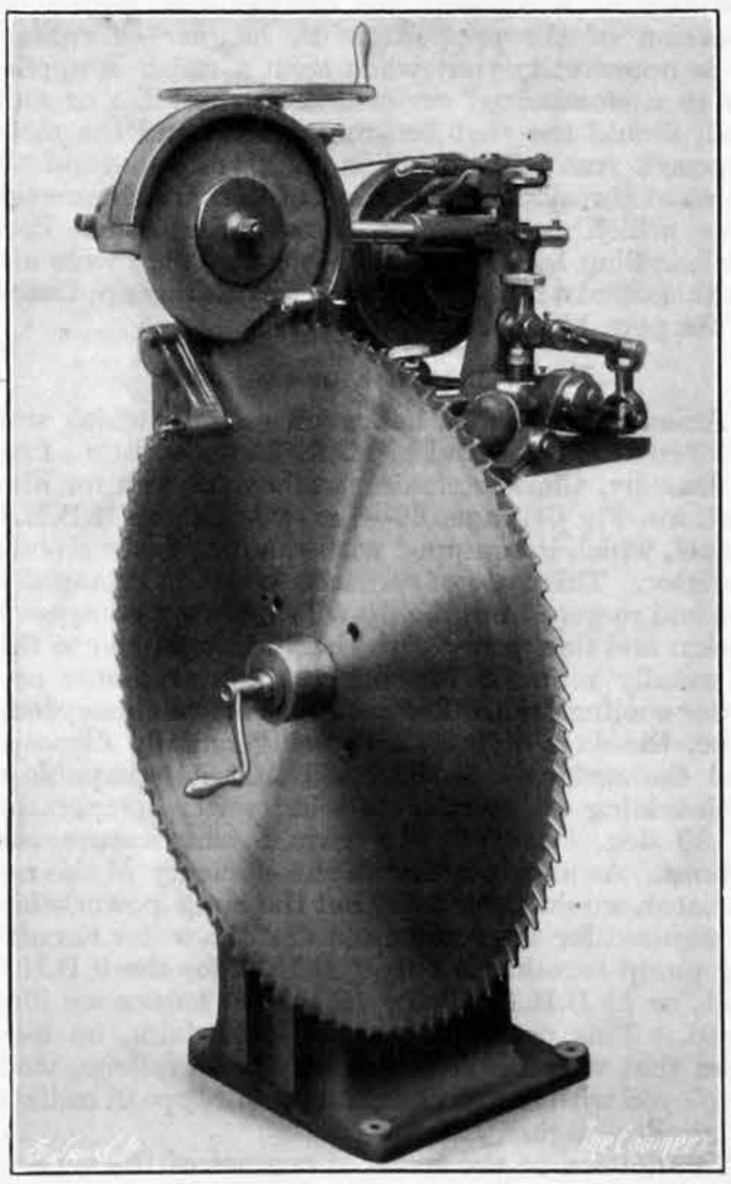


FIG. 48—SAW-SHARPENING MACHINE—CLIFTON

saw spindle, which is made of high-carbon steel, is driven by worm and double helical gearing, all the gears being totally enclosed and running in an oil bath. The controls are conveniently grouped together at the front or working position.

The vice has been designed to be exceptionally powerful and the hand wheel is arranged to give a hammer blow so that the proper grip is easily obtained without serious effort on the part of the operator. The saw blade is of Firth's latest segmental type, and a copious supply of cutting liquid is delivered by a rotary belt-driven pump to the blade being driven from the tank formed in the bed. The machine illustrated is belt driven by a 9 H.P. motor with a jockey pulley tensioning device, but can also be arranged for motor drive. Another machine shown on this stand was the saw sharpener which was exhibited in operation and is illustrated by Fig. 48. It has been specially designed to sharpen correctly the latest form of high-production saws. The correct cutting angle, large radius at the root of the teeth and the curved back, which gives the strongest form of tooth, are all automatically obtained, while the bevelling of the alternate teeth and the topping are also easily derived. As shown, all the control handles are placed within easy reach of the operator, who stands at the front of the machine, and the various motions can be changed while the machine is running. The saw is carried on a compound slide with a vertical and a transverse motion in order to suit different diameters and to keep the angles required. The spindle which carries the grinding wheel runs in ball bearings and, as is shown, the machine is arranged for a direct belt drive.

THE STAVELEY IRON AND COAL COMPANY, LTD.

It is some time since we have seen the Staveley Company, of Chesterfield, at the Fair, but this year it showed a rather interesting form of cast iron piping made by the centrifugal process.

The noteworthy feature about this process, which is only just about to be put to the test of commercial production, is that the mould is lined with sand, so that any immediate chilling of the metal, as it is cast, is avoided, and no subsequent annealing of the pipe is necessary. The result is that a casting of the quality associated with the "pot," from which piston rings are commonly cut, is produced, and a corresponding improvement in the pipe has been effected.

It may be that the old-fashioned cast iron pipes were effective for their service, but the system of casting them vertically obviously leads to a differentiation in the qualities of the metal from end to end of the pipe. By the process of centrifugal casting, however, the pipe may be produced with practically uniform characteristics throughout—a fact which we verified by means of a pipe that had been cut into a long helix. This helix was fully flexible longitudinally, but also it was noticeable that on torsional stress the several turns took up corresponding positions.

The process of manufacture of these pipes is briefly as follows:—The sand moulds are made in flasks by jolting the sand with the flask in a vertical position, the sand being fed in gradually from revolving sand bins. In this process a special sand is necessary, and it is kept blended by means of two types of mixers working in conjunction with each other, samples being taken at intervals for testing purposes. After the mould has been formed, liquid blacking is applied to the inner surface by means of a dish, which allows the blacking to flow evenly down the inside of the mould. This operation allows of easy stripping of the pipe from the sand after cooling. The spigot end of the pipe is formed by means of a plate containing a cake of refractory material, which prevents any chilling on the extreme end of the pipe. After fixing this plate in position, the mould is dried by blowing a gas flame alternately through each end. The mould

is then transferred to the spinning machine and the socket core placed in position. The mould is now ready for the casting operation. The molten iron is distributed by means of 3-ton ladles, being poured from them preparatory to casting into small tilting ladles, the quantity for each pipe being weighed by a machine, thus ensuring a uniform weight being maintained for each pipe. The temperature of the molten iron used is about 1350 deg. Cent., and an observation of the temperature of each cast is made by means of an optical pyrometer.

Immediately after transferring the iron to the tilting ladle, a very small quantity of dry soda is placed on the molten metal. The flask is then revolved and when a maximum speed is attained the iron passes down a short spout into the spigot end of the pipe. A pipe is at once formed by the centrifugal action forcing the metal on the surface of the mould. Any particles of dust which become detached from the mould form a fusible slag with the soda, and this slag is easily removed by a scrubbing apparatus after cooling. After casting, the speed is maintained for about three minutes. The flask is then allowed to roll slowly down a gantry. Cooling is allowed to take place over a period of one hour, by which time the flask has arrived at the stripping station. This slow uniform cooling should render the pipe free from internal strains. On arrival at the stripping station, the flasks are placed in an air-tight box, and the sand liberated by means of a compressed air pipe. Passing forward on to a table arranged for stripping, the pipes are pushed out of the flasks by means of hydraulic rams on to carriages, which convey them to the finishing gantries. Each pipe, after being cleaned, is inspected and passed on for weighing, and then on to the testing apparatus. There every pipe is subjected to a hydrostatic test of 600 lb. per square inch, and when found satisfactory passes on to the dipping plant. The pipes are next preheated in horizontal stoves and coated with a bituminous coating.

It is noteworthy that the used sand falls into a receiving bin below ground level, and, being fed into a shaker conveyor, passes into a cooling drum. The find dust and burnt clay are extracted by a gentle current of cooling air, the sand is conveyed to a screen for extracting lumps and foreign matter, and enters a Smith mixer where clay bond is added. The sand is tempered by passing forward into a Simpson mixer, and is then ready for further service in the plant, being distributed by conveyors and elevators.

Jackson and Hunt.

There were on the stand of Jackson and Hunt, 30, Paradise-street, Birmingham, several machine tools, including a bar straightening machine, by Oldfield and Schofield, Ltd., Halifax; a new capstan lathe, by the Stanley Machine Tool Company, Ltd., Halifax; the Planitor grinding machine, illustrated in Fig. 49, made by the exhibitors, and some small grinding and linishing machinery.

The Planitor grinding machine is intended for such services as grinding the faces of flat irons or other

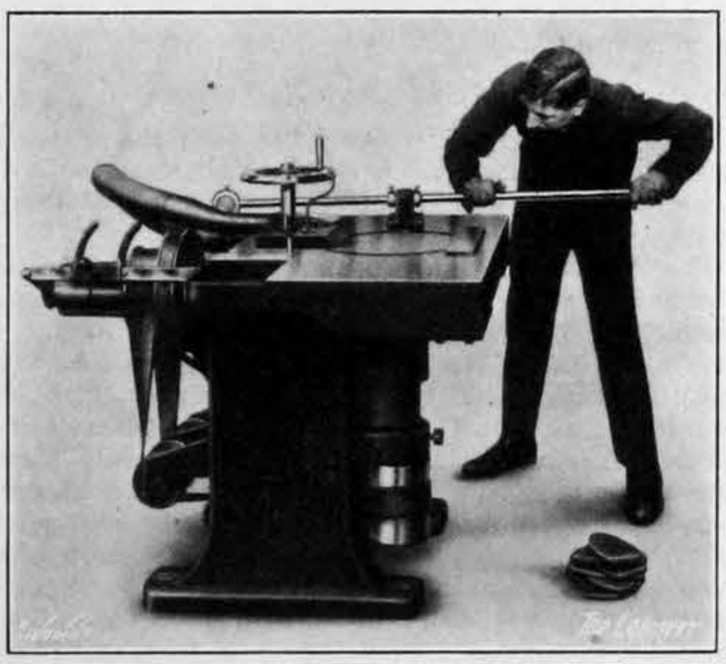


FIG. 49—SURFACE GRINDER—JACKSON AND HUNT

pieces with a plain flat surface, and is guaranteed to produce a flat within one-thousandth of an inch, while it will remove metal remarkably quickly. As will be seen from the illustration Fig. 49, there is a flat table, through an annular slot in which the edge of a cup grinding wheel protrudes, the wheel being mounted on a vertical spindle. The work-piece is passed back and forth across the edge of the wheel with the aid of the lever and cramp shown, but in the case of awkward shaped pieces, which would be difficult to clamp, it may be pushed across directly by hand against the edge of a fence. The depth of the cut is determined by the height of the spindle, which is regulated by the horizontal hand wheel. This wheel is graduated in thousandths of an inch, and by means of a screw raises or lowers the spindle housing in slides. There is an angular adjustment of the housing in the slides, so that the spindle can be tilted to give the wheel a leading edge. The spindle runs in dust-proof ball bearings.

In the illustration we give it will be seen that the spindle is driven from a countershaft by a belt running over guide pulleys, but that one actually shown at the Fair had a self-contained vertical motor at the back and a simple belt drive. The motor also drives an exhauster fan for taking away the dust, which may be collected in any convenient manner. The machine is made in three sizes with wheels 12in., 16in., and 24in. in diameter.

The Pyrene Company, Ltd.

There was a demonstration of a new process for rust-proofing iron and steel on the stand of the Pyrene Company, Ltd., Brentford, Middlesex, which is illustrated in Fig. 50.

In this process the articles to be protected are immersed in a bath of boiling water and "Parco"

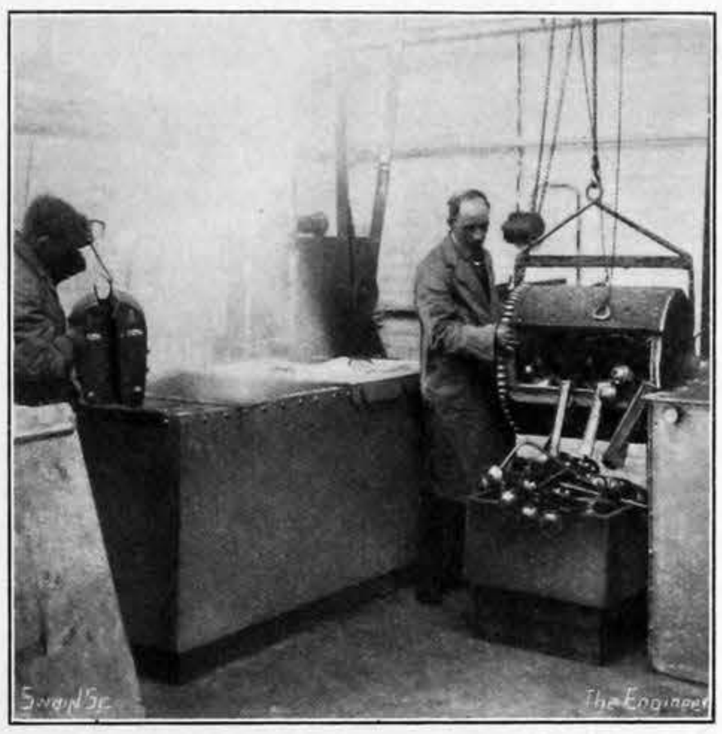


FIG. 50—RUST-PROOFING PLANT—PYRENE

powder—the constituents of this powder are, naturally, not divulged. The result is that the surface of the metal is converted into an insoluble phosphate, which is said to be impervious to moisture under ordinary atmospheric conditions. There is no practical increase in the dimensions of the parts treated, and, as a consequence, it is eminently suitable for those which require a precision finish. Neither does the process affect the temper, the magnetic or physical properties of the metal treated. Paint, or enamel, can be readily applied over the Parkerized surface.

In another process of the company, that of Bonderizing, a chemical primer is used only as a base for paint, lacquer or enamel. In this case, as in Parkerizing, a low-temperature bath is necessary, which is made up of "Bonderite" powder and boiling water. By a short immersion of 8 to 10 minutes, the surface of iron and steel parts is converted to practically a non-metallic coating. This coating is opaque and, while being perfectly smooth to the touch, is sufficiently absorbent to ensure the permanent cohesion of the applied paint, lacquer or enamel. It is noteworthy that when such a finish is applied on to a Bonderized surface, it will not lift or flake and, should the part become abrased and the metal exposed, rust will not, it is said, creep beyond the point of abrasion. On account of the short immersion time which is necessary, Bonderizing lends itself for handling by conveyor methods. There were also on this stand a number of fire-extinguishing appliances of the portable and fixed types.

R. A. Lister and Co., Ltd.

Among the various heavy oil engines which were exhibited on the stand of R. A. Lister and Co., Ltd., of Dursley, Gloucestershire, we have chosen for illustration—Fig. 61, page 268—the two-cylinder 18 B.H.P. model, which is equipped with the firm's new circular radiator. This type of radiator, which is arranged at the end remote from the fly-wheel, is very compact in design and does away with the additional height that is usually required for a rectangular radiator or a water cooling tank. The radiator is of the honeycomb type, the axes of the tubes being radially disposed, and the surface is so designed that it is capable of maintaining an even circulating water temperature of 80 deg. Cent., under normal temperature conditions. As an indication of the efficiency of the new radiator, we may mention that the horse-power which is required for the cooling fan and the water circulating pump together is only $\frac{3}{4}$ B.H.P. for the 9 B.H.P. unit, or $1\frac{1}{2}$ B.H.P. on the 18 B.H.P. engine we illustrate. This power is, the makers claim, no more than that which is absorbed by the fan alone, when employed with the ordinary motor car type of radiator at similar engine ratings.

In addition to the series of engines of the type we have just described, a $6\frac{1}{2}$ B.H.P. hopper-cooled engine for contractors' service was shown; also two Lister pumps, a horizontal pump electrically driven, and a deep-well pump. The horizontal pump was designed for suction lifts up to 25 lb. and heads up to 375ft.

Another group of exhibits illustrated the Lister-Light fully automatic installations operating with heavy oil engines, which are now manufactured in sizes of 2·5, 4·5, 10, 15, and 20 kW. The example on view included a 4·5-kW plant and a 1-kW petrol engine driven lighting plant, complete with dynamo, generator, switchboard, and radiator. Many improvements have been embodied in the Lister "Rail-truck," a view of which is reproduced in Fig. 62, page 268, and several auto-trucks were also shown at Birmingham. These included two new 2-ton models. One of these had an elevating platform suited for working in conjunction with stillages and 17in. diameter rear wheels, giving more even running on uneven surfaces. To suit individual local conditions, power units with gear ratios varying from 15 to 1 to 37 to 1 can be supplied. The truck can be fitted with either $3\frac{1}{2}$in. or $5\frac{1}{2}$in. lift platforms, with solid rear axle suspension, and with the $5\frac{1}{2}$in. lift the rear axle may be sprung if desired.

The lifting gear consists of two heavy angle bars attached to the underside of the chequered steel plate platform, and running parallel to and inside the chassis, with which they are level when lowered. These bars are carried on four hinged links attached to brackets on the underside of the chassis. Power for elevating the platform is supplied by a hydraulic pump and twin jacks, situated in the fore part of the chassis.

A truck fitted with 10in. rear wheels, designed to draw a load of 1 ton up a gradient of 1 in 14, was also exhibited, also a special truck designed for milk delivery. The trucks we have referred to can be supplied for rail gauges of 16in. to 24in., and although most of the power units are petrol engines, heavy oil engines of the Lister type can be fitted if so desired.

Wallis and Steevens, Ltd.

The outstanding exhibit of Wallis and Steevens, Ltd., Basingstoke, was one of the company's lightweight motor rollers, as illustrated by Fig. 63, page 268. It has a weight of 2 tons, but this may be increased to 4 tons by fitting extra heavy rolls. It is driven by a four-cylinder, overhead valve, petrol engine, developing 13·5 horse-power at 1150 revolutions per minute.

The transmission gear is of the spur and bevel type throughout, and the gear-box gives four speeds, of 1, $1\frac{5}{8}$, $2\frac{1}{2}$ and 4 miles per hour in either direction. All the gear shafts are carried in ball bearings and reversal is effected by dog clutches. The back rolls are of the self-cambering type, which we have previously described in connection with this firm's steam rollers. That is to say, the rear axle is articulated, so that the rolls can conform to the camber of the road and prevent the edges making terrace marks. The deflection of the axle is controlled by a spring, but it may be locked rigidly if it is so desired. The rear rolls are offset on their hubs, so that by reversing them, as shown in the end view, two different widths of rolling can be obtained. The machine has an overall length of 9ft. 4in., a wheel base of 5ft. 9in., and can be turned in a circle of 8ft. 6in. radius.

The Aerograph Company, Ltd.

The general principle of paint spraying is, of course, familiar to our readers, but the plant illustrated in Fig. 51, which was exhibited by the Aerograph Company, Ltd., of 43, Holborn-viaduct, London,

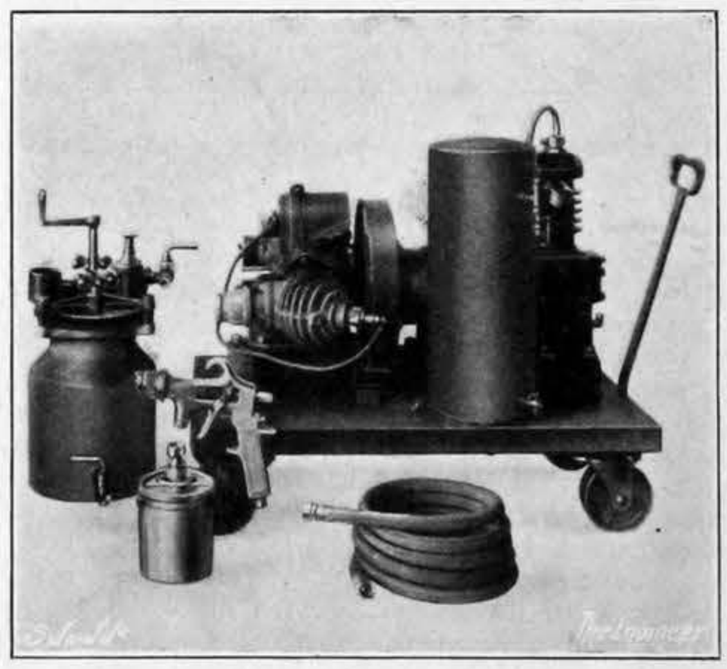


FIG. 51—PORTABLE PAINT SPRAYER—AEROGRAPH

E.C. 1, is noteworthy on account of its compactness and portability.

The machine which we illustrate is intended for medium-sized jobs, where as much as a gallon of paint may be used at one time, and is of the type in which the paint is held in a stationary container on the ground, fitted with a stirrer, so that the paint may be kept of the proper consistency. This container is subject to air pressure from a little compressing set, which forces the paint up to the spraying "gun." There it is met by another supply of compressed air, which atomises the paint and projects it on to the surface to be painted. It will thus be seen that the operator has to handle two flexible pipes connected with the gun. Should, however, only a small amount of paint be required for a job, a 1 point container can be attached directly to the gun and then only one pipe connection is necessary. The compressor is of the vertical, single-acting type, and is driven by a $\frac{3}{4}$ H.P., two-stroke Amanco petrol

engine. Alternatively, an electric motor can be used. There is, of course, an air receiver with the proper fittings.

ASHWELL AND NESBIT, LTD.

The rotary pump, of which we give a sectional view in Fig. 52, was exhibited by Ashwell and Nesbit, Ltd., of Barkby-lane, Leicester.

The peculiarity of this pump, which, it will be seen, is of the orthodox excentric multivane type, is that the vanes are restricted in their centrifugal action, so that they cannot bear too harshly on the casing, and thus increase wear. The vanes are each provided with a central boss, as shown in the drawing, which is bored through and is threaded on to a shaft. The

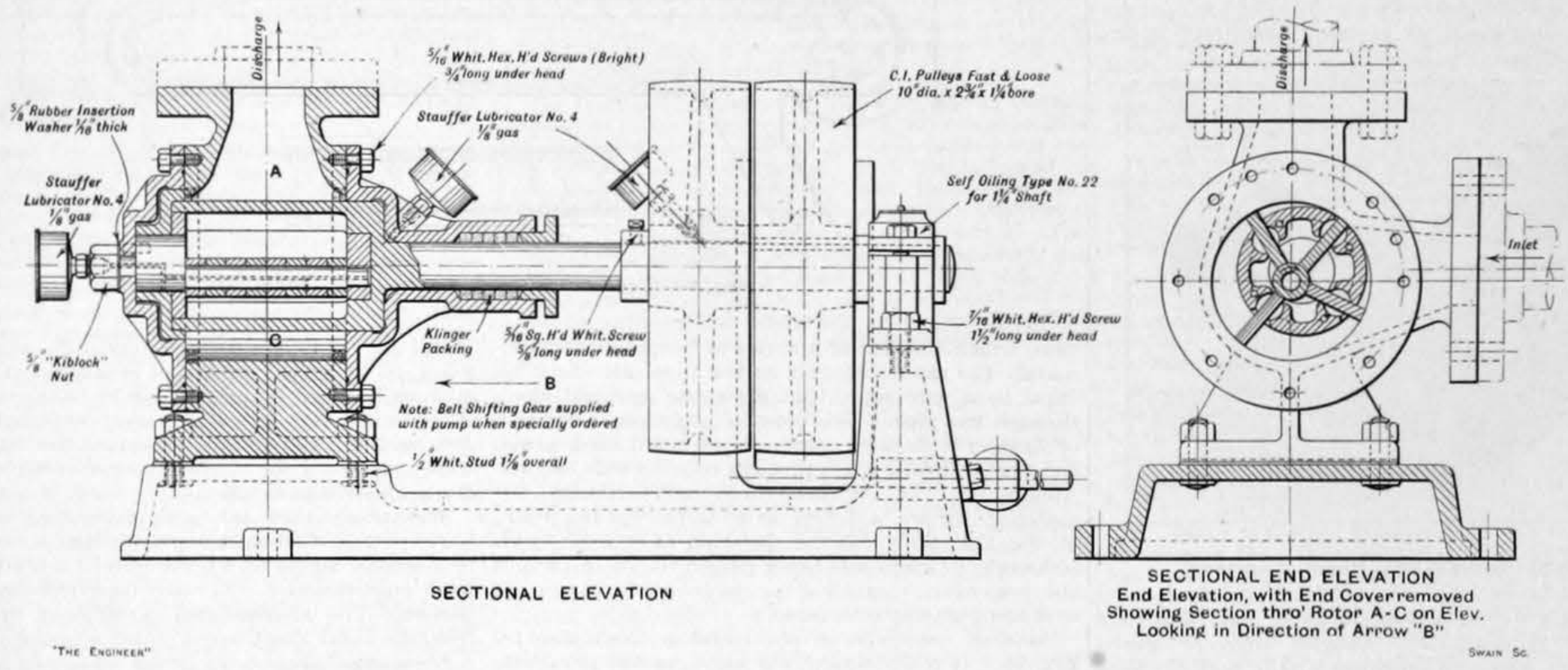


FIG. 52—ROTARY PUMP—ASHWELL AND NESBIT

result is that the vanes cannot fly out beyond a predetermined limit, and their edges may be made just so close to the circumference of the chamber that they will pump effectively without rubbing contact. The drive to the vanes is transmitted through a spider which is fitted with cylindrical guides to accommodate their angular movement.

Apart from the merit of absence of end wear on the blades, the arrangement avoids the necessity for bars across the inlet and outlet ports to carry the blades across those openings.

THE BRITISH OXYGEN COMPANY, LTD.

It is probably common knowledge among our readers that the British Oxygen Company and Allen-Liversidge, Ltd., have joined company, so they had a combined exhibit at the Fair. In Figs. 53 and 65, page 268, we illustrate two of the oxy-acetylene machines on the stand.

The first of these machines is a 55in. universal

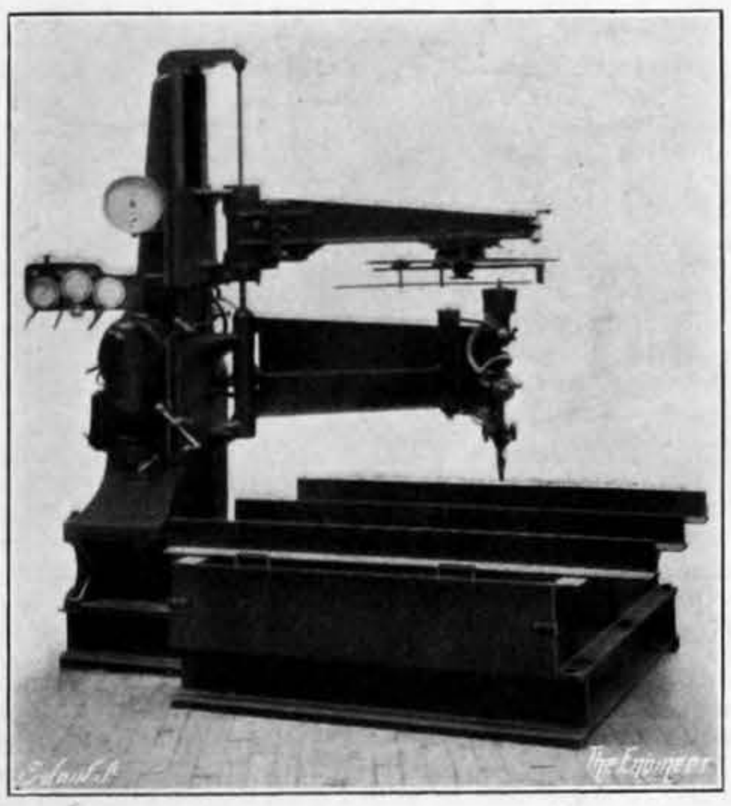


FIG. 53—OXYGEN CUTTING MACHINE—BRIT. OXYGEN

oxygen cutting machine of the general type, which has already been described in our columns, and, consequently, need not be enlarged upon here. It is of the type in which a magnetically controlled pointer runs round an iron template, to guide the cutting blow-pipe to the desired form, or, alternatively, the blow-pipe can be actuated mechanically to make geometric forms. This machine will cut through steel plates up to 15in. thick, and leaves a surface that, for many purposes, needs no subsequent machining.

There was also the handy little portable cutting machine shown in Fig. 65. As will be seen, it is intended for clamping on to such a member as an I-joist for cutting off at any position, or angle, and is actuated by a hand feed. Arrangements are provided for fixing the machine on a wide variety of rolled shapes.

There were also on this stand a new type of trolley welding plant, specially designed for manœuvring in confined spaces, a big torch, or blow-pipe, using acetylene as fuel, for heating up pieces of metal prior to bending and some flare-lights supplied by bottles of dissolved acetylene.

TECALEMIT, LTD.

Various forms of lubricating systems were exhibited by Tecalemit, Ltd., of Mitre House, Scrubbs-lane, Willesden, N.W. 10, and among them we have chosen for illustration that represented by the drawing Fig 54, which is intended for the lubrication of industrial machinery from a central point, without it being necessary to have recourse to ladders or galleries to get access to the various bearings.

The device, it will be seen, comprises a series of pump plungers, which are " drowned " in a container of lubricant. Each of the plungers has a separate delivery and may be used to supply oil to from eight to ten separate points. Thus with five plungers, the maximum generally considered advisable, some

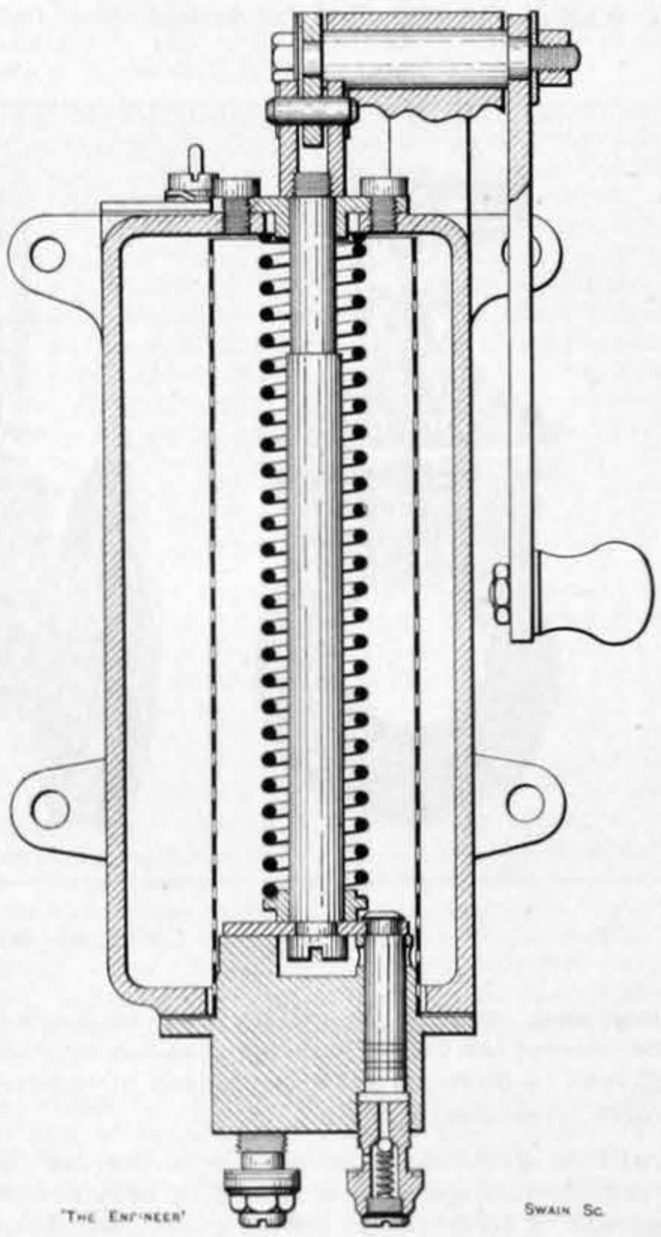


FIG. 54—LUBRICATING SYSTEM—TECALEMIT

fifty bearings can be supplied. The plungers are attached to a common plate at the bottom of an operating rod, which passes through a guide in the head of the container, and is connected by a steel jaw with a short lever. By lifting the hand lever the operating rod is lifted against the pressure of a spring to the limit afforded by the shoulder on the rod. With the plungers withdrawn from the pump chamber, oil passes in by way of holes drilled in the head of the pump body, after having passed through a fine mesh filter which surrounds the main rod and spring. When the handle is released, oil is forced into outlet adaptors against spring-loaded ball valves, and thence to the distributing pipes. The advantage of this system is that, though the five pumps are entirely self contained and distribute oil independently of each other, they are actuated by the same lever simultaneously, and at the same pressure.

In order to restrict the supply of oil to those bearings which do not need much lubrication, a small plug is fitted in a union in the supply pipe. This plug holds in place a wire gauze filter, and has a screw groove cut on its exterior for the passage of the oil. The amount of restriction in the supply of oil is varied by increasing or decreasing the length of the plug, and consequently the length of the passage, thus governing the amount of oil which can pass through in a given time.

The advantages of this system of regulating the flow of lubricant are apparent when it is considered that the result is obtained by varying the length of the passage, which is of comparatively large cross-sectional area, instead of varying the cross-sectional area and thus increasing the risk of blockage.

MULTIPURPOSE MACHINES, LTD.

A very handy little machine, which was exhibited by Multipurpose Machines, Ltd., of 85, New Bond-street, London, W., is illustrated in Fig. 55. It has, it will be seen, the general characteristics of a hack-sawing machine, but can be used for a variety of operations. It comprises a saw bow reciprocated by a crank and pitman above a work-holding saddle on a circular bed. This saddle has four faces, any one

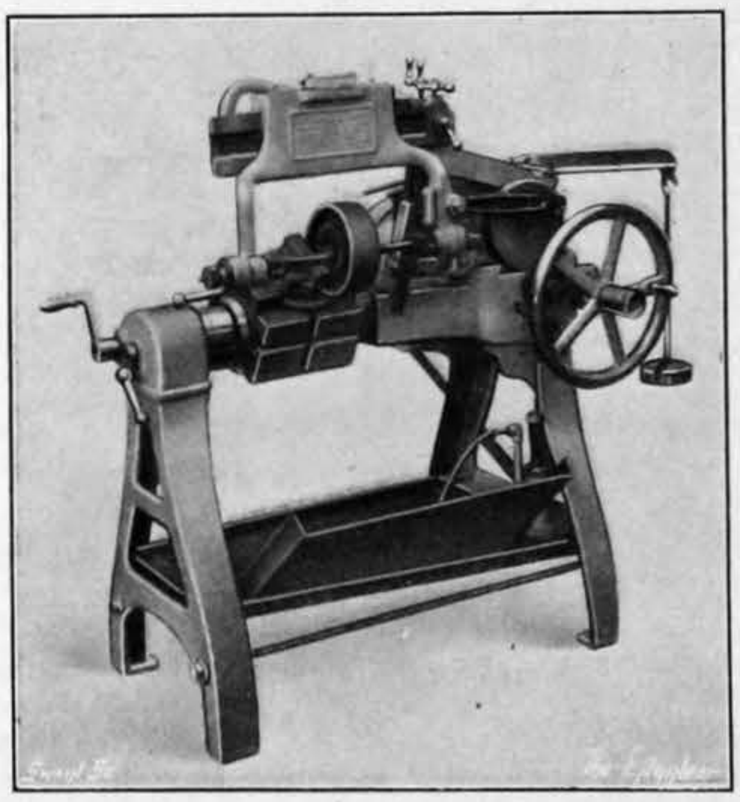


FIG. 55—SAWING, FILING, ETC., MACHINE—MULTIPURPOSE

of which can be brought into the operative position by rotation on the bed. These faces are equipped with various forms of gripping devices, including a vice, so that practically any form of piece can be readily gripped. The saddle can be traversed along the bed by means of a screw to bring the work into the most convenient position, and the head carrying the bow can be cross-traversed. As a consequence, stock can be sawed off in slices without it being necessary to move the piece in the vice. By substituting a file or cutter for the saw a variety of other operations can be carried out, such as slotting, shaping, and broaching.

TANGYES, LTD.

The exhibit of Tangyes, Ltd., of Cornwall Works, Birmingham, was marked by its very comprehensive character. The oil engine department was repre-

sented by several exhibits, the largest of which was a 144 B.H.P. horizontal twin-cylinder, cold-starting, heavy-oil engine, embodying the firm's special features, including variable admission oil governing, low compression pressure, and the Tangye patented super-compression starting equipment. The horizontal oil engines made by the firm are supplied in sizes varying from 5 to 230 B.H.P. in single and two-cylinder units, and from 288 to 460 B.H.P. in four-cylinder units. One of the smaller engines shown was a 38 B.H.P. single-cylinder unit, combined with a "Texrope" driven generator, forming a very neat and compact lighting set. Several examples were shown of the more recently introduced Tangye vertical oil engine for small outputs, the engines on view including units having designed outputs of $2\frac{1}{2}$, 4 and 6 B.H.P. respectively.

Among the pumps we noted a three-ram pump,

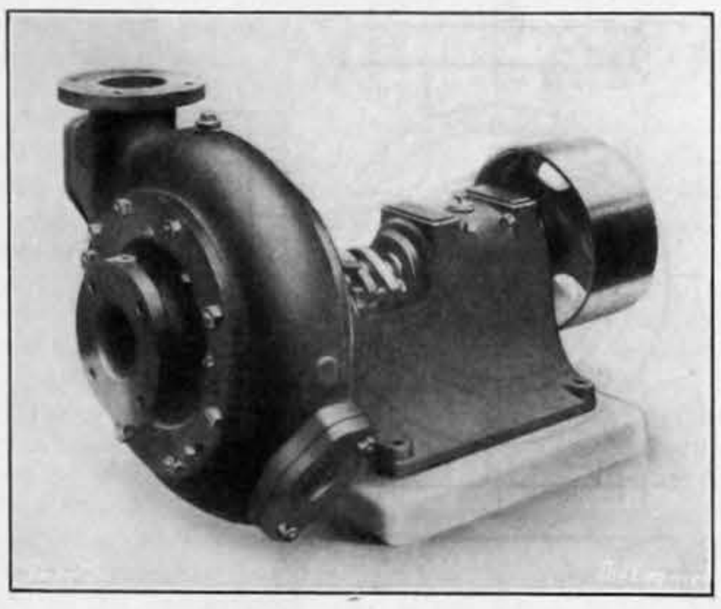


FIG. 56—CHOKELESS PUMP—TANGYES

with a bore of 5in. and a stroke of 8in., and four single-ram pumps with designed delivery heads up to 150ft. For high pressures a $2\frac{5}{8}$in. bore by $2\frac{1}{2}$in. stroke single-ram pump for 350ft. head was on view, while other exhibits in this particular section included a 5in. six-stage turbine pump and a 4in. centrifugal pump. A new type of pump recently introduced by Tangyes is the chokeless pump, shown in Fig. 56. The pump body is of the normal centrifugal overhung type, but the impeller has been specially designed to pass solids and stringy matter. The robust pedestal bearing and accessible pump glands may be noted.

An unusual exhibit was the tea roller, which we illustrate in Fig. 57. It is representative of machines supplied by Tangyes for service in Ceylon, India and China, and is designed to exert severe pressure and twisting action upon the withered tea leaf. The jacket or box containing the leaf is given a wide

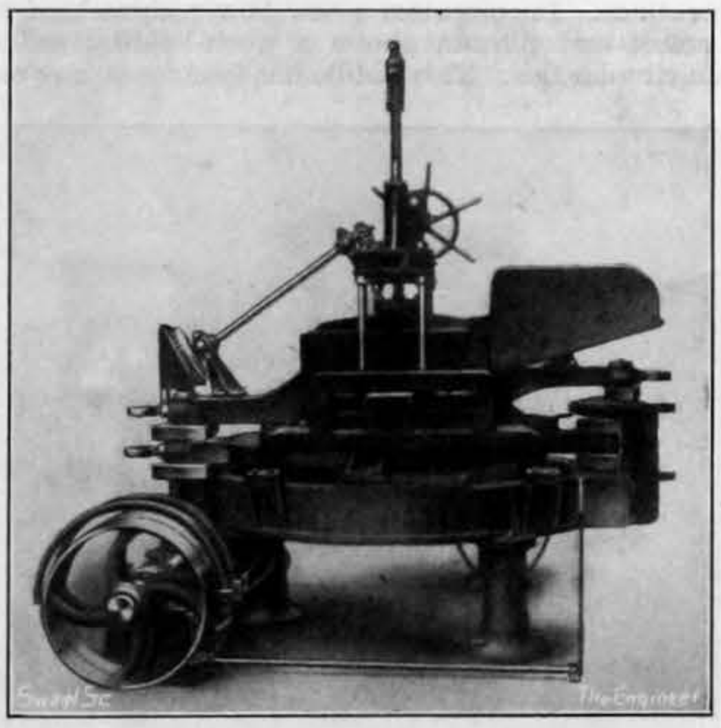


FIG. 57—TEA ROLLING MACHINE—TANGYES

sweeping action over the table, while to the table itself there is imparted a similar sweeping movement, but at a different angle to the jacket. The two movements are so designed that their interaction gives an excentric motion to the leaf, closely resembling that of the human hands when imparting a twist to tobacco leaf. The pressure lid is made to revolve at about half the speed of the table and the jacket, so that the movement of the leaf takes place while the pressure is applied. As shown, there is a hand wheel provided for adjusting the degree of pressure exerted on the leaf. Under normal tea factory conditions the withered leaf is rolled from four to six times, the hard pressure not being usually applied during the first and second rolls. The power required varies from 2 B.H.P. to 5 B.H.P., according to light and heavy rollings.

The hydraulic exhibits of the firm included a range of hydraulic jacks, the smallest having a lifting power of 2 tons and the largest a 250 tons lift. A working model of the firm's hydraulic car lift and turntable for garage use was also on view, while there were several examples of hydraulic moulding presses for moulded products, the presses being equipped with automatic draw-back gears.

REDLER PATENTS.

The principles involved in the conveying systems demonstrated by Redler Patents, of Sharpness, Glos., are not really new, but their application has been brought to a high degree of perfection.

We have, on a previous occasion, made reference to the pipe form of conveyor manufactured by this

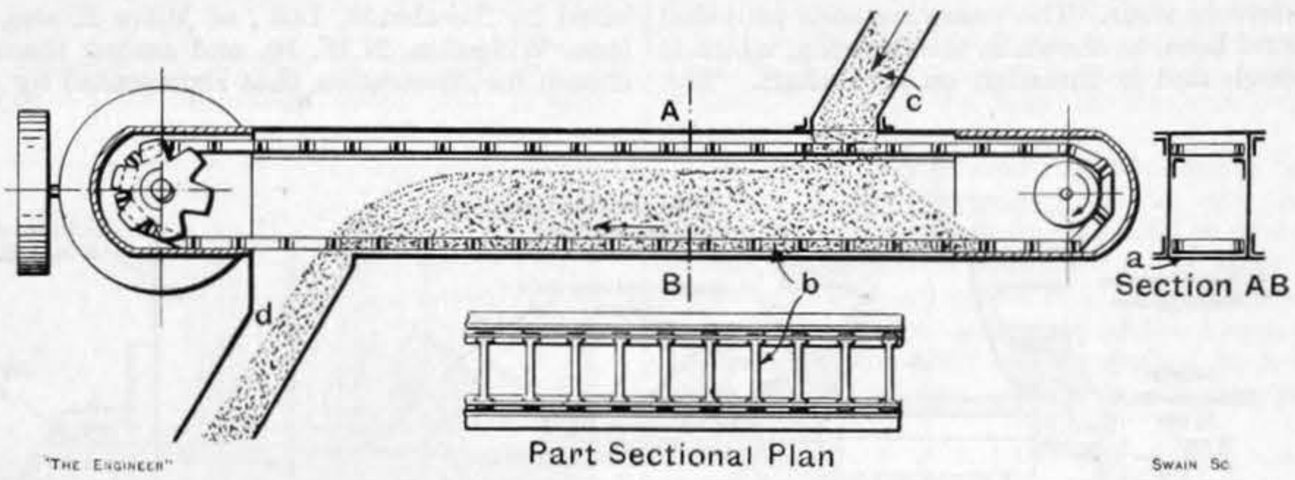


FIG. 58—CONVEYOR FOR GRAIN, ETC.—REDLER

firm, which consists of a series of hoops, of approximately the same diameter as the pipe, attached, by clips, to a wire rope, that draw the material along through the pipe. This class of conveyor is capable of dealing with such materials as small coal, grain, &c., and will raise them through considerable heights. Apparently, the conveyor does not damage the material, for we watched an example on the stand at the Fair daily for the duration of a week, and, although the grain was being passed round and round the conveyor, there was no appreciable indication of it being ground or bruised.

Another conveyor on the stand is illustrated by Fig. 58. It really acts on the same general principle, but, instead of the hoops and wire rope, relies on a broad and shallow link chain for the conveyance of the material. As will be seen, the supply can be sent into the conveyor at the top, at any point along its length, through the meshes of the chain, and can be discharged further on at any point, through the bottom of the trough. On this stand there was also an elevator, working on the same principle, capable of raising 300 tons an hour, through which, although it was full when in operation, two men could climb when it was stationary.

GEORGE WALKER AND SON, LTD.

An ingenious form of gate valve was exhibited by G. Walker and Son, Ltd., of Stroud, Glos., which

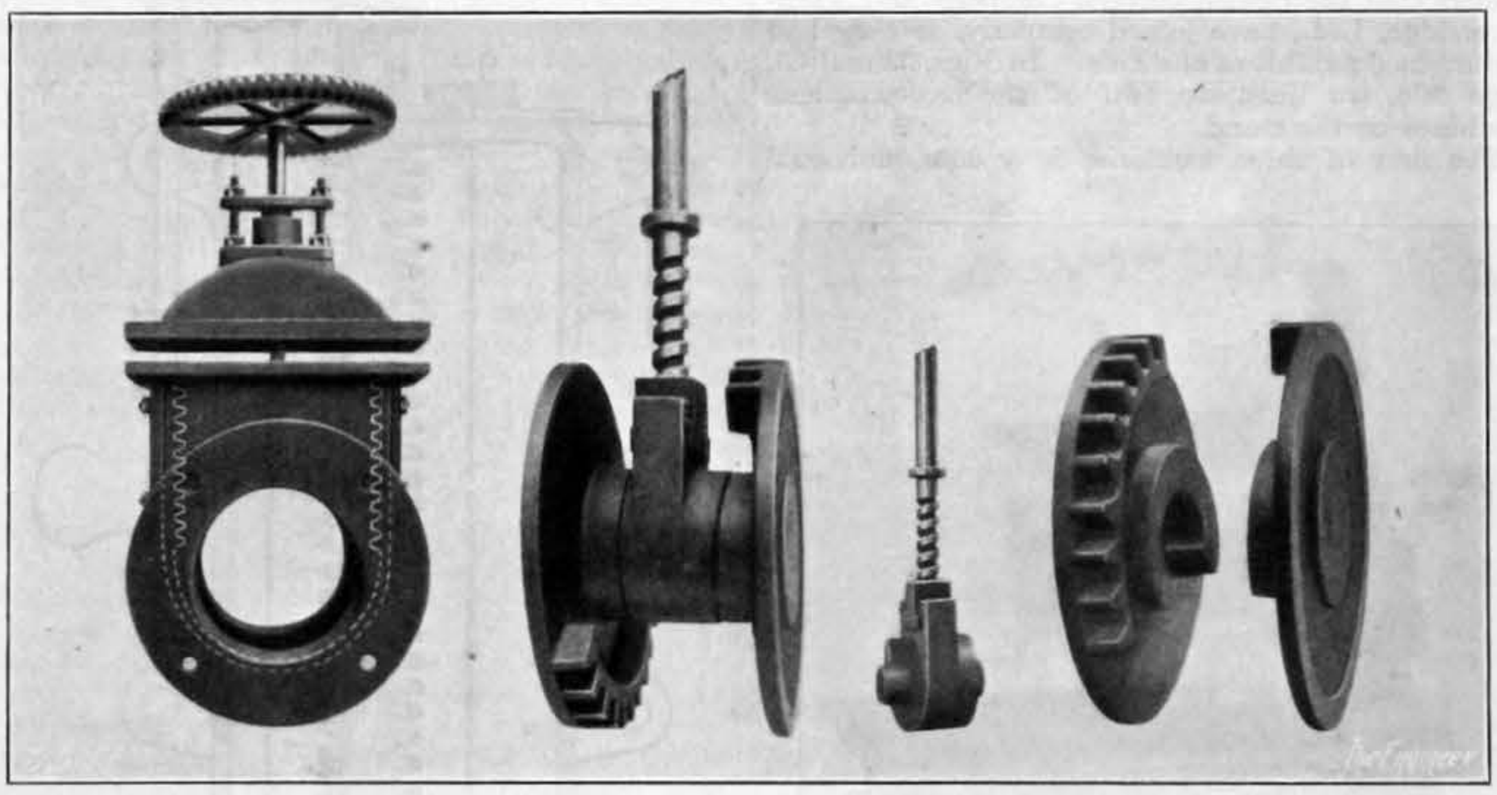


FIG. 59—GATE VALVE—WALKER

is illustrated in Fig. 59. This picture gives the several parts of the valve taken apart and re-assembled in different fashions to show the action of tightening the valve on its seatings.

It will be seen that the valve is of the disc type, with double facings. Each facing is provided with a quadrant of teeth round its periphery, which mesh with corresponding teeth cast in the body of the valve. Between the two faces there is a casting with trunnions that engage with them. This casting has scroll-like excrescences, which engage with corresponding scrolls on the valves. The scrolls are of opposite hand. The centre casting is furnished with a normal screw and hand wheel operating gear. The result of this arrangement is that as the valve is pushed down, for closing, the valve discs are rotated, on account of their teeth engaging with those of the body, and the scrolls, moving one over the other, force the discs into tight contact with their seatings. The reverse action, obviously, happens when the valve is opened. These valves are made in a large number of sizes for pressures from 30 lb. to 100 lb. per square inch and of bores up to 48in.

REDSHAW LISTER WOOLLEN MACHINERY CO., LTD.

A handy form of run-about petrol truck, illustrated by Fig. 60, page 268, was demonstrated by the Redshaw Lister Woollen Machinery Company, Ltd., of Spen Vale Works, Heckmondwike, Yorks.

As will be seen from the illustration, it is of that form in which the power unit and single driving wheel are combined together and are mounted on a pivot, so that the vehicle can be steered in any direction with the full tractive effort being maintained. As a consequence, it is unnecessary to fit any reversing gear in the transmission system, as the whole driving unit need only be turned round, with respect to the chassis, to go astern.

The truck may be equipped either with a $3\frac{1}{2}$ horse-power, two-stroke petrol engine, or with a four-stroke engine of 6 horse-power, according to the local requirements. In each case the engine is air-cooled. The transmission is effected by a chain from the crank shaft to the clutch and thence through a three-speed gear-box, giving ratios of 15·5 to 1, 23·5 to 1 and 40·3 to 1.

The machine equipped with the smaller motor will comfortably take a load of 1 ton up a gradient of 1 in 20, while the 6 horse-power set will climb a slope of 1 in 14 with a load of a ton.

(To be continued.)

IT sometimes happens that in parts of the roads in a mine—in a return air-way, for example—the air becomes charged with a small proportion of fire-damp, say, 1 per cent. This percentage is far below the percentage of fire-damp which is explosive, and, in itself, is quite harmless; but it is necessary to consider whether in the unhappy event of a coal dust explosion this small additional amount of inflammable material would make it more difficult to extinguish the coal dust explosion. In other words, would such conditions require that a higher percentage of stone dust be mixed with the coal dust on the roads in order to neutralise the impetus given to the explosion by the inflammable gas? A series of tests to provide the answer to this question has been carried out by the Safety in Mines Research Board in the Buxton Four-foot Gallery, and the answer that it gives to the question is "Yes." It answers also the further question: "What percentage of stone dust is required to neutralise the effect of a given percentage of fire-damp in the air?" This additional percentage of stone dust is found to be different for different kinds of coal, and it is higher for coals of low volatile content than for coals of high volatile content. A coal dust, the danger of which is neutralised by an equal quantity of stone dust when no fire-damp is present, would require about 5 per cent. more stone dust for each 1 per cent. of fire-damp in the air. Full particulars of the work are to be found in "The Inflammation of Coal Dusts: The Effect of the Presence of Fire-damp," by T. N. Mason and R. V. Wheeler, just published by H.M. Stationery Office—S.M.R.B. Paper No. 64, price 6d. net.

Railway and Road Matters.

THE Institute of Transport asks us to announce that the ordinary meeting on April 13th is to be specially devoted to a consideration of the final report of the Royal Commission on Transport.

THE extension of the Euston-square Station of the Metropolitan Railway, to accommodate longer trains, being now nearly completed, it is proposed to commence the similar work at Great Portland-street on May 1st.

THE rule *nisi* calling upon the Minister of Transport to show cause why he should not be prohibited from proceeding with the proposed regulations for controlling motor coaches in London—mentioned herein on February 6th—was dismissed on the 25th idem.

THE Pennsylvania Railroad announces that as the present low cost of labour and equipment and the decreased traffic presents a very favourable time for undertaking new work, the proposed expenditure of 175,000,000 dollars during the next few years is to be accelerated, and to be completed in 2½ years.

THE annual dinner of the Institution of Locomotive Engineers, organised by Mr. James Clayton and held at the Trocadero on Friday, February 27th, under the chairmanship of the President, Mr. Kelway Bamber, was the largest in the history of the Institution, places being laid for over 180 diners. Notable amongst the guests was Monsieur Valentin, of the P.L.M. Railway.

THE *Beyer-Peacock Quarterly Review* for January, 1931, contains a very interesting article written by Mr. W. Cyril Williams on "The Leopoldina Railway." As our readers know, this railway is the largest metre-gauge railway in Brazil, and is British owned. The system comprises concessions which were granted as far back as 1854, and also includes the first piece of railway line constructed in Brazil and opened in that year.

THE Great Western Railway has issued particulars of the scheme just put in hand for the reconstruction of Cardiff General Station and the adjacent Riverside Station, which will virtually become one terminus, although the latter will retain its name. There will be eight through platform lines, instead of six, to serve four island platforms. Four of the lines will be 1000ft. long each, and be used by main line trains; two will be 800ft. long and accommodate the Taff Vale traffic, and the other two will be at Riverside and be 600ft. long.

THE London and North-Eastern has, with its report for 1929, followed the example of the London, Midland and Scottish, and issued the "report of the directors" separately from the "financial accounts and statistical returns." As the latter is now sent only to those shareholders who ask for it, there is a great saving in stationery and postage. There is also another departure, and that, as the report says, is "by way of an experiment, a review of the company's business during the past year; it is thought that in this way the convenience of stockholders may be met and the proceedings of the annual meeting simplified and facilitated." How full and complete the statement is may be judged from the fact that it fills two closely printed pages of the same size as the annual report.

WE are again indebted to the courtesy of the Secretary to the Indian Railway Board for a copy of the Board's annual report. That for the year ended March 31st, 1930, is just to hand, and we have been struck by many improvements therein over previous reports. The photographic illustrations are finer and colours are used in some of the diagrams in order to make the comparisons more pronounced. We shall, as in past years, deal with the report from time to time in paragraphs in this column. Meanwhile, it may be noted that the number of passengers rose from 620 to 634 millions, but their journeys must have been shorter, as the passenger miles increased only from 22,095 to 23,053 millions. The tonnage of freight fell from nearly 91 to 87 millions, but the ton-miles dropped only from 21,889 to 21,525 millions. The gross earnings were 104·78 crores of rupees—a crore is 100 lakhs of rupees and a lakh is 100,000 rupees—and the expenditure 100·74 crores of rupees, as compared with 105·90 and 98·09 crores of rupees in 1928–29. The net gain was 4·04 crores, but that was not sufficient to meet the contributions payable to general revenues, so it had to be made good by a withdrawal from the reserve fund to the extent of 2·08 crores—in contrast to the previous year, when 2·58 crores were transferred to reserve.

THE annual report for 1930 of the London, Midland and Scottish Railway shows that the capital expenditure of the year amounted to £3,772,880, which amount includes £846,458 on "lines," £492,618 on rolling stock, £155,336 on land, £39,304 on hotels, £46,500 in a subscription for part ownership in MacBrayne's steamers to the Hebrides, and £2,527,104 on omnibus undertakings. It is proposed to spend £4,418,000 on capital account during the present year, of which £2,743,000 will be on "lines," £275,000 on rolling stock, £78,000 on manufacturing and repairing plant and works, £105,000 on road motor vehicles, £114,000 on docks, £45,000 on hotels, and £950,000 on subscriptions to road transport undertakings. The receipts from railway business proper were £68,241,425, as compared with £73,195,264 in 1929, and the expenditure £56,073,830 as against £58,154,565. Other businesses were run at a loss and brought the net receipts of £12,167,594 for 1930 down to £11,976,708. The addition of miscellaneous net receipts and the deduction of miscellaneous charges, together with £211,655 brought forward and of £279,106 taken from General Reserve, allowed for a dividend of 2 per cent. for the whole year, as against 4 per cent. in 1929. The coaching train miles run by steam locomotives rose from 83,708,622 to 84,105,109, but the goods train miles fell from 54,066,378 to 52,398,634. The total engine mileage was, however, decreased from 225,586,475 to 219,802,194, of which we are glad to notice the very gratifying fall from 26,954,926 to 25,173,394 in light running and assisting. The number of passengers decreased from 315,747,658 to 298,906,148, of which 9½ millions were from third-class and 7 millions from workmen. Freight traffic fell from 149,332,591 tons to 139,645,965 tons, of which decrease over 4¼ millions were from coal, coke, and patent fuel.

Notes and Memoranda.

THE production of the gold mines of Ontario, Canada, during 1930 was valued at £7,077,000, compared with £6,676,000 during the previous year. Mainly owing to the operations of the mines in Ontario, the Dominion of Canada now ranks second among the gold-producing countries of the world, coming next to South Africa, and displacing the United States from the second position.

ACCORDING to a statement made by the President of the Southern Pacific Railroad, at the recent San Francisco convention of the Associated General Contractors of America, in order to meet intensified competition the railroads of to-morrow will pull longer trains over heavier rails, with short hauls co-ordinated with motor traffic. An editorial note in "Steel" states that A.R.E.A. specifications list a 150 lb. rail. Most railroads now are buying 110 lb., 127 lb. and 130 lb. sections. The usual length is 33ft., with 66ft. used for special work.

THE technical separation of coal into vitrain, clarain, druain and fusain is, according to J. L. Strevens, possible by elastic percussion, and the methods worked out are simple and economically sound. It is best achieved in pendulum mills in association with preliminary dry dressing, where the ash content of coal is high. The vitrain fraction is best adapted for coke manufacture. The clarain-durain fraction is best adapted for retorting, gas manufacture, hydrogenation, and for blending with gas-poor and highly swelling coals, also as raw material for low-temperature cokes. The fusain can be directly applied for powdered fuel firing, or as a raw material for colloidal fuel.

A SCHEDULE which calls for a total day's run of 171 miles at a top speed of 1000ft. a minute has, says the *Engineering News Record*, been adopted for automatic control elevators in a 42-storey office building under construction in New York. The elevator schedule has been based upon an estimate that 15,000 persons will ride up or down each day. It is expected that by April 1st, when the building is to be completed, the present city regulation limiting elevator speeds to 700ft. a minute will be modified. The architect reports that the maximum distance from offices to elevators is 50ft. on the lower floors of the building, and 6ft. on the tower floors. With normal traffic conditions, it will take only 50 seconds for a tenant on the 42nd floor to reach the street entrance of the building.

THE commercial stocks of bituminous coal in the United States, used largely for industrial purposes, amounted to 37,200,000 tons on January 1st, 1931. In comparison with the amount on hand at the beginning of the previous quarter, this is an increase of 1,300,000 tons, but it is 3,100,000 tons less than the quantity in storage on the same date last year. Exports during the last quarter of 1930 averaged 331,000 tons a week, as against 382,000 tons in the preceding quarter. The weekly rate of consumption within the United States during the fourth quarter of 1930 amounted to 8,987,000 tons, as compared with 7,370,000 tons in the previous quarter. In comparison with the average weekly rate of consumption during November and December, 1929, however, the rate of home consumption, plus exports for the period under review, shows a decrease of 16·6 per cent.

THE "Dalmatienne," a French company which has been formed for the utilisation of the water-power resources of Dalmatia (Jugo-Slavia) has, according to the *Chemical Trade Journal*, almost completed construction of an important plant for the manufacture of nitric acid by the Fauser process, using synthetic ammonia manufactured in its Dugirat factory. The main feature of the process is that the ammonia is catalytically oxidised under a pressure of three and a-half atmospheres. The capacity of the plant will be 280 tons of 36 deg. Bé. nitric acid, which will be used for the production of calcium nitrate and ammonium nitrate. A second plant, working the same process, is being constructed in Holland at the Sluiskil plant of the "Société Neerlandaise de l'Azote." This plant will have a daily capacity of 125 tons of 36 deg. Bé. nitric acid for use in the production of nitrate fertilisers.

IN opening a paper read before the North-Western Section of the Institute of Fuel, Mr. G. V. Slottman pointed out that fuels and the air for their combustion are the most important raw materials, both in weight and value, consumed in the heavy steel trade. A common steel billet selling at about £5 per ton has had expended upon it, in the transition from ore to steel, the energy of some 2 tons of coal. Twenty tons of air, much of which has been compressed to a pressure of 15 lb. per square inch, and preheated to a temperature of between 500 deg. and 1100 deg. Cent., has been used for combustion. Some 200 kilowatt-hours of power have been generated to drive the rolling mills, the transport system and the various steel-finishing units. In all, between 20s. and 30s. have been added to the manufacturing cost by the heat and power requirements alone, a total of between 20 and 30 per cent. of the cost of production.

A PAPER by F. C. Kelley, issued by the American Institute of Mining and Metallurgical Engineers, deals with the causes of oxidation of stainless iron and low-carbon steel in hydrogen furnaces and methods of preventing it. The fundamental knowledge obtained from a series of experiments which are described is applied to the continuous annealing of these materials. The chief causes of oxidation are water vapour held by the furnace insulation, moisture condensed in the cooling chamber, and air which diffuses into the furnace against the pressure of the hydrogen. Low-carbon steel has a critical temperature range of oxidation, which does not favour slow cooling from the annealing temperature if bright material is desired. Stainless iron undergoes selective oxidation in a furnace of the same type, and this oxide is not easily reduced. The paper concludes by describing two different furnace designs for the continuous annealing of these materials. One is used for low-carbon steel, and the other for stainless iron. The furnace designs are based on the data obtained from the experiments described in the paper.

Miscellanea.

IT is said that a large deposit of good coal has been discovered in Kwangtung, China.

IT is proposed to re-start operations at the old mine of the Cape Copper Company at O'Okiep. A new railway may have to be built to the coast to replace the former narrow-gauge line.

THE new works of the South African Iron and Steel Industrial Corporation at Pretoria West is to be equipped with a Lodge-Cotterell electrostatic plant for cleaning the blast-furnace gases.

DURING the year ending December 31st last 1031 landings and 1025 departures were recorded at the municipal aerodrome at Manchester. Air taxis accounted for 108 landings and 113 departures.

THE Durban, South Africa, Municipal Electrical Department has decided to lay a length of 4¾ miles of 33,000-volt underground cable. It will be of the 0·1 square inch three-core type, made by Callender's Cable and Construction Company.

A NEW company, under the title of the Union Construction Company, Ltd., has been formed in South Africa, with works at Germiston, for fabricating steel structures. It will take its supplies of raw material from the coming Pretoria steel works.

ALTHOUGH it is only just over four years since the first vessel built on the "bracketless system" proceeded to sea, there are now built and under construction on this system no less than 125 ships, representing a deadweight carrying capacity of 1,121,000 tons.

WELLINGTON (Somerset) has lost one of its oldest and most highly respected residents by the death, at the age of 90, of Mr. William Bishop, the last of three brothers who were partners in the iron foundry and engineering firm of Bishop Brothers, Wellington. Mr. William Bishop only retired from business two years ago.

A USEFUL statistical summary entitled "The Mineral Industry of the British Empire and Foreign Countries," has been compiled by the Imperial Institute—H.M. Stationery Office, 5s. 6d. The volume includes statistics for 1927, 1928, and 1929, where available for some fifty minerals. Under each heading are given the total production for each producing country and the imports and exports for all countries.

IN his annual report, Mr. J. R. More, General Manager of Natal Railways and Harbours, remarks:—"Arising out of the working of the recently introduced high-power Garratt (G.L.) locomotives, the question of extending electrification from Mason's Mill to Cato Ridge has been revived and a further estimate has been prepared by the Administration's engineers. If the proposal is adopted, train loads of 1500 tons would be taken right through from Glencoe to Cato Ridge by the electric locomotives and thence to Durban in unbroken loads by the G.L. engines. The proposals are at present under consideration by the Administration."

THE scheme for the award of the "Beit Railway Trust Fellowships for the Two Rhodesias" has now been completed. This scheme has been made possible by the provisions of the will of the late Sir Otto Beit and offers facilities for two years' post-graduate work for three candidates. The fellowships will be tenable at any university or institution, approved by the trustees, in South Africa, Great Britain, the Oversea Dominions, Europe, or the United States of America. Each fellowship is valued at £250 per annum if held in South Africa and £375 per annum if held overseas. Information concerning the award may be obtained from P.O. Box No. 4, Buluwayo, Southern Rhodesia.

IT is announced that the Manchester Corporation has sanctioned the use of, and that the Manchester waterworks are already laying on street works, water pipes made from the new ternary-lead alloy discovered by the British Non-ferrous Metals Research Association. The new pipes, which are only two-thirds the weight of pure lead pipes, have a tensile strength 84 per cent. greater and a resistance to vibration—a main cause of street pipe bursts—217 per cent. greater. Composed of 98·25 per cent. lead, 1·5 per cent. tin, and 0·25 per cent. cadmium, their resistance to corrosive waters is greater than that of lead itself, and 13 cwt. of the alloy gives the same yardage of pipe as a ton of lead.

THE final boring of the Boyati Tunnel, near Athens, Greece, the longest hydraulic tunnel in Europe, has been accomplished by the American firm, Ulen and Co. This tunnel is an important link in the big Athens water supply system, which was started in 1925, and which will be entirely completed within the next few months. The Boyati Tunnel is bored through the Parnes Mountains, and is 8½ miles long. The engineers have also utilised a section of the aqueduct built by the Roman Emperor Hadrian in 130 A.D., which until 1926 was the only substantial course of water supply for Athens. It was reported recently that the Marathon Lake, created by the marble-faced Marathon Dam, had overflowed, indicating that over 11,000 million gallons of water were impounded.

A MESSAGE from New York states that the Standard Hydrogenation Corporation announces that it has begun the construction of plants to convert refuse oil and low grades of petroleum into petrol and domestic gas at various places in North Carolina. On the completion of these plants, which will cost 100,000 dollars each, the company intends to erect others in New York and Virginia. The process employed by the company differs from the cracking method in that it is one of conversion, and can even be applied to the residue left from cracking operations. In brief, it vaporises the hydrocarbon base material contained in petroleum, and then passes the vapours through a zone containing a metallic alloy catalyser. Twenty-one years of experiment are stated to be behind the process, and it is believed that the cost of production of gas by this method will be well below that of production by other methods. The company intends eventually to construct plants for the manufacture and sale of gas wholesale to public utility companies.

SOME EXHIBITS AT THE BRITISH INDUSTRIES FAIR, BIRMINGHAM

(*For description see page* 260.)

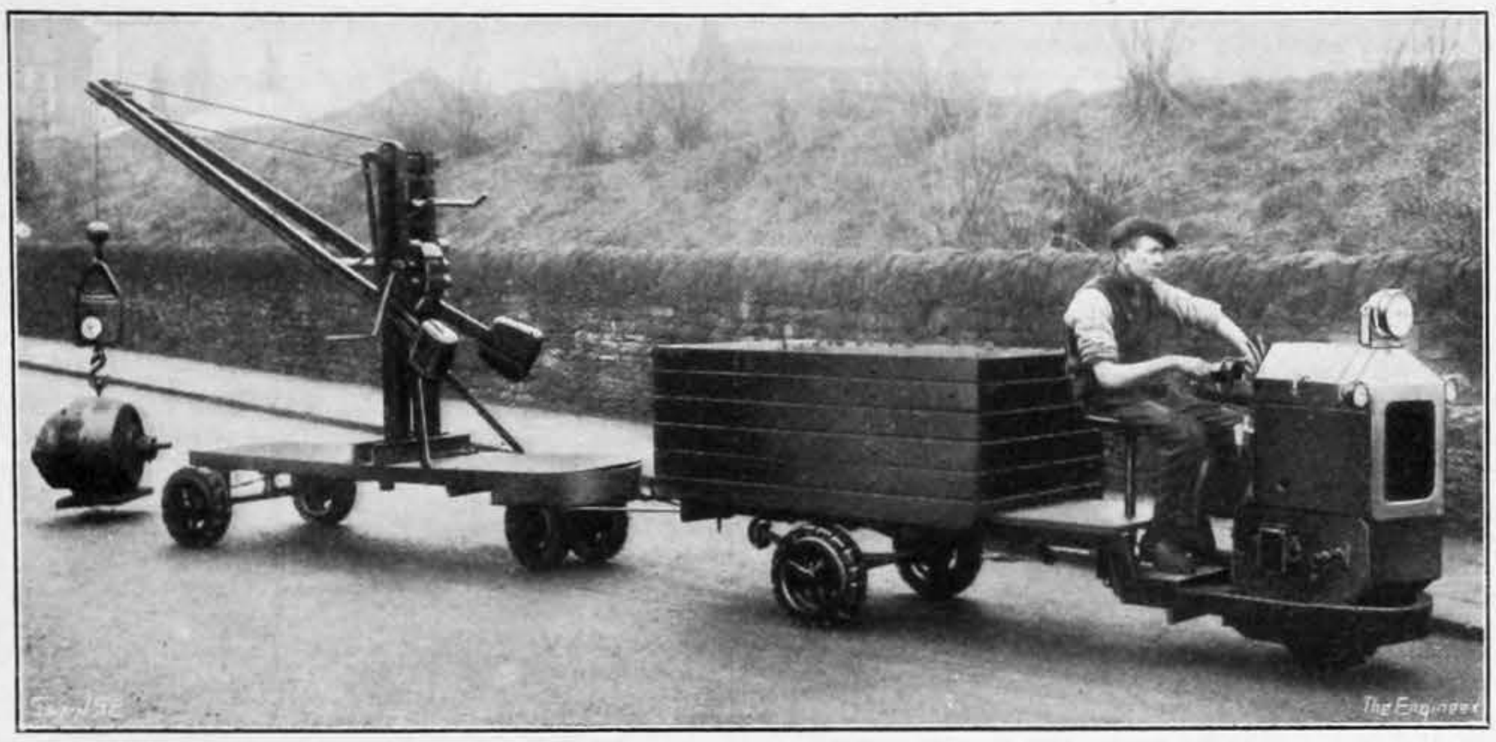


FIG. 60—PETROL TRUCK—REDSHAW - LISTER

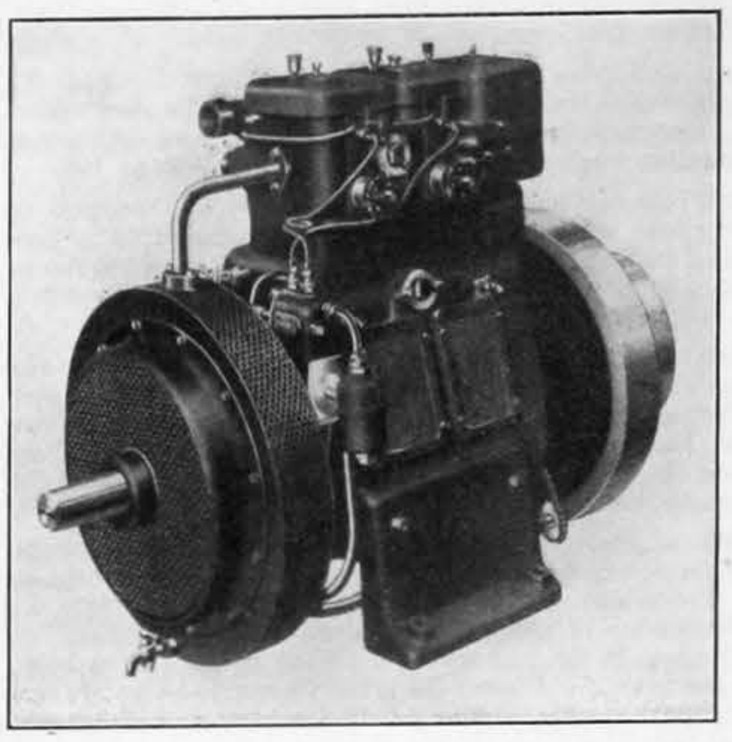


FIG. 61—18 B.H.P. OIL ENGINE—LISTER

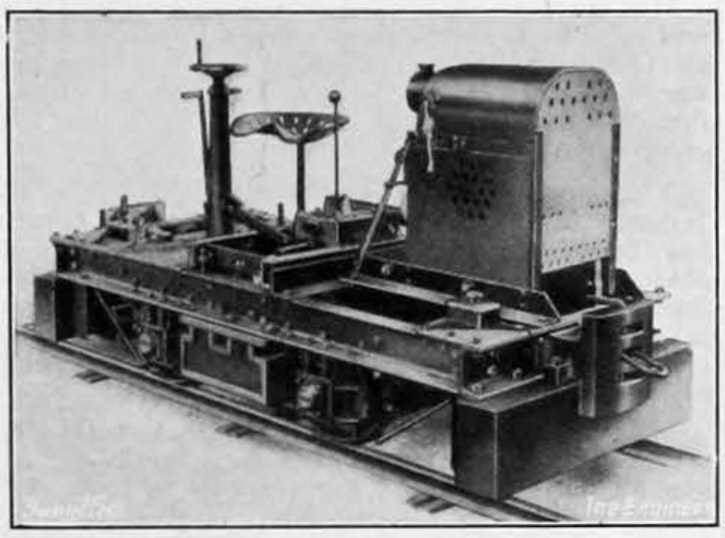


FIG. 62—RAIL TRUCK—LISTER

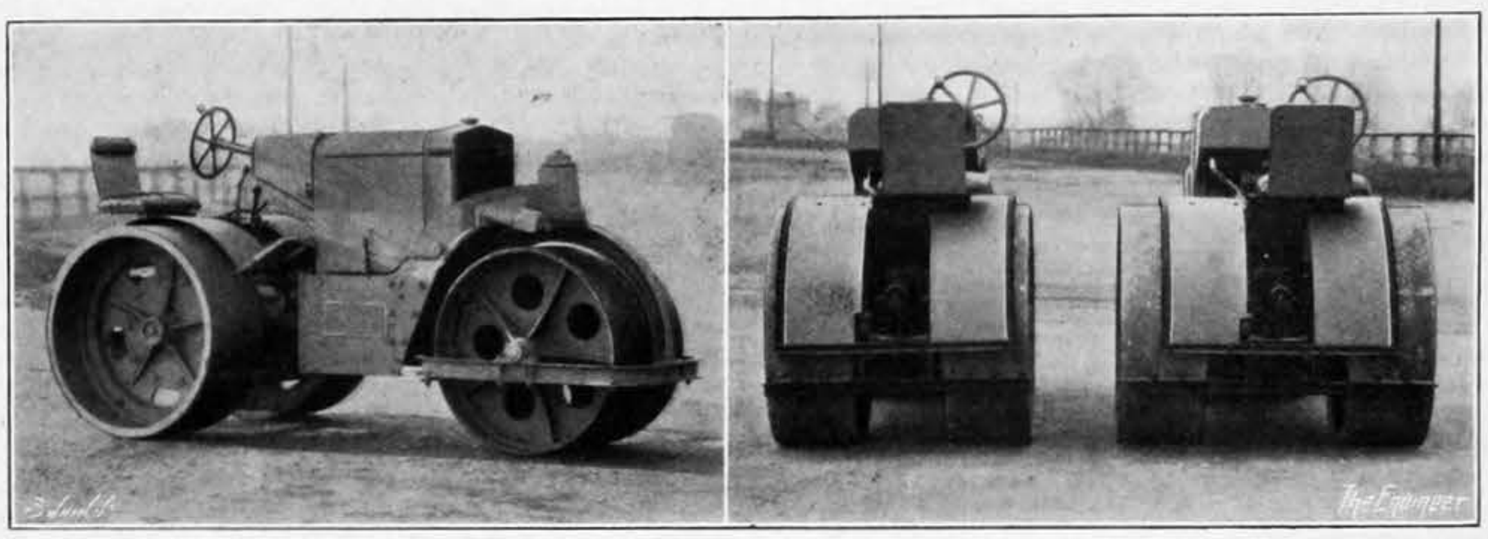


FIG. 63—MOTOR ROLLER—WALLIS AND STEEVENS

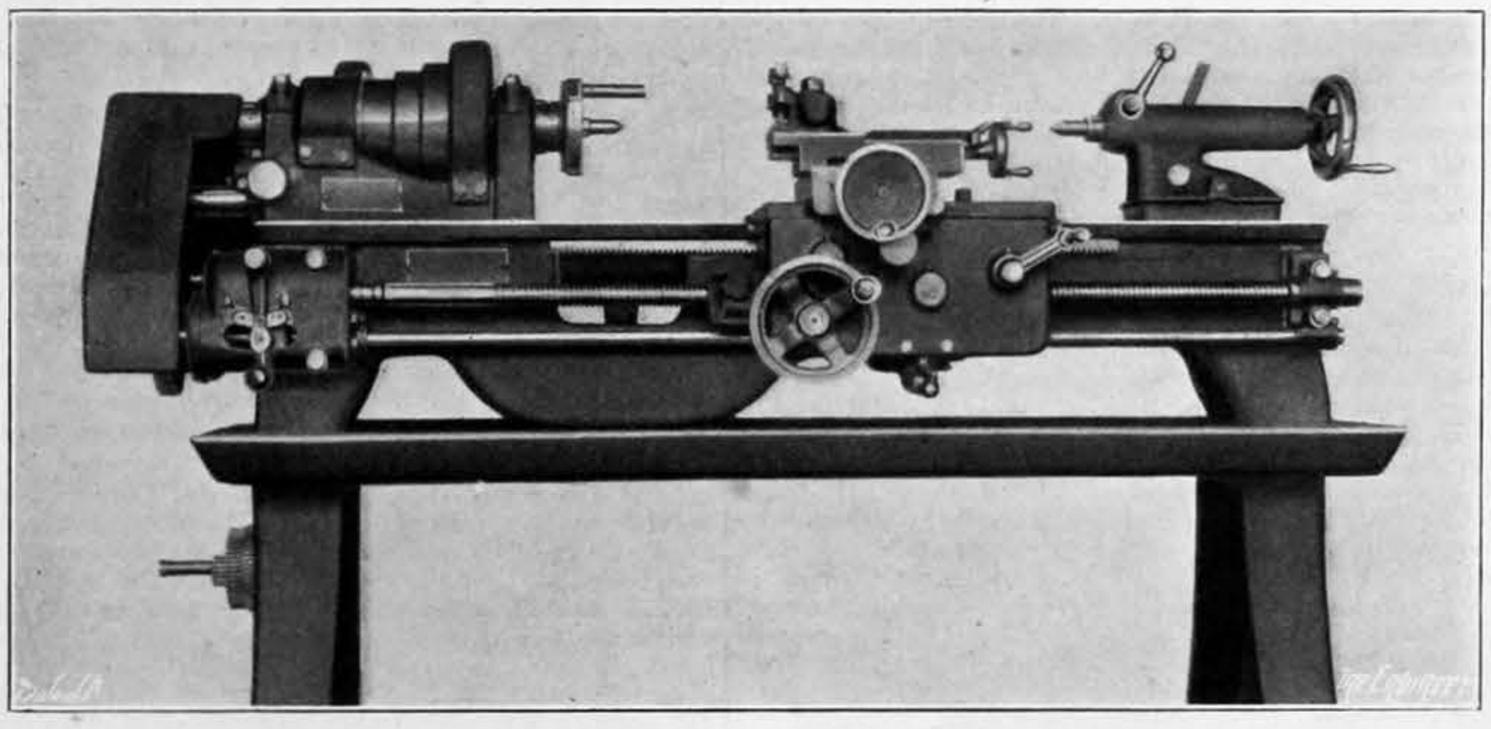


FIG. 64—5½IN SCREW-CUTTING LATHE—HARRISON

FIG. 65—OXYGEN CUTTING MACHINE—BRIT. OXYGEN

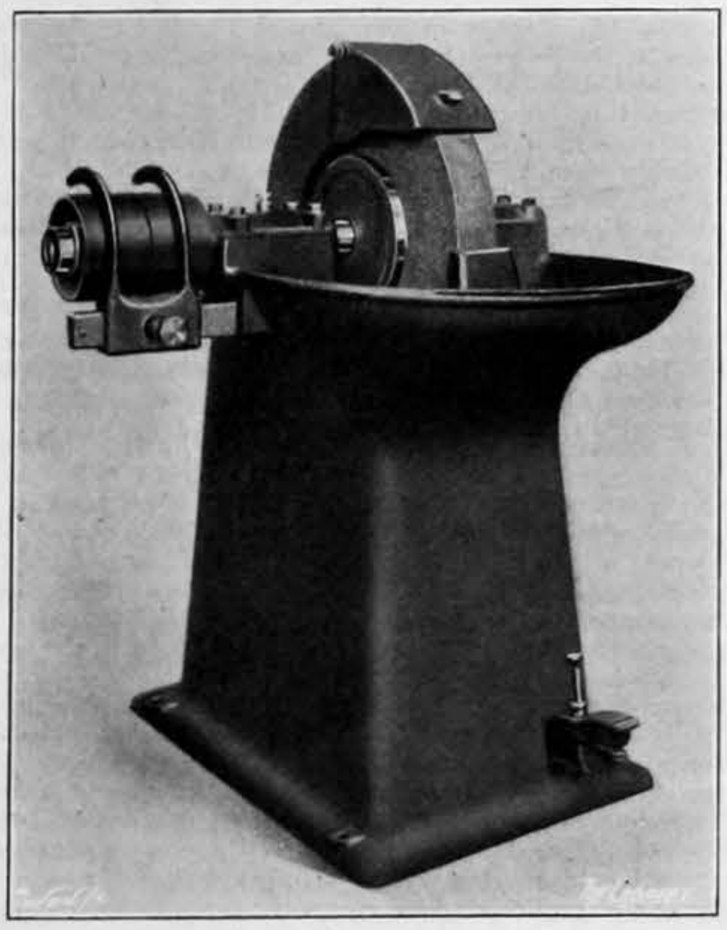


FIG. 66—GRINDING MACHINE—HARRISON

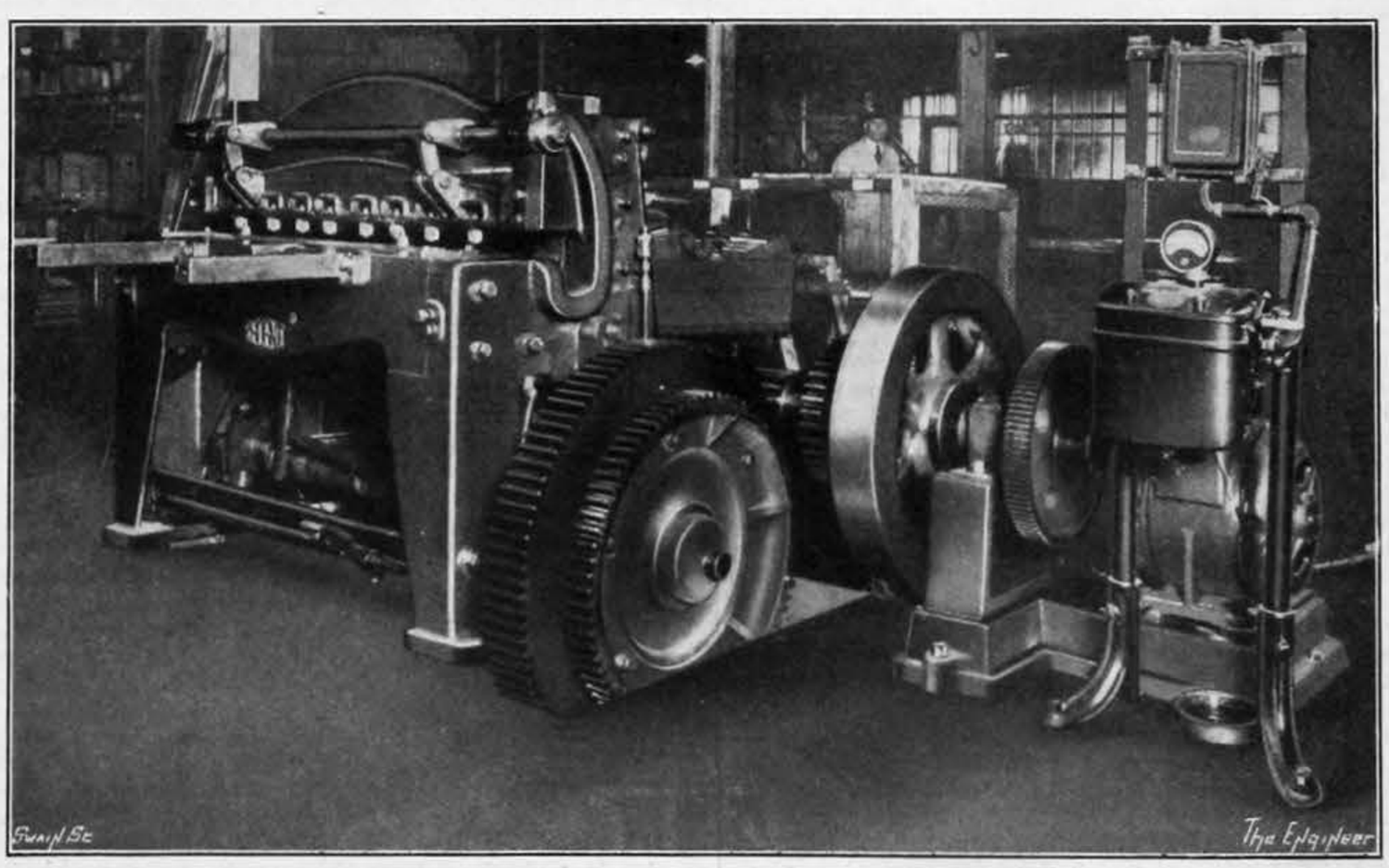


FIG. 67—DOUBLE-GEARED GUILLOTINE SHEARS—BROOKES (OLDBURY)

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Contents.

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THE ENGINEER.

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MARCH 6, 1931.

Economics and Unemployment.

THE widespread unemployment in every industrial centre of the world and the equally prevalent distress in the agricultural areas have directed attention more than ever before to the economic foundations of civilisation. At no time in the history of the world has there been so vast an aggregate demand, not only for the ordinary necessities of life, but also for the innumerable comforts and luxuries which mankind has learned to require and to provide. Nor has there ever been such a vast population ready and willing to meet this demand, provided with all the skill and equipment for the purpose, yet forced by some strange incoordination to exist miserably in idleness, living on their own poor resources or becoming demoralised by a system of doles. This state of affairs is paradoxical, and if it could be regarded by an intelligent being on another planet, would appear preposterous. With an unsatisfiable demand for the products of industry and skill, the spectacle of millions of men trained to create these products, yet unable to live except on scarcely veiled charity, would provide a sad picture of human intelligence. Nevertheless, such, in its broad outlines, is the position to-day. How it has come about is a question of which the answer is only pertinent if it can guide us towards a restoration of better conditions. It is easy to blame the war in a vague way, but the war cannot be undone. Besides, it has been over for more than a dozen years. The two outstanding effects of the war, from an economic point of view, were the destruction of wealth on a colossal scale, and the serious derangement of the delicate fabric of commercial intercourse. As regards the former, the wealth destroyed, enormous as it was, was probably no more than that accumulated in a generation or so, and it could be replaced in even less time. The earth still "brings forth her increase," the mines are as productive as ever, and human ingenuity increases in a logarithmic ratio. We cannot therefore regard the mere destruction of wealth as the root of our present evils. Nor can the tribute being paid from one country to another in the settlement of accounts have much influence on the depression which afflicts the world as a whole. Victors, vanquished, and neutrals are suffering alike, and, almost equally, from a paralysis of their industrial and agricultural activities, and from the unemployment and misery which such a condition entails.

The second great effect of the war, namely, the derangement of international commerce, is probably more fundamental in its results than the mere volatilisation of accumulated wealth. It is also much more complex in its nature. All nations sought new and more secure sources of supply for the goods of which they were temporarily deprived, and whenever possible they developed industries of their own. These they protected by high tariff walls to the discomfiture of their ancient suppliers, and in many cases they were enabled to undersell the latter, even on his own ground, by an indirect subsidy afforded by the depreciation of their currency. How powerful a stimulus can be given to exports by a depreciated currency is shown by the fact that when the German mark had fallen to a fraction of its gold value, the Government had absolutely to prohibit exports except by a practically unobtainable licence, otherwise the country would have been denuded of everything of value by the foreign buyers swarming in the capital. The fall of the Belgian franc also to one-seventh of its pre-war value had a correspondingly stimulating effect on Belgian industry, and at the same time automatically closed the home market to countries in which the gold standard was adhered to. These matters, however, now belong to ancient history. The illusion of prosperity due to inflation of currency is so temporary and the hardships to the nation so real, that no sane Government will resort to it again, except under the direst necessity, even if it has ever come about otherwise. The currencies of all the industrial countries are now stable and on a gold basis, and nothing remains of the inflations but the impoverishment of large classes of the inhabitants on the one hand and possibly a certain footing in foreign markets on the other. This footing, moreover, in so far as it can be maintained, can only be based on efficiency of production and salesmanship; hence it might, and probably would, have equally come about in any case. So also might the high tariffs which do so much to hinder international trade. There was international competition before the war, and hardly a nation that did not seek to favour its own industries by placing impediments in the way of those of its neighbours. This has indeed been the case ever since Governments and industries have existed. There have been periods of abounding prosperity in spite of tariffs and years of depression when no such reason could be adduced. At the present time there is nothing to hinder the free exchange of goods between the industrial North of England and the agricultural South, or to take a larger example, between the farmers on the prairies of the Middle West and the manufacturers of the Eastern States of America. Yet none can dispose of their own products, nor help by absorbing those of their fellow countrymen. The owners of idle factories, or of rotting crops, cry out against overproduction, but how can there be over-production of food when millions are going hungry, or of manufactured goods while millions want them. The statisticians tell us of trade going in cycles, lean years following fat years with some peculiar rhythm. But this only states a possible fact, without either explaining it or offering the least guidance as to how the periods of leanness may be mitigated. It may well be that when an abundance of crops over a great part of the world increases the consumption of manufactured goods, agriculturalists and industrialists alike are thereby stimulated to greater production. Foreseeing still greater prosperity ahead, they may too largely discount the future, to find themselves after a time with their products unsaleable on their hands. Then follow the years of economy and repentance, progress being paralysed by the outlook appearing as black as it had formerly appeared brilliant. Such alternations of optimism and pessimism might furnish a subjective basis for trade fluctuations sufficient to satisfy a shallow philosopher. But whatever there may be in the theory, it does nothing to explain why factories are idle and men walk about workless while the goods they might be producing could be consumed and paid for by another army of men, were the latter not also workless from the same obscure cause.

One is almost tempted to wonder whether the enormous economic machine which has been built up during the last century, serving and being served by hundreds of millions of workers, has not grown so complex that, like the Monster of Frankenstein, it has escaped from the control of its creators. Governments, as much as individuals, seem powerless to restore it to smooth working order, because nobody can understand the principles on which it works. A patch here, an additional complication there, and a little lubricating oil supplied from time

to time, and the machine is somehow kept lumbering along its unknown path with continual squeaks, groans and partial breakdowns. But serve it and be served by it we must, so that the sooner the men who matter in the world can learn to direct it wisely and with unanimity, the sooner shall we be free from the distress caused by its mismanagement. The variety of opinions which are held upon economic questions is extraordinary, even if we discount all those based on national or political prejudices. Every "ism" has its high priests, with its army of more or less instructed followers. In spite of their fervour they differ so widely in their aims and objects that the vector resultant of their efforts is zero or nearly so. This perhaps is well, for enthusiasts are bad advisers. There is another thought from which comfort may perhaps be derived. The points on which there is the most acute difference of opinion are just those which matter least. This may seem curious, but it is generally true. The very fact that diametrically opposite opinions may be held by equally intelligent people suggests that the chances are even that either is right; hence either view may be acted on with equal justification, and probably with very little difference in the ultimate result. Furthermore, had the classical disputes been of real importance they would have been settled long ago, either by agreement or by the demonstration which time always affords. Hence it is not to be expected that world economics are to be put on a sound basis by the adoption of any panacea known to political controversy. If anything can be done on a large scale, it can only be by international agreement on some steps proposed or at least endorsed by the men in every country who are most qualified to give an opinion on industrial and financial questions. We are unhappily so far from the possibility of seeing a such supreme economic court in existence and so much further from the likelihood of its decisions being loyally acted on by all industrial nations, that the idea may be dismissed as a dream. We must try to get our own bit of the economic machine working well first, and gearing, as well as may be, with the parts controlled by our neighbours. With 45 million people all wanting something or other, and two million or so able and willing to do the work they cannot find, there is surely some way of better adjusting the needs of both to the benefit of all. For a shoemaker to need a shirt while a shirtmaker needs a pair of shoes, and for both to stand idle at the same time, living on the charity of others, is a paradox as absurd as it is deplorable.

Compulsory Research.

Since 1918 the Department of Scientific and Industrial Research has made grants totalling £768,000 to the research associations which, with its assistance, have been established by twenty-five different industries or groups of industries. The amounts granted are of various magnitudes. In the eleven years of its existence the Cotton Industry Research Association has received £110,000 odd; in twelve years the Scientific Instrument Research Association has received grants totalling just on £109,000; and in course of nine, the Electrical Research Association has been granted £76,000. At the other end of the scale there is the Scottish Shale Oil Research Association, which during the first five years of its existence received a grant of £7500, and which during its second five years has managed to continue without Government assistance. There is also the case of the Colliery Owners' Research Association, which has conducted its operations for five years without a grant, and which only now in the sixth year of its age is to receive a sum not exceeding £600 from the Department. While the magnitude of the total grant made to any association may be taken as a measure of its activity in the conduct of research, it may also in some respects be interpreted as an indication of the extent to which the association is deficient in the support which it receives from the industry it serves. It was never intended that the associations should derive a portion of their income permanently from the Department. As originally planned, the scheme anticipated that after five years the associations would become self-supporting. Few or none of them have reached that happy state, and, accordingly, we find some of the associations, after existing for ten, eleven, or twelve years, still drawing considerable annual sums as grants.

Of the million pound fund with which the Department started its scheme for the encouragement of scientific and industrial research, a balance of £218,000 remained on March 31st last year. The fund is being depleted at the rate of about £80,000 per annum, and is therefore now within measurable distance of exhaustion. The Government has agreed to ask Parliament to provide the moneys necessary to continue the scheme when the original fund is exhausted. Nevertheless, the situation is unsatisfactory from several points of view. To an outsider, the Department appears to have sought every possible excuse for continuing the grants when the original periods during which they were to be made came to an end. It is continuing to withhold its right to interrupt the payments, as witness the fact that it has just drawn up a new scheme under which the Electrical Research Association will receive grants during the third five-year period upon which it is about to enter. There are, however, signs that the Department is dissatisfied with the meagre support which certain of the research associations receive from their industries and from others who directly benefit by their work. In its annual report published this week it is made quite clear that the Department's Advisory Council is favourably inclined towards a compulsory levy on all firms in an industry for the support of its research association. Failing the domestic arrangement for such a compulsory levy the Council, if we interpret its meaning aright, seems to have it in mind that, at the request of a sufficiently large majority of the firms in any industry, Parliament should give statutory authority for the imposition of the levy on an equitable and national basis. With the Department's assistance, a voluntary levy scheme has already been arranged for financing the research association of the woollen and worsted industries. With the co-operation of ten trade federations connected with different sections of those industries a voluntary levy of 2d. per bale is to be imposed on all imported wool, mohair, &c., retained for home consumption, while the employers in the processing sections are to pay a levy of a farthing per week per operative. An arrangement has been made with the shipowners transporting wool from the Dominions to impose the levy as part of the freight charges at the port of entry. From these two sources it is estimated that a total annual sum of about £20,000 should be forthcoming. Certain wool buyers have, however, shown a reluctance to assist in carrying out the scheme, and as a consequence the total receipts from the levy will amount to about 87½ per cent. of the above-named estimate.

The tax-paying public, through the Department, already contributes substantially to the finances of the research associations. The rest of the money is supplied by a limited number of the firms engaged in the industries served by them. Both the public and the subscribing firms obtain the advantage of any advance or development arising from the work of the associations, the firms as the manufacturers of the improved or novel product, and the public as its ultimate consumer. There are, however, many firms which do not support their associations, but which, nevertheless, obtain almost as much advantage from them as if they contributed to their funds. There are, too, many intermediate bodies between the manufacturer and the ultimate user which directly benefit by the improvements introduced by the manufacturer. The electrical industry provides a clear case in point. If the Electrical Research Association enables the manufacturers of electrical plant to produce improved equipment, the benefit is transmitted to the public by way of the electricity supply undertakings. It is only just that these undertakings, which in their own way draw advantage from the improvement, should contribute to the funds of the Research Association. In the particular case of the electrical industry the supply undertakings have recently agreed to bear a reasonable share of the Electrical Research Association's expenses. There are, however, many other associations which are supported only by a few firms directly interested in their work, and which with a fair amount of assistance from the other firms connected with the industry and from those making use of its products, would be able to double and treble their activity and value. It is hard to resist the logic of the plea for national support for the research associations on an equitable basis. If, however, it is to be secured by means of a compulsory levy, the task of making the imposition equitable in any one industry will clearly be one of extraordinary difficulty, and one from which Parliament might well ask to be excused.

The Suez Canal.

Criticism of the relatively high rates charged—of necessity—by British railways is very common, but less is heard of those connected with other forms of transport. The Suez Canal Company is, however, once more being taken to task, as it was many years ago, for imposing excessive dues on shipping. The complainant is the Liverpool Steam Ship Owners' Association, and the case, when contrasted with that of the railways, would appear to be a strong one. Railway shareholders count themselves lucky if they get a dividend of 5 per cent., whilst the fortunate original holders of the Canal shares may take up to 25 per cent. in dividend before any receipts are spent upon the reduction of shipping dues. Their property is an excellent one. In 1925, over 464·75 million francs were available for distribution, but in 1929 the amount had risen to nearly 737·5 million francs, and the dividend per 250f. share had mounted from 300f. to 530f. in the same period. In face of these figures, the Liverpool appeal for a reduction of dues would appear to be reasonable. It is quite true that the rate per ton is now down almost to pre-war level, but in 1913 the volume of tonnage passing through the canal was 20,033,000 tons, and last year it was 31,668,759 tons, so that the total receipts have enormously increased. It is interesting to note that the canal charges "amount on an average to no less than 13 per cent. of the gross freights outwards and inwards," and that in practice the Panama Canal dues work out at 15 to 25 per cent. below the Suez Canal dues. When it is remembered that about 60 per cent. of the ships using the canal are British, it will be seen that the heavy rate falls principally on British trade. It is, in fact, an insidious form of national taxation, for the British Government is the largest single shareholder holding about 44 per cent. of the present stock. The purchase of the Suez Canal shares by the British Government was, as everyone knows, a brilliant business stroke. It has brought to the nation 35 million pounds in fifty years, but now that shipping is in a serious position, a lower rate of interest might in the long run prove to be the wisest economy, for what the country lost in dividends on the canal, it would regain in income tax from more prosperous industries.

Scientific and Industrial Research.

The report for the year 1929–30 of the Department of Scientific and Industrial Research was issued at the beginning of this week. Copies of it may be obtained from any branch of his Majesty's Stationery Office, price 3s. 6d. net. Below we give a summary of the Advisory Council's report.

Locomotive Experimental Station.

The Committee appointed to examine a proposal that a national locomotive experimental station should be established has now submitted its report. The Committee, which was composed of the chief mechanical engineers of the four leading railway companies, three locomotive manufacturers, two prominent railway consulting engineers, two university professors and a representative of the Crown Agents for the Colonies, under the chairmanship of Sir Alfred Ewing, was able to report unanimously in favour of the proposal and succeeded in framing a scheme adequate, in its view, to meet present needs and to allow for future expansion. The scheme provides for a station equipped with modern testing plant embodying certain novel features in construction and a dynamometer car for use on the railway track itself.

The main part of the work of the station would be the running of locomotives on rollers to enable tests to be carried out under comparable conditions. The cost of tests carried out on behalf of individual railway companies, locomotive builders or consulting engineers would, as far as possible, be covered by the fees charged. In addition, however, to routine tests, general research on or relating to locomotives would form an essential feature of the work of the station, and special financial provision would have to be made to meet the cost entailed.

The Advisory Council agrees with the Committee that while it is desirable that the station, if established, should possess the status, and its certificates of tests should carry the authority, derived from Government recognition and support, it would be preferable in every way that the station should have an independent existence and should not be maintained as a State-controlled institution. The Committee recommends that the station should be placed under the management of a body analogous to a research association. The Council agrees with this view.

Fuel Research.

Low-temperature Carbonisation.—In spite of many failures there are now in existence a few systems of low-temperature carbonisation which have been developed to a commercial scale. Several large plants are at work or about to start operations. A conference of firms interested in the development of low-temperature processes called together by the Depart-

ment, met twice in order to consider what further lines of research were required by those developing the new method of treating coal, and to discuss the bearing of further experimental work on the difficulties which they were experiencing.

It was generally agreed that further work was principally required on the properties of the tar obtained in low-temperature distillation, especially in the direction of obtaining, by cracking or by hydrogenation, a conversion of a large percentage of its bulk into motor spirit. The conversion of tar into motor spirit has been actively investigated for some years at the Fuel Research Station. Briefly, it has been shown that it is possible to convert by hydrogenation some 70 per cent. of the tar by volume into motor spirit, together with some 20 per cent. of neutral oil which could again be treated so as to obtain further motor spirit. The possibilities of obtaining similar results at lower pressures are being studied. Investigation of the tar, with the object of using it as a raw material for the manufacture of chemicals, preservatives, drugs, &c., has also been carried out at the Chemical Research Laboratory of the Department.

The conferences referred to led to the formation of the Low-temperature Coal Distillers' Association of Great Britain, and the Council welcomes the institution of this body as affording a means of closer contact between Departments of the Government and the firms interested in the low-temperature carbonisation of coal.

References have been made in earlier reports to the circumstances in which the Gas Light and Coke Company agreed to undertake a test, under strictly commercial conditions and on a commercial scale, of a low-temperature carbonisation process. The arrangements included provision for the formation of a "Fuel Production Company, Ltd.," the capital of which was guaranteed under the Trades Facilities Act, the gas company acting as managers for the Fuel Company, and bearing all running and management costs. The company selected for trial in this connection the general design of retort which had been developed at that date at the Fuel Research Station. The plant has proved more expensive to work than had been anticipated, due mainly to the fact that the metal used for the retorts deteriorated rapidly in such a way as to increase the labour costs beyond reasonable limits. Four different types of retort, involving differences in metal and design, were embodied in the Richmond plant, but all have suffered distortion. This has long been a major technical difficulty in the use of certain types of externally heated retorts, but there is good reason to believe that, largely as a result of the attention which has been given to the problem by the British Cast Iron Research Association, it is being rapidly overcome. Since the placing of the contracts for the Richmond plant, further designs have been tried at the Fuel Research Station, and one of these has stood for two years without distortion. The future of the Richmond plant is now under consideration.

Hydrogenation.—By treating coal with hydrogen at temperatures of 400 deg. to 500 deg. Cent., and at pressures of some 200 atmospheres, it is possible to convert a large proportion of the coal substance into liquid fuels. It would obviously be of great advantage to the country if this process could be developed so as to produce liquid fuels, and especially motor spirit, from home sources. Experiments have been continued at the Fuel Research Station, to study the reactions that take place, using both small bombs and a continuously working plant with a nominal capacity of 1 ton of coal a day. The action of catalysts has been studied using coal—containing the minimum of ash—which has been specially cleaned for the purpose. The latest results show that it should be possible to obtain a minimum of 120 gallons of light spirit per ton of coal—*i.e.*, about 40 per cent. by weight of the coal treated—together with some heavier oils. There are very few firms that have the knowledge and experience necessary for working a process of this kind, and as Imperial Chemical Industries, Ltd., has been working to develop the process on a commercial scale, this aspect of the question has not been dealt with by the Department.

Pulverised Fuel.—The study of the problems involved in burning coal in the pulverised form is one of those to which increasing attention is now being given at the Fuel Research Station. The Babcock and Wilcox boiler and the Lancashire boiler at the station have now been adapted for the use of pulverised fuel, the former having been raised 9ft. to provide the large combustion space commonly used in commercial practice on land. The necessary drying and pulverising plant has been provided. It is intended to use this plant, in the first instance, to obtain experience of present practice, and then to use it for such further experiments as seem desirable. The physics of the subject have been studied and three different types of experimental burners and furnaces have been constructed with a view to obtaining quantitative data on the factors which govern the burning of solid particles in combustion chambers of the minimum volume compatible with commercial conditions.

BUILDING RESEARCH.

The work of the Building Research Station at Watford continues to cover a wide field. Two developments in particular engaged the Council's consideration during the year. The Steel Structures Research Committee has submitted its proposed scheme of work. The programme involves a study of existing regulations for buildings and bridges in Great Britain and abroad, and the collection of details of present methods of design; special investigations into external loads, into strains on existing buildings, into stress analysis and into certain problems relating to strength of materials; and research on the analysis of stresses generally. The Committee is considering an investigation into the use of electric arc welding in steel structures.

In order to secure prompt and effective application of the results of the Committee's work, a conference was called of bodies and persons concerned in the design, erection, and uses of steel structures, and it is hoped as a result that a standard practice for the use of structural steel in buildings in this country will prove practicable. The cost of the work is at present about £4000 a year, of which the interested industries are providing half.

The other question considered during the year was mainly an administrative one, and affected the arrangements made for work on architectural acoustics. In future a joint committee of the Executive Committee of the National Physical Laboratory and of the Building Research Board, with Sir William Bragg as chairman, will control the work undertaken on the subject at Teddington and Watford respectively. In this way the general researches on acoustics at the former station will be suitably interrelated with the application of existing knowledge in building problems at the latter.

WILLIAM FROUDE NATIONAL TANK.

The Council in its report last year referred to a proposal to erect a second tank at the National Physical Laboratory for research in connection with ship resistance and propulsion, and for tests on ship forms, propellers, &c., desired by shipping firms. It reported that the demands for test work to be carried out in the William Froude National Tank, which had been constructed in 1909–10 through the generosity of Sir Alfred Yarrow, had become so great that research work had become almost impossible, and it recommended that the Department should offer to bear half the cost of an additional tank, up to a limit of £10,000, provided that the remainder was forthcoming from other sources.

It is perhaps not surprising, in view of the economic situation in the shipping and shipbuilding industries, that this offer met with an unsatisfactory response, and there appeared little hope, in the depressed state of those industries, that the requisite funds for a new tank would be forthcoming. The congestion of work to be undertaken in the existing tank was becoming worse. Not only was research being hindered seriously, but orders for tests were accumulating to such an extent that long delay in carrying them out was unavoidable, with the result that numerous orders for tests were withdrawn and sent to the Continent, where in recent years facilities for such work have been greatly increased.

The Council could not regard this position as other than grave. It is obvious that there is serious danger, if demands for tests of ship designs can be better met abroad that orders for construction will also be sent abroad. These facts compelled the Council to revise its previous recommendation, and to recommend that the whole capital cost of a new tank should be provided initially by the State.

In the preparation of the design for the new tank every effort has been made to ensure that it will be able to cope with all demands to which developments in both the size and speed of ships for many years to come are likely to give rise. The tank will be 678ft. long, 20ft. wide, with a depth of 9ft., and it will be possible to test models up to speeds of 40ft. per second.

RADIO RESEARCH.

The work of the Radio Research Board has now reached a definite stage. Apparatus and methods yielding reliable and consistent results have been worked out for the investigation of fundamental problems connected with the propagation of waves, the nature and origin of atmospherics and radio direction finding. To reap the full benefit of this initial work and to make the best use of the experience and knowledge gained by the radio research organisation of the Department, it appeared that closer co-operation between large users of radio telegraphy or telephony and the Department was desirable. The appointment of Colonel Lee as Chairman of the Board has secured more intimate co-operation with the Post Office, and financial arrangement have been made by which fundamental problems in radio can be referred immediately by the Post Office to the Department for investigation. In addition, the staff of the Department can be made freely available for the assistance of the Post Office in solving practical difficulties when desired. Investigation of waves under 10 m. for the purpose of communication is to be one of the first problems to be undertaken.

Besides undertaking work in close co-operation with the Post Office, certain special investigations are being conducted on behalf of the British Broadcasting Corporation.

During the year a demonstration was given at the Radio Research Station, Slough, to the Under-Secretary of State for Air, the Director of Research Air Ministry, and technical officers of the Royal Air Force, of the cathode ray direction finder. As a result, the Air Ministry has requested that this instrument may be further developed with a view to producing a rapid direct-reading instrument suitable for use at ground stations.

WATER POLLUTION RESEARCH.

The study of water pollution and its prevention continues to make steady progress. Further work has been done in the biological and chemical survey of the river Tees. The hydrographical work has been completed and a report on the results will shortly be published. Data have been obtained showing the volumes of water moving in different parts of the estuary at various states of the tide; the rates of surface and sub-surface flow have been determined, and the quantity of fresh water reaching the sea on each tide has been computed. These figures will be of great value in assisting in the interpretation of the biological and chemical data still in the process of collection.

A definite stage has now been reached in the investigations on the purification of beet sugar effluents by the method of biological filtration which has been in progress for some years with the financial support of the industry. This method has been developed both in the laboratory at Rothamsted and on a practical scale at Colwick. As a result of the practical filtration experiments made at Colwick during the 1929–30 season, in the course of which a purification exceeding 90 per cent. was secured, sufficient data are now available to enable pollution to be avoided.

Till recently the Water Pollution Research Board's work on both sewage and beet sugar effluents has been concerned mainly with the biological and chemical aspects of purification, with little reference to physico-chemical relationships. Consideration of the results obtained during the work on beet sugar effluents has indicated that it is desirable that the influence of the colloids present should also be studied. Arrangements have accordingly been made for an investigation of the colloidal properties of beet sugar effluents and of sewage to be undertaken under the direction of Professor Donnan at University College, London. The problem, especially in the case of sewage, is very complex, but there can be no doubt that more information on the subject will greatly assist the development of purification processes. As a first step, determinations are to be made of the nature and amount of the colloids present.

Another investigation which has been begun during the year is concerned with difficulties not infrequently experienced by water supply undertakings due to the corrosive action on iron mains and the plumbo-solvency of certain waters. The attention of the Department has been drawn to these questions by the Ministry of Health, which has emphasised their importance and has urged that investigations should be undertaken to discover more reliable methods than are at present known for meeting the difficulties. Arrangements have accordingly been made for experimental work on this subject to be undertaken at the Chemical Research Laboratory, Teddington, where work on the base exchange process of water softening is already in progress for the Water Pollution Research Board.

ATMOSPHERIC POLLUTION RESEARCH.

In April, 1927, the Department accepted responsibility for co-ordinating observations of atmospheric pollution taken all over the country, and for carrying out research into the nature of this pollution and of the best methods for measuring it. This task was undertaken at the request of a number of local authorities and of certain supply undertakings and industrial concerns, which undertook to contribute between them at least half the cost. To direct the work an Atmospheric Pollution Research Committee was set up under the Department with Dr. G. C. Simpson as chairman. The work of this committee has been examined by the Council during the year. It was satisfied that with a very modest expenditure a useful and fairly extensive programme of work was being undertaken. It comprises investigations to establish the significance of the records which are now being obtained and investigations into new methods for obtaining information on special aspects of pollution.

SCIENTIFIC GRANTS.

In the Council's report last year reference was made to the capital grant of £1500 towards the erection of a liquid hydrogen plant for use in the development of the researches undertaken at the Cavendish Laboratory, Cambridge, under the direction of Dr. Kapitza. This installation is now complete. The liquefier is of original design and was made in the laboratory, and the other parts have also been produced in this country. The present output of the plant is about 2 litres of liquid hydrogen per hour, and it should be possible to increase this output considerably. The plant, which is of novel construction, is the only one of its kind in this country.

The experiments on the resistance of metal conductors at very low temperatures, temporarily suspended pending the provision of a supply of liquid hydrogen, have now been resumed, and will be further developed during the coming year. Research on strong magnetic fields during the current year has been directed to the study of magnetic susceptibilities

and magneto-striction in para- and dia-magnetic substances. Methods and apparatus have been successfully devised for this purpose, and it has been possible to observe magneto-striction in crystals of certain dia-magnetic substances, such as bismuth, graphite, and tin.

Several papers were published during the year as a result of the work on X-rays carried out at the Royal Institution under the direction of Sir William Bragg, towards which continued grant assistance has been afforded. These papers were concerned either with the results of investigation of the structure of organic compounds or of improvements of the technique employed in such work. An entirely new method was devised for measuring the intensities of X-rays, as recorded on photographic films and plates, and was used in a detailed investigation on naphthalene and anthracene. An X-ray generator was developed for the production of very intense X-rays, and a second generator of improved design was subsequently built which is now in use in the laboratory. The results obtained are very encouraging, and the erection of a plant of considerable dimensions is contemplated.

In connection with Professor Bone's researches on gaseous reactions at high pressures, systematic experiments were completed during the year on explosions of hydrogen-air, carbonic oxide-air, &c., mixtures at initial pressures of 250, 350, and 500 atmospheres. The spectra of continuous flames of hydrogen and carbonic oxide burning in air and in nitrous oxide at various pressures up to 50 atmospheres were studied. Work was also continued on catalytic reactions at high pressure, and on the flow of gases at pressures up to 400 atmospheres through copper and steel pipes of small diameter. The isotherms of various single gases, *e.g.*, carbonic oxide and hydrogen, and their binary mixtures at temperatures of 0 deg. and 50 deg. Cent., and at pressures up to 1000 atmospheres, were also determined.

A 230-TON STEEL CASTING.

A SINGLE-PIECE steel casting weighing 460,000 lb. and believed, according to the *Engineering News-Record*, to be the largest ever made, was completed, ready for erection, at the Bethlehem plant of the Bethlehem Steel Company on February 16th. The casting is a cylinder jacket for the 14,000-ton forging press in the company's plant. It is 12ft. 10in. high, 23ft. 4in. long and 10ft. 2in. wide. Six open-hearth furnaces were used for the melting of the steel for the required metal, which was deposited in 10 minutes through four troughs, one at each end of the mould and two at the side.

The forging press for which the casting was made has been in service since 1893. Before the war it was used exclusively for the armour plate forging; recently it has turned out heavy forgings for pressure vessels used in the oil and chemical industries. Helium tanks for the army and navy have also come from the press, which has a capacity of about 12,000 tons annually. Early in December the old cast iron cylinder jacket, made up of several small castings, cracked, and work was immediately started on patterns for a new steel casting.

The whole job occupied about ten weeks. Some 13,000ft. b.m. of lumber was required for the patterns. The mould was made in a large concrete pit with heavy steel reinforcing over the full surface. Adjacent pits were filled in and reinforced to assure adequate lateral resistance. To provide rapid cooling of the molten metal as it came in contact with the mould, 2 tons of nails were used over the surface of the mould. The mould was dried by a special pipe and blower system.

The larger cores, for the cylinder holes, weighed 60 tons each. All cores were double-bricked shafts. The cope or superstructure that was added to the mould to accommodate the extra metal needed because of contraction of the metal in the mould, was loaded with 1,000,000 lb. of weight to assure against floating of the cores. The surplus portion of metal or sinkheads was made up of cast iron, because of an accident which left only five ladles of steel available. After the casting had been in the mould ten days, the sinkheads were cut off and the cope was removed. The total pouring time, including sinkheads, was 38 minutes.

Annealing and machining were done in the forge department. Annealing required nine days with a top temperature of 1300 deg. Fah. For the machining operation six machines were brought from the machine shop and set up on special foundations around the casting. Erection will constitute a major problem, since the 230-ton mass must be lifted 55ft. in the air to set it over the press columns. A special steel tower carrying two 125-ton shop cranes has been erected for this purpose.

BOOKS RECEIVED.

Newcastle-upon-Tyne Commercially Considered. Newcastle-upon-Tyne Town Clerk's Office, Town Hall. Price 7d. net for postage.

Money versus *Man.* By F. Soddy, M.A., F.R.S. London: Elkin Mathews and Marrot, 54, Bloomsbury-street, W.C. 1. Price 3s. 6d. net.

Land Drainage and Flood Protection. By B. A. Etchwerry. McGraw-Hill Publishing Company, Ltd., 6, Bouverie-street, E C 4. Price 15s. net.

Directory of Shipowners, Shipbuilders and Marine Engineers, 1931. London: The Directory Publishing Company, Ltd., 33, Tothill-street, S.W. 1. Price 20s. net.

The City of Birmingham: Official Handbook, 1930–1931. Compiled and edited by W. S. Body. Birmingham: City of Birmingham Information Bureau, Council House. Issued free.

Trends in Steam Turbine Development.

By A. G. CHRISTIE.*

THE present trends of steam turbine development are towards (*a*) the use of higher steam temperatures and pressures; (*b*) increased capacities at the various speeds, and increased output from a single casing; (*c*) the employment of better materials for turbine parts, and particularly for blading; (*d*) higher efficiency over a wide range of load; (*e*) adjustment of the turbine more closely to the particular requirements of service; and (*f*) the development of binary fluids for use in turbines. The effect of such tendencies will be the production of larger, more reliable and more economical turbines than those now available.

HIGHER TEMPERATURES AND PRESSURES.

The possibilities of steam pressures have been determined from the operation of various commercial units to the critical pressure of 3200 lb. per square inch, and the gains from increases of pressure are now fairly well known. Attention has recently been directed to studies of the effect of higher steam temperatures, which conditions present

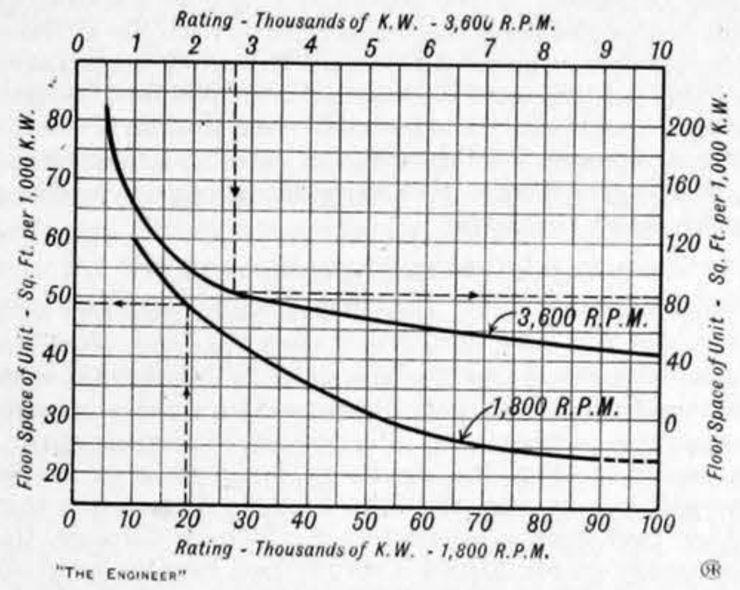


FIG. 1

Floor space required for single-cylinder 3600 r.p.m. turbine alternators and also for single-cylinder 1800 r.p.m. units. This area consists of a rectangle enclosing turbine, generator, and direct-connected exciter with an added rectangle for any offset valve gear.

more difficult problems than pressure alone. Metals, such as were formerly used in turbine construction, develop undesirable properties at temperatures above 750 deg. Fah. Tensile strength and fatigue limits decrease rapidly at higher temperatures, while the tendency towards that indefinite elongation known as "creep" also increases. The limiting temperature in a steam turbine is therefore fixed by the properties of available metals.

Progress has been made by searching out those materials that may be used safely at the higher temperatures and by designing spindles, blades, casings, &c., to be sufficiently strong under such conditions. "Creep" cannot be entirely overcome. However, parts may be designed so that the working stresses will lead to a rate of creep at the given high temperature which has been considered within safe limits over a period of years. Certain designers

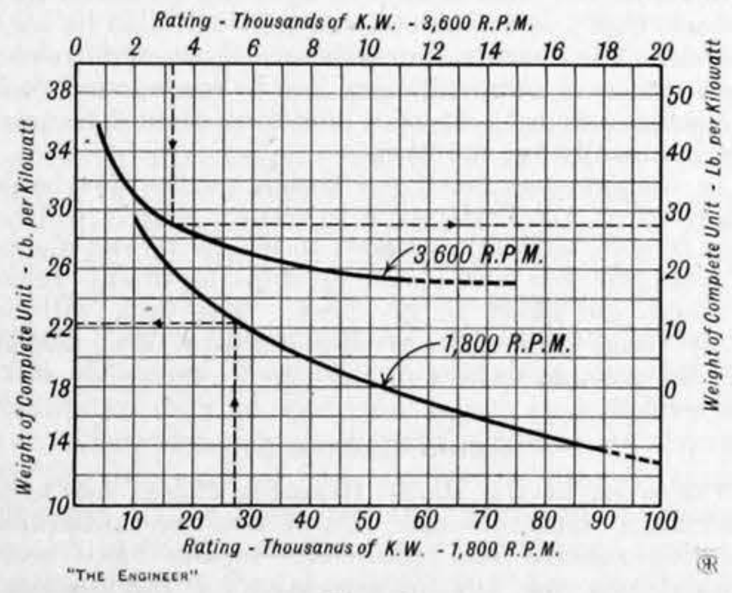


FIG. 2

Weights of single-cylinder 3600 r.p.m. turbine generators and of 1800 r.p.m. units.

have chosen this rate of creep as 0·01 per cent. per year, and this or a similar figure may be accepted as a standard rate for high temperatures.

With this rate of creep and with materials now available, turbines can be built for steam temperatures up to 900 deg. Fah. with assurance of satisfactory operation, while units for 1000 deg. Fah. can be constructed with every hope of successful operation throughout their useful life.

Methods of supporting casings for high temperature, and provisions for adequate expansion to eliminate causes of deformation in cylinders are under development.

The application of higher steam temperatures will have a profound influence on future station design. Previously turbines with no reheating were limited to initial steam conditions of 450 lb. per square inch and 750 deg. Fah. If higher pressures were used with the same temperature, the moisture content at exhaust became excessive. Conservative designers aim to keep this moisture content below 12 per cent. to prevent erosion in the last blade rows. A single-cylinder turbine of 68,000 kW, with no reheating, has already been built for 650 lb. per square inch, 825 deg. Fah. With 900 deg. Fah. steam temperature, the steam pressure may be raised to 750 lb. per square inch. Hence substantial increases in steam pressure may be expected in future non-reheating turbines when temperaures above 750 deg. Fah. are employed.

A large number of American stations now use, or will soon use, 1200 lb. to 1400 lb. per square inch steam pressures with steam temperatures of 750 deg Fah., and with a single stage of reheating. Steam temperatures of 900 deg. Fah. may make it economical to increase the steam pressure of reheating stations to 2000 lb. or 2500 lb. per square inch.

Steam conditions in future stations will probably be standardised as follows:—With no reheat, 400 lb. per square inch, 750 deg. Fah.; and 700 lb. per square inch, 850 deg. Fah.; while with one stage of reheat, 1400 lb. per square inch, 750 deg. Fah., and 2000 lb. to 2500 lb. per square inch, 900 deg. Fah. In the latter case, two stages of reheat may be used if high efficiency is desired.

These considerations apply in general to large central stations. However, the gains from increased temperatures and pressures are equally applicable to industrial plants

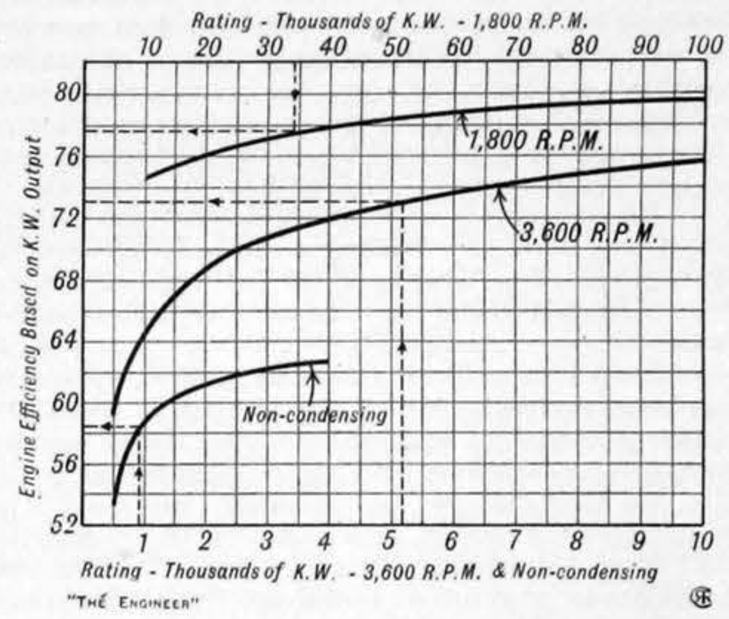


FIG. 3

Average engine efficiency for the load point of best efficiency based on kilowatt output at the generator terminals.
Curve A.—Single-cylinder turbines at 3600 r.p.m., for steam conditions up to 300 lb. per square inch gauge, 600 deg. Fah., 28·5in. vacuum.
Curve B.—1800 r.p.m. turbines for steam conditions up to 450 lb. per square inch gauge, 750 deg. Fah., 29in. vacuum.
Curve C.—Non-condensing units for steam conditions up to 250 lb. per square inch gauge, 550 deg. Fah., atmospheric pressure at exhaust.

When such plants operate without vacuum or exhaust against back pressure into a service main, the proportional gains from using high pressure and high superheat are larger than in condensing central stations.

INCREASED CAPACITIES.

The use of turbines of large rated capacities results in several economic gains. Floor space per kilowatt decreases with increasing size, as shown in Fig. 1. This results in a smaller turbine-room and a lower building cost per kilowatt. Steeple compounding has been introduced to provide a further saving in floor space. Manufacturers are endeavouring to reduce the lengths of their turbo generator sets to save more floor space. The weight per kilowatt decreases with increased ratings, as indicated by Fig. 2. Hence foundation costs are lessened. Attention is drawn to the decreased weight of units that operate at 3600 r.p.m., as compared with units of the same rating at 1800 r.p.m. Fig. 3 shows that the efficieney also tends to increase with higher turbine capacities though at a lesser rate in the largest units. First cost per kilowatt, in Fig. 4, also decreases with increased capacity. The economic justi-

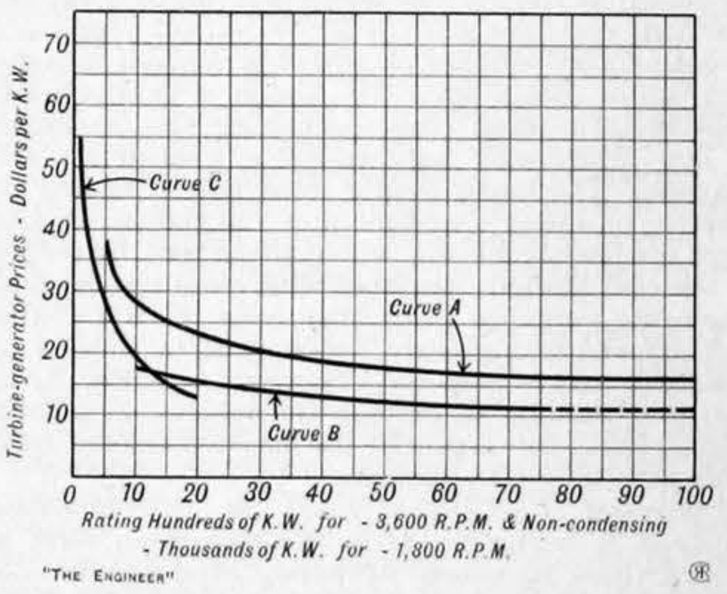


FIG. 4

Prices for turbine generator units in the United States. Prices include bare turbine and generator without auxiliary generators or direct-connected exciters, and are for units delivered and erected. Prices are for pressures up to 400 lb. per square inch gauge, steam temperatures up to 725 deg. Fah., and, when condensing, up to 29in. vacuum.
Curve A.—3600 r.p.m., condensing units.
Curve B.—1800 r.p.m., condensing units.
Curve C.—Small non-condensing sets.

fication for the trend towards higher capacities is evident from a consideration of these data.

Single-cylinder condensing units of 10,000 kW at 3600 r.p.m. have been built in this country. C. A. Parsons and Co. have single-cylinder condensing units of 15,000 kW at 3600 r.p.m. in operation, one at Regina, Saskatchewan, Canada, and are offering similar turbines of 20,000 kW and 25,000 kW with one casing. The largest unit at 1800 r.p.m. with a single cylinder has a capacity of 80,000 kW. These single-cylinder units of high capacity pass such great volumes of steam through the last row of blades that the leaving losses are large. Such losses tend to offset the gains in engine efficiency which come with increased size. As the result, these large units cannot be

* Professor of Mechanical Engineering, Johns Hopkins University, Baltimore. Paper read before Mid-West Power Conference, Chicago, February 11th.

expected to establish records of efficiency. However, American engineers favour the single-cylinder units, as they decrease station cost and are simpler to operate.

Attention has already been drawn to the large sizes of single-cylinder turbines now available at 3600 r p.m. Turbines can be built for this speed up to 50,000 kW in two tandem cylinders and up to 100,000 kW when two low-pressure cylinders in tandem are provided. These turbine capacities are beyond the limits of any 3600 r.p.m. generators developed to date. These compound units have certain economic advantages that deserve consideration. Their weight is less than a unit of similar capacity at 1800 r.p.m. The shafts are shorter between bearings, and, having less mass, can start under high-

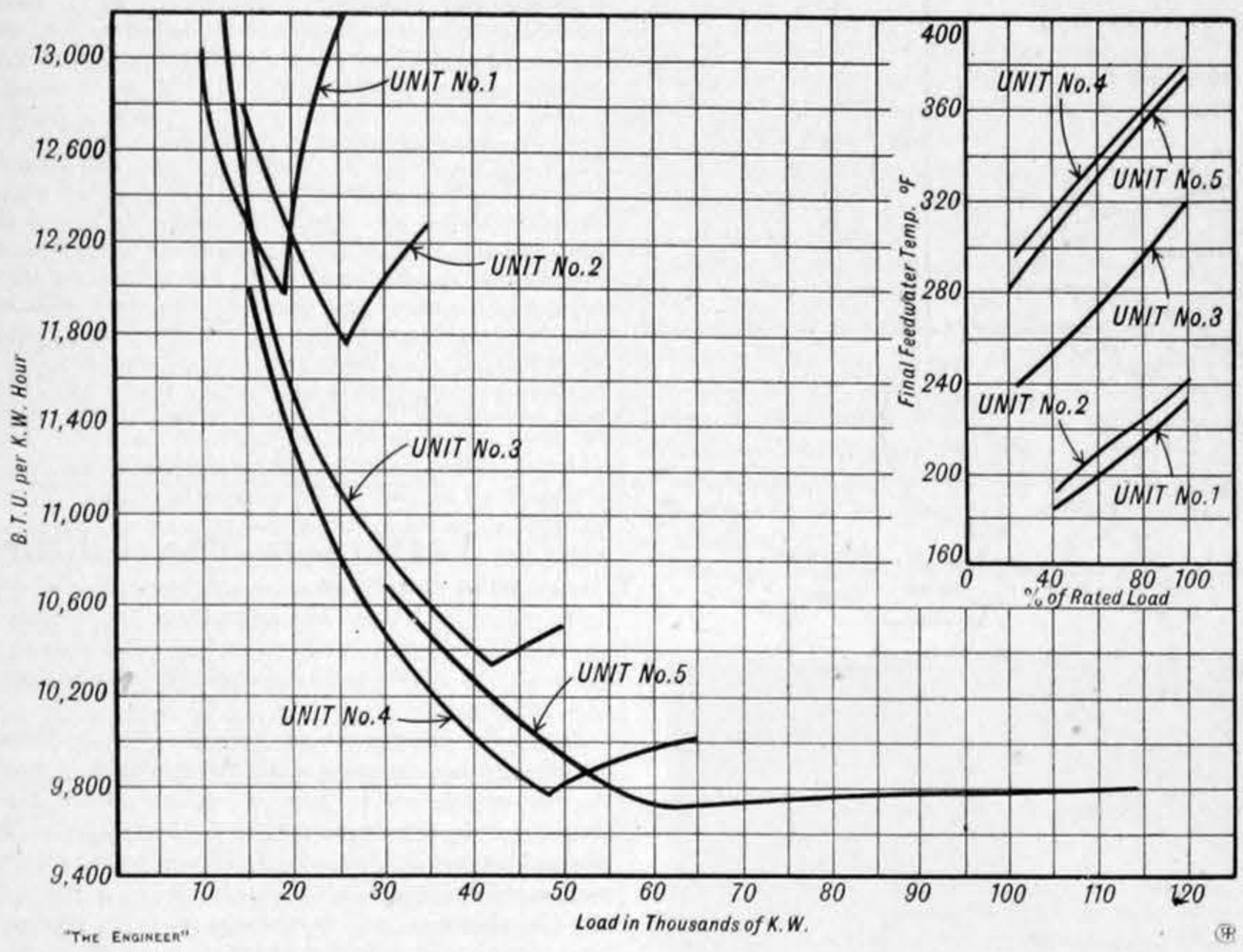


FIG. 5

Improvement in steam turbine performance. The economy characteristics of a series of five units installed and building for a central station during a period of eight years, from data furnished by Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Final feed-water temperatures at various per cents. of rated load are also shown.

Unit No. 1.—25,000 kW at 93 per cent. power factor. Operating conditions, 350 lb. per square inch gauge, 675 deg. Fah., 29in. vacuum, two-stage bleeding. Installed in 1923.

Unit No. 2.—35,000 kW at 93 per cent. power factor. Operating conditions, 350 lb. per square inch gauge, 675 deg. Fah., 29in. vacuum, two-stage bleeding. Installed in 1925.

Unit No. 3.—50,000 kW at 85 per cent. power factor. Operating conditions, 600 lb. per square inch gauge, 725 deg. Fah., 29in. vacuum, four-stage bleeding. Installed in 1927.

Unit No. 4.—65,000 kW at 85 per cent. power factor. Operating conditions, 600 lb. per square inch gauge, 725 deg. Fah., 29in. vacuum, reheat to 725 deg. Fah., four-stage bleeding. Installed in 1930.

Unit No. 5.—115,000 kW at 95 per cent. power factor. Operating conditions, 625 lb. per square inch gauge, 750 deg. Fah., 29in. vacuum, reheat to 750 deg. Fah., four-stage bleeding. To be installed in 1931.

temperature conditions more rapidly than units of the same size at 1800 r.p.m. Finally, the efficiencies with the same blade speeds and same kilowatt rating are higher in the 3600 r.p.m. than in the 1800 r.p.m. units. These advantages, when more generally recognised, will lead to a wider use of large turbines at 3600 r.p.m.

Multi-cylinder units at 1800 r.p.m. have been built in tandem up to 160,000 kW. Such tandem compound units for large capacities are finding favour among power plant designers, and will be used more extensively in the future. Triple tandem turbines up to 150,000 kW at 1800 r.p.m. for 1200 lb. per square inch are under construction. Cross-compound turbines with several generators, ranging up to 208,000 kW are being used in increasing numbers. The trend in central station practice is towards the use of larger units and the above capacities will be exceeded when system loads warrant the increased sizes of turbines.

IMPROVED MATERIALS.

The manufacture of shafts and turbine discs has been improved through better steel foundry and forge shop practices, through internal inspection by means of boreholes, through vibrating the discs before assembly and through careful static and dynamic balancing after completion. As a result of improvements in these practices, troubles with such elements are steadily diminishing.

Many turbine difficulties are traceable to blade troubles. Blade vibration is a common cause of failure. Much research work must still be done to find the proper location of lashing wires, the correct method of silver soldering these wires, the best form of shrouds and even the most effective form, size and angles of the blades themselves to resist vibration in the larger sizes of turbines now used.

Two trends in turbine development have been responsible for much blade trouble. In order to secure added capacity and improved efficiency, blade speeds have been steadily increased, until tip speeds of 1150ft. per second are now in use. These operating conditions require long blades of high strength and rigidity. Such blades are liable to vibrate. The second trend is the increasing use of large heat drops at high efficiency which lead to high moisture contents in the exhaust steam. This moisture causes rapid erosion of the blades in the last rows of the turbine which not only decreases turbine efficiency, but also increases the risk of failure of low-pressure blading, and, further, necessitates the replacement of such blades every three to five years. Such replacement is expensive and necessitates a serious outage. Future developments will provide alloy steels for use at these high blade speeds, which will have longer life under the wet steam conditions in the last rows.

Stainless steels at present seem best suited for long blades. A steel with about 12 per cent. chrome and 0·1 per cent. carbon has given much promise for such service.

Moisture is difficult to remove from this low-pressure steam. Different schemes, such as drainage grooves, by-pass orifices, &c., have been tried, but the best results so far reported only indicate the removal of about 25 per cent. of the total moisture. A study of eroded blades shows that the destructive moisture is concentrated on the outer half of the blade, but not wholly at the periphery. The droplets are, undoubtedly, of small size and difficult to separate from steam at high velocity. Hence, the ineffectiveness of the various catchers and other devices.

The late Professor Goodenough offered the theory that the water droplets travel through the stationary nozzles and blades at a slower speed than the steam, and thus do not enter the blades at the proper relative angle. The faster steam enters the blades tangentially as it should, but the slower water droplets are struck by the back of the blade and rapid erosion results. This explains why erosion occurs on the back of the inlet edge of the blade.

Of the various blade materials tried under these conditions, properly heat-treated stainless steels and some nickel alloys seem best. Plating the edges of these blades with erosion-resisting metals has been tried and heavy plating of chromium appears promising. Sprayed coatings of tantulum, sheathes of Hecla and other metals, caatings of stellite and nitriding, also appear to resist erosion and are being further investigated. There is reason to expect that an erosion-resisting blading may soon be developed.

A suggestion has been made to provide hollow stationary blades or hollow diaphragm partitions in which a hot medium can circulate. The heat from these blades would dry the low-pressure steam passing them. If this can be done, it would not only decrease erosion, but would increase turbine efficiency.

Turbine builders and users now recognise the seriousness of the problem of properly dealing with this wet exhaust steam. Further research will develop improvements in materials or ways of eliminating the trouble.

Oxidation difficulties in blading have been largely overcome through careful de-aeration of feed water. Some dissociation may later be found in high-temperature superheaters, but its effects are at present hard to predict.

Much trouble has resulted from deposits on turbine blading, and a technique has been developed to remove this in stations where the deposits are troublesome. Purer make-up for boiler feed water, less condenser leakage and drier steam from boiler drums to superheaters, will do much to overcome this trouble.

IMPROVED EFFICIENCIES OVER WIDE LOAD RANGE.

Efficiency in turbines is largely a matter of price. Each manufacturer offers units which will give about the same efficiency and will sell at about the same price as his competitors. Turbines of higher efficiency than these commercial units can be built if one is prepared to pay the higher cost of these improved designs. Load conditions, early supercession by more modern units, changing steam conditions, low fuel costs, and other factors, frequently make it uneconomical to purchase a turbine of the highest efficiency. Nevertheless, the performance of steam turbines is being steadily bettered and this improvement will continue.

Large turbines are generally provided with bleeders and some have reheaters. Hence, performance is best expressed in terms of B.Th.U. per kilowatt-hour rather than in pounds of steam per kilowatt-hour.

The gains in efficiency from improvements in the design will be comparatively small for any particular feature, but, in the aggregate, may lead to substantial advances. Efficiencies of 82 to 85 per cent. at the coupling are obtained on some American turbines, while an efficiency of 87·7 per cent. at the coupling is claimed for a European turbine of 85,000 kW. As previously stated, the high leaving losses inherent in the design of many turbines of large capacity, lead to moderate efficiencies of such units. Better performances may be expected to result from lower leaving losses, from reduction of moisture in exhaust stages, from improved blading in the high-pressure section, and from a greater combination of impulse and reaction effects in all blading. Regarding the latter, there is already a tendency to secure reaction effects from blading on types of turbines which were formerly considered as of the pure impulse type.

Recent designs provide for high efficiency in B.Th.U. per kilowatt-hour over a wide range of load through the use of secondary, tertiary and even quaternary inlet valves. This is shown in Fig. 5, where the heat consumption of the largest unit does not vary more than 100 B.Th.U. per kilowatt-hour from 55,000 kW to 115,000 kW loads. The governor design becomes more complicated when such additional admission valves must be controlled. Manufacturers provide inherent excess capacity in many turbines so that full load can be maintained should boiler pressure drop below normal. But generators are designed with little spare capacity, and if additional overload capacity is desired, this must be specified and paid for, or the generator may be purchased for a lower power factor.

The gains in heat consumption obtained through the use of bleeder heaters have been fully analysed and discussed, and are generally understood by engineers. These bleeder heaters have usually been of the closed type. Successful operation of the high-pressure, direct-contact heaters at South Amboy station may lead to a more extended use of this type.

The last high-pressure heater is frequently furnished with highly superheated steam. It is possible to design a counter-current closed heater to take advantage of this superheat and thus raise the feed water above the saturation temperature corresponding to the steam pressure in this heater.

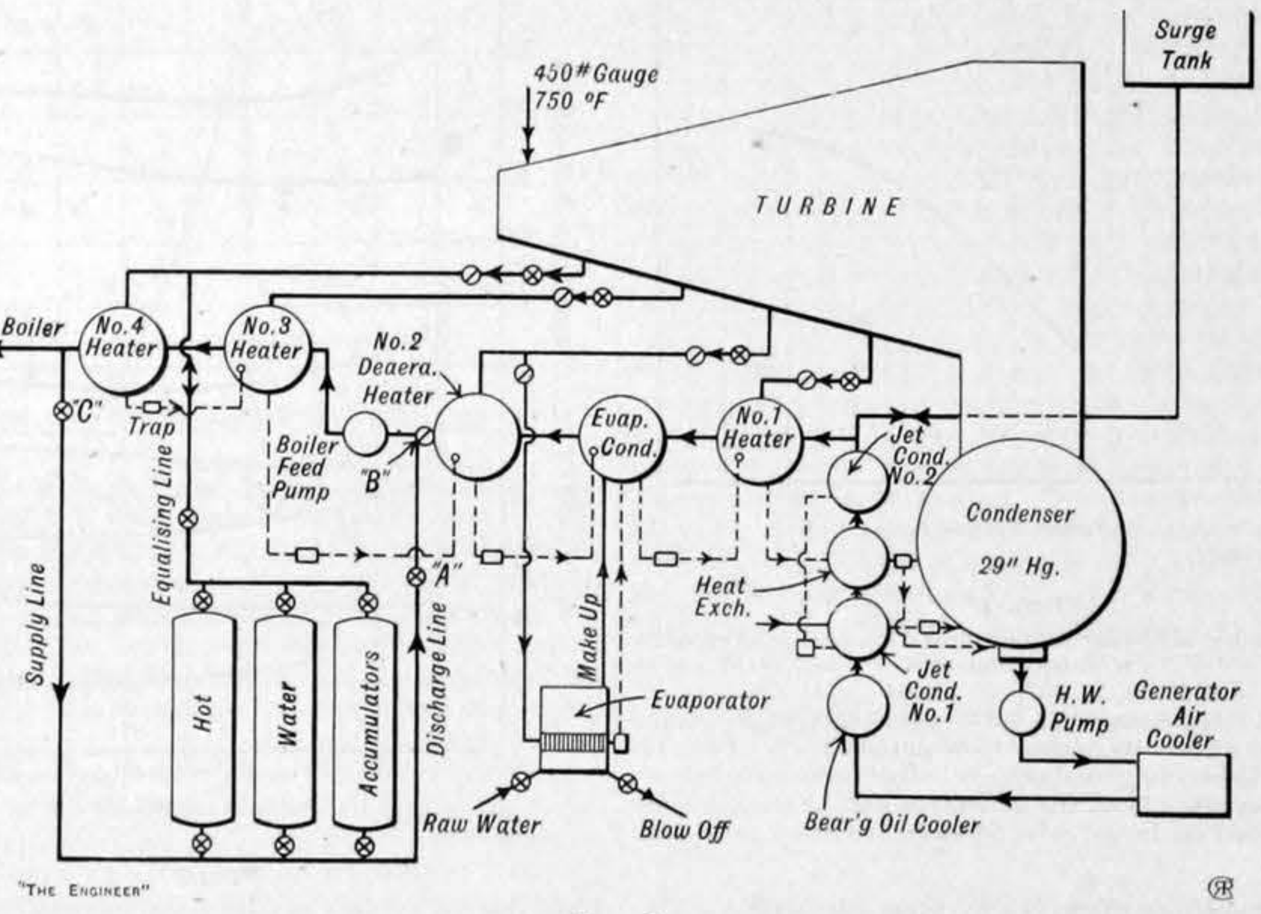


FIG. 6

Feed-water heating cycle and arrangement of equipment. Storage after No. 4 heater.

Mr. Warren Viessman and the writer showed in a recent paper† that, after a turbine has been fully loaded with all bleeders in service, still further gains in turbine capacity can be secured by cutting off bleeder heaters at the time of peak load. To demonstrate these possibilities a turbine receiving 673,000 lb. of steam per hour at 450 lb. per square inch, 750 deg. Fah., and exhausting at 29in. vacuum was assumed to have four bleeder heaters. If these are all shut off at the time of peak load the station

† "Low Cost Peak Load Capacity, with Bleeder Turbines," by Warren Viessman and A. G. Christie. Metropolitan Section, A.S.M.E., January 8th, 1931.

capacity can be increased 17·7 per cent., but the cold condensate to the boiler would increase boiler output about 27 per cent. Hot water storage after the last bleeder heater, as shown in Fig. 6, would permit peak load operation with bleeders out of service for two hours, and with no change in boiler capacity, and would give the 17·7 per cent. increase in capacity. This plant can be installed together with added generator capacity for about 24·35 dollars per kilowatt. The adjusted station heat consumption per kilowatt-hour is practically the same for the

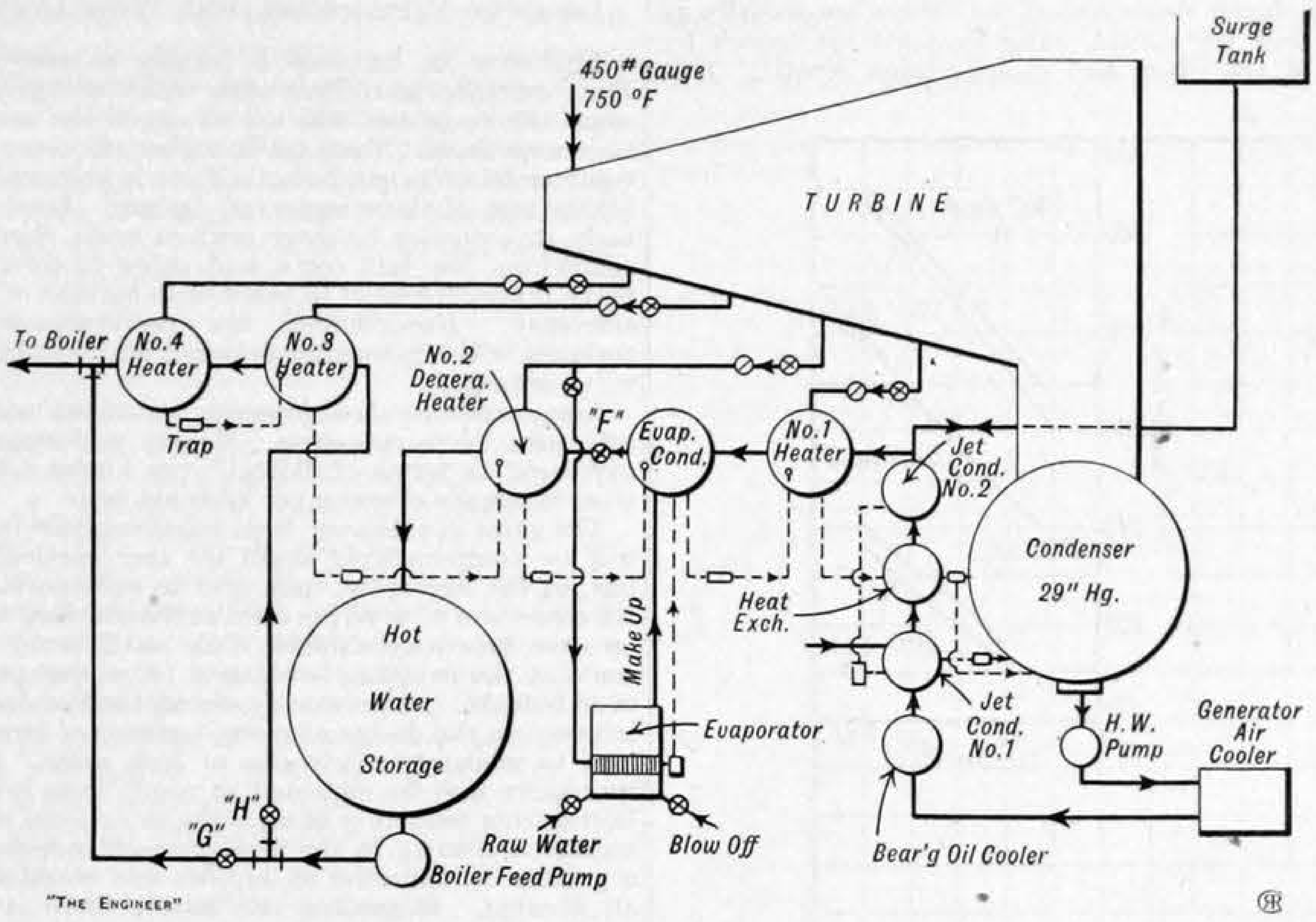


FIG. 7
Feed-water heating cycle and arrangement of equipment. Storage after No. 2 heater.

peak load with the bleeders cut off, as during normal operation. A cheaper arrangement giving the same increase in capacity is shown in Fig. 7, where the hot water storage is placed at low pressure after the second bleeder heater. In this case boiler capacity must be increased 15·4 per cent. Fig. 8 shows the increases in station capacity with different numbers of heaters. The paper discusses other methods of increasing peak load capacity by discontinuing the use of bleeder heaters when there is no objection to colder feed water and to additional forcing of boilers. These gains in capacity by cutting off bleeder heaters can be secured after all the gains from other means of overloading have already been obtained. Such methods of providing additional capacity at peak loads can be employed in many present and future central stations.

Reheating of steam is necessary with pressures of 1200 lb. per square inch and above. Flue gas reheating is apparently gaining ground on account of the marked improvement in station economy achieved by its use. Steam reheating is more convenient in certain stations, but is less economical than gas reheating. The use of diphenyl oxide for reheating purposes is being investigated and appears to have interesting possibilities.

The use of hydrogen for generator cooling will probably

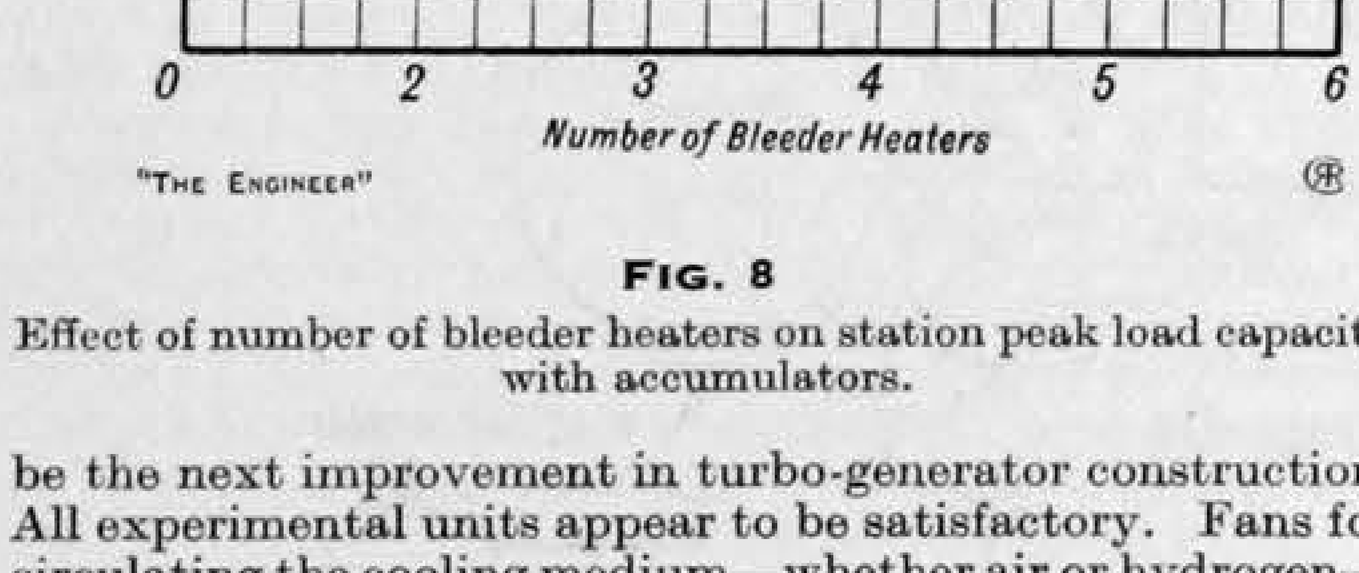


FIG. 8
Effect of number of bleeder heaters on station peak load capacity with accumulators.

be the next improvement in turbo-generator construction. All experimental units appear to be satisfactory. Fans for circulating the cooling medium—whether air or hydrogen—should be separate from the generator and be designed for variable speed on large units to save auxiliary power at light loads.

ADJUSTMENT OF TURBINE TO SPECIFIC SERVICE.

The desire to reduce power costs by keeping station investment at a minimum led to a study of turbine frames and their economic ratings as fixed by their probable use factor throughout their whole operating life and by the cost of fuel. It is obvious that with low use factors and cheap coal, leaving losses can be increased and the output of a given casing can be greater, thereby reducing first cost, than in the case of a base load station with expensive coal. Fig. 9, from a study by Mr. Francis Hodgkinson, of Westinghouse Electric and Manufacturing Company, shows that a casing may have an economical rating from a dollar standpoint ranging from 30,000 to 50,000 kW, depending upon the value of K, which is the product of use factor expressed on a decimal, and costs in dollars per 1000 lb. of steam. If the most economic installation is to be secured for a given service, it is evident that there must be close co-operation between the manufacturer and the engineers of the purchaser in order to find which turbine frame and what rating of this frame will develop power at the lowest total cost in any given plant. No frame hereafter will have one fixed rating.

The same degree of co-operation between turbine builder and purchaser is essential in the choice of an industrial turbine particularly where this is of the reducing or bleeder type from which steam is to be taken for industrial purposes. The problems of such turbines are becoming increasingly complicated and require the best engineering skill for their successful solution.

Special turbines of rugged design, capable of being started quickly and of high capacity for a given frame, have been used as steam stand-by units for hydro-electric systems. Future turbines will be better suited to their services than those now in use.

BINARY FLUID TURBINES.

The excellent performance of the mercury boiler and turbo-generator plant at Hartford, Conn., has definitely established that combination as a commercial unit. For ten months last year this plant operated at a heat rate of 10,310 B.Th.U. per kilowatt-hour of net station output. Engineers expect ultimately to reduce this consumption

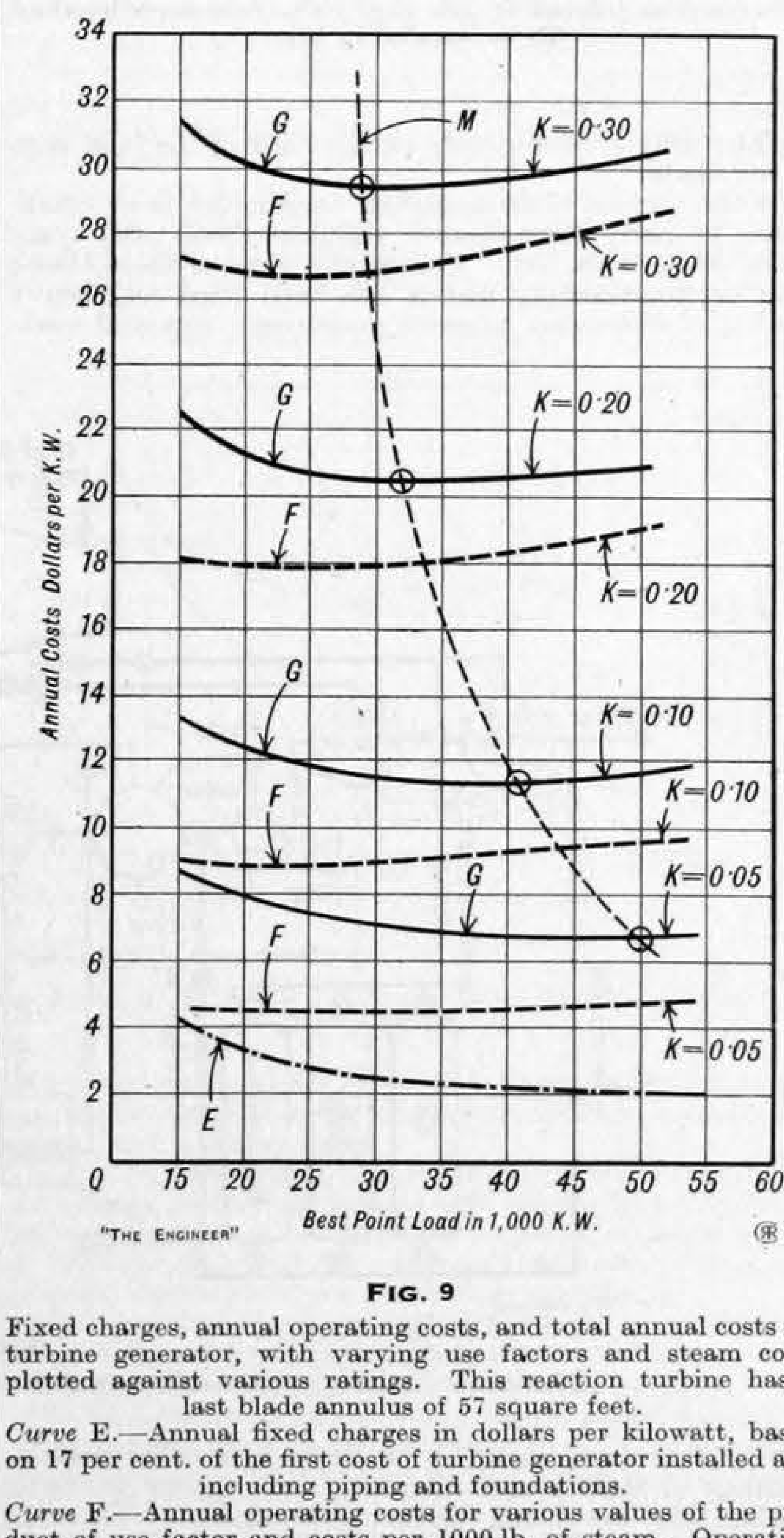


FIG. 9
Fixed charges, annual operating costs, and total annual costs for turbine generator, with varying use factors and steam costs plotted against various ratings. This reaction turbine has a last blade annulus of 57 square feet.
Curve E.—Annual fixed charges in dollars per kilowatt, based on 17 per cent. of the first cost of turbine generator installed and including piping and foundations.
Curve F.—Annual operating costs for various values of the product of use factor and costs per 1000 lb. of steam. Operating costs are based on the average load carried with an average steam consumption 2½ per cent. higher than that calculated for the given load from assumed data. Hence, annual operating costs = steam consumption in pounds per kilowatt hour at given load, as calculated from assumed data ÷ 1000 × 1·025 × cost of steam per 1000 lb. × use factor × 8760.
Curve G.—Total annual costs = Curve E + Curve F for each value of K.
Curve M.—Loci of minimum values of G for various values of K.

to about 8500 B.Th.U. per kilowatt-hour. No data are available regarding initial and operating costs. Consideration must be given to this combination in planning new plant, particularly if this plant is for a base load or for high use factors.

The success of the mercury turbine will encourage attempts to develop processes to use other materials than mercury, such as diphenyl, diphenyl oxide, and zinc ammoniate. Some of these, or others yet untried, may prove suitable for power plant use.

CONCLUSIONS.

These notes have discussed some present problems and trends in steam turbine development. Steam turbines will be built for high economy over a wide range of load when using higher steam temperatures and pressures than at present. Blade materials will be improved better to withstand vibration and erosion, and this improvement will increase the reliability and availability factors of the turbines. Greater care will be taken to fit the turbine to its load conditions than heretofore. Finally, the use of binary cycles will increase.

One will ask, "What is the probable limiting performance to be expected of a steam turbine?" This has not yet been approached, and American economic conditions may never warrant the plant investment to achieve this ultimate end. Probably the best estimate of this limiting performance is that for a large plant with steam at 2500 lb. per square inch, 1000 deg. Fah., having two stages of reheating to the same temperature, and with six stages of bleeder heating, leading to a station heat rate of about 9500 B.Th.U. per kilowatt-hour of net output. Within the bounds of our present knowledge this may be taken as the best performance to be expected of a steam turbine.

Letters to the Editor.

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

TIDAL POWER.

SIR,—In your issue of February 20th, there appeared an article by an unnamed correspondent, giving details, so far as known to him, of three different systems for deriving electrical energy from the tides. The first of these systems is that which, he understands, has occupied the careful attention of a body of experts appointed by the Government, and would appear to have been considered unsuitable, for reasons which are not difficult to gather. The second system is my own, which, he omits to mention, has been thoroughly tried out by the satisfactory functioning of a demonstration unit. The third system is that of a Swiss engineer named Huguenin, which is admittedly still in the theoretical stage.

I note that in regard to my own system, he mentions that it "is said to use only one-way-flow turbines," which allows him to suggest that the Huguenin method of two-way-flow has a special advantage. Surely, your correspondent cannot think that such a point will have been overlooked by any hydraulic engineer, or that the two-way-turbine is a monopoly of any system. It will be sufficient if I say that for a unit built for demonstrating the conversion efficiency of my method, I adopted such means as were most conveniently to hand. The figures derived from the working of my unit have been certified by competent authorities, and are scarcely in question. What the figures of the Huguenin system may ultimately prove to be, we are not able to say with certainty at this stage. But I would like to point out that from the statements of your correspondent it is evident that the suggested possible overall efficiency of 80 per cent., with a storage efficiency of 55 per cent., represents 60 per cent. of the tidal energy as direct electrical load, which is, obviously, an unhappy confession.

It will not be necessary for me to criticise the defects of any system depending upon the compression of the amount of air needed for the generating of electrical energy upon the scale in view, but it will seem highly desirable to avoid involving any Government department in a hypothetical inquiry before providing proven facts and figures by the testing of a demonstration unit. Furthermore, it should be noted that the Huguenin scheme, as outlined by your correspondent, depends upon the building of a barrage already estimated at an entirely prohibitive figure, and would entail the ultimate silting of the Severn Estuary, and each is in itself sufficient to place the proposed method at a penalising disadvantage.

In conclusion, I may be allowed to express surprise that before entering upon his comparison, your correspondent did not avail himself of the known facts in regard to my system and its principle and methods. He would then have avoided stating that I propose to depend upon the storage of steam produced by the hydraulic brake, which I do not. I will not ask space of you for the defence of my system. My demonstration unit is open for inspection, and the plans already evolved for use upon a suitable scale are such as depend upon proven working efficiency and give no room for doubting a complete success.

And, if in the making of a theoretical comparison, there may be time to consider that troublesome, but rather important, little matter which is the cost factor, it will be found, I think, that the advantage is overwhelmingly upon my side.

P. SHISHKOFF.

ROADS AND RAILWAYS.

SIR,—You may think it worth while to give space to put before technical readers the following general reflections on our transport policy, because to those who base their hopes of the future upon memories of the past, our policy can only be described as in one word, disastrous. The question then arises, What new basis of hope is offered by the progress of mechanical invention?

More than a thousand million pounds have been spent by public authority since the European War on the conversion of our highways into motor tracks. About one-third of this cost has been met by those road users who pay motor licence and motor spirit taxes; but a substantial amount—in the region of fifty or sixty million pounds—has been extracted from the railway companies for the benefit of their competitors. Commercial and operating conditions on the roads are comparatively free from official interference. Clearly we have subsidised that transport service which best helps the foreign producers of our imports to compete against local producers. On the other hand, road transport does little for our home industries which could not have been done equally well by either coasting vessels or canals or railways or horses. Our gifts of route space and track construction have encouraged an extravagant demand for fashion and variety in the design of motor vehicles.

Our island position makes ocean transport vital to us. Ocean transport undertakings need outward cargoes, and the former prosperity of our exporting industries was based upon cheap inland movements of heavy materials. Steam can be heated by the cheapest fuel on the market; clearly, steam haulage over metal rail tracks is the best method yet known to us for heavy inland transport.

A very large proportion of railway expenditure is in those on-costs which have no direct relation to work accomplished, such as upkeep of way and works, and the service of the debt for law expenses, land purchase, and construction of track and access. The cost of hauling one sort of material, as compared with another, could be neglected; charges for railway carriage used to be regulated by the capacity of the traffic to bear them. It happened that food and other inward traffic was of higher value in proportion to weight and bulk than most of the outward traffic; consequently, the inland distribution of imported commodities paid more of the railway on-cost than was paid by the materials moved for shipbuilding and for export. Most railway requirements are supplied from home sources.

It is not reasonable to suppose that our heavy trades can long survive such attacks as are organised on the largest scale by Governments in England against the transport system on which they depend, these attacks being based upon the solid public demand for favoured conditions for inward and luxury traffic. Many people advocate subsidies of one sort or another to English agriculture. We shall certainly find ourselves subsidising agriculture, because less food will be sent to us from outside this island, if we wreck the railways, unless new productive industries can be built upon the basis of road motor transport. Until such new industries show themselves, on a larger scale than our motor manufacturing industry, I think that engineering firms would be well advised to turn their attention, more than hitherto, towards agricultural machinery.

E. PEASE.

Hinderwell, North Yorkshire, February 26th.

CLARKE, CHAPMAN AND CO., LTD., AND THE LATE SIR CHARLES PARSONS.

SIR,—We are instructed by our clients, Clarke, Chapman and Co., Ltd., to refer to an obituary notice of the late Sir Charles Parsons, which appeared in the issue of THE ENGINEER, published on the 20th ultimo. At the foot of the second column of the notice, it is stated, quite correctly, that "in 1889 the partnership between Sir Charles and Clarke, Chapman and Co. was dissolved, but the latter kept the rights in the turbine patents." This statement assumes, however, a serious aspect when it is considered in conjunction with the further statement which appears half-way down the third column, to the effect that "it must have been a great relief to the inventor when, in 1894, the courts restored to him the rights in his original patents."

The true facts of the case are that by the deed of partnership entered into between the Hon. C. A. Parsons—as he then was—and Clarke, Chapman and Co., all patents taken out by any partner became the property of the partnership. When Sir Charles Parsons decided in 1889 to dissolve partnership, the question arose as to the disposition of the patents, and the continuing partners in Clarke, Chapman and Co. offered immediately to submit the whole matter to arbitration, and to transfer to Sir Charles Parsons the patent rights upon such terms as the arbitrator might award. The arbitration duly took place, but before any award had been made, an agreement was entered into between the parties, by which the patents were retained by Clarke, Chapman and Co. In 1894 an offer was accepted by Clarke, Chapman and Co. for the patents, and they were assigned to Sir Charles Parsons.

When taken in conjunction, the two statements in your obituary notice clearly imply that the retention of the patent rights by Clarke, Chapman and Co. was a wrongful procedure, which was only put right when in 1894 the courts restored to Sir Charles Parsons the rights in his original patents. This is a grave misstatement of fact, and the implication is, in our opinion, calculated to damage the commercial reputation of our clients.

WATSON, BURTON, BOOTH AND ROBINSON.
GEORGE R. HODNETT.

Newcastle-upon-Tyne, March, 3rd.

THE "ROCKETS."

SIR,—It might be as well if I added that all of the Leicester and Swannington Railway engines mentioned in the list which accompanied my letter in your issue of the 6th inst., page 154, had, according to Mr. Stretton, inside cylinders.

"Comet," "Phœnix," "Samson," and "Goliath," Nos. 1 to 4, and "Liverpool," No. 7, were built as 0–4–0 engines. In 1833 "Samson" and "Goliath" were altered to 0–6–0's, and are said to have been the first of their type in this country. "Atlas" and "Vulcan," Nos. 6 and 8 respectively, were also 0–6–0's, while No. 5, "Hercules," and No. 9 "Ajax," were 0–4–2's.

F. W. BREWER.

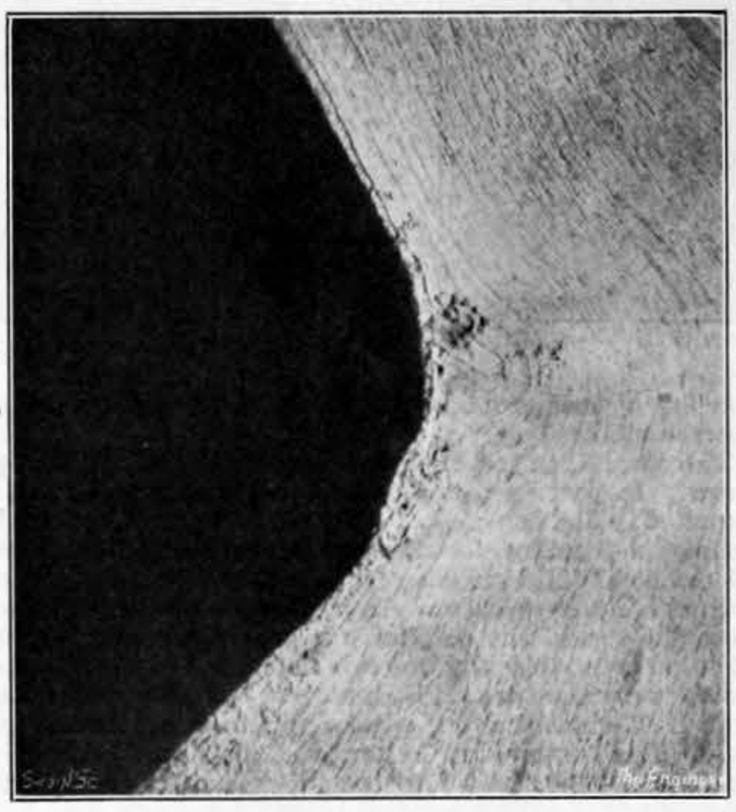
Stevenage, Herts, February 28th.

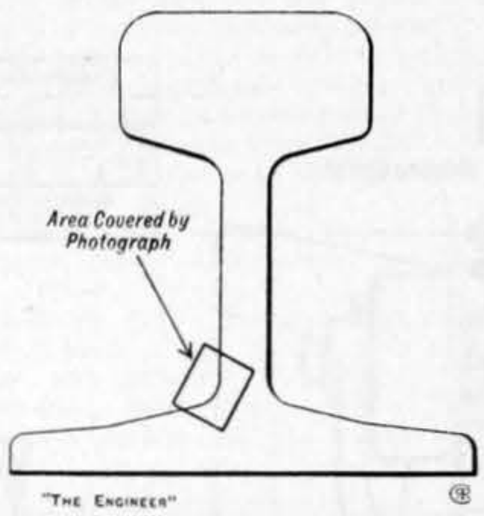
FAILURE OF FLAT-BOTTOM STEEL RAILS.

SIR,—As I have had the opportunity to investigate several similar failures, I was interested to read Mr. Huddart's article published in your issue of December 12th, 1930, and the letter from Mr. Wraight in your issue of February 20th, 1931.

It is an unfortunate fact that failures of F.B. rails in the manner described have occurred too frequently during the last few years to allow the matter to rest. At first the failures were treated as isolated cases which were not likely to be repeated, but the defect producing these breakages has occurred in rails rolled by two of the best-known rail mills in this country, and its elimination has become a matter of some moment. The actual cause of the defect is somewhat elusive, and although the general conditions which produce it are known, it is impossible to say at the moment with any certitude the exact cause, and any fresh information on the subject would be invaluable.

I am afraid that Mr. Huddart's article does not throw





DISTORTION OF FLOW LINES IN WEB OF RAIL

any new light on the subject. In fact, starting out to deal with the breakage of rails, the investigation described deals rather with the wearing properties as affected by normalising. There are a number of points in connection with this article that I should like to take up with the author, but I am afraid they are not relevant to the particular matter under discussion. Mr. Huddart's inferences regarding the cause of the fracture do not appear to be very conclusive. He starts out to say that the fractures in the rails coming under his notice occurred owing to a lap and that the lap—and presumably the failures—can be avoided by "suitable machining of the rolls combined with correct reduction of section at each pass." He then states that "the lap has little or no effect on a rail in a normal state of structure," and finally expresses the opinion that the actual cause of fracture is chilling due to the exposure of the rails on the hot bank to rain and cold winds.

It must be admitted that, bearing in mind the form of fracture, chilling was at first suspected of being a contributory cause, but investigation showed that this was not the case and that the defect is of a much more complex nature. Another line of investigation was the possibility of a lap being formed due to the "ragging" of the rolls, but here again an examination of the facts proved that this was not the cause.

Mr. Huddart mentions a paper published by the Government of India dealing with the trouble that has been experienced with rails rolled in India. The defect there has been somewhat extensive, as is apparent from Mr. Wraight's letter, in which he refers to large batches rejected and gives the results of his investigation on these rails. Mr. Wraight has apparently worked somewhat on the lines initially taken in an investigation with which I have been intimately concerned, but had he proceeded further he would have discovered a very interesting feature which gives a clue as to the manner in which the defect is produced.

I entirely agree with him that a lap in the position indicated will always produce fracture, but that failure will occur in many instances, even though no actual lap be present. From the clusters of ferrite lines in the region of the laps, shown in Mr. Wraight's photographs, it would appear that the laps referred to have welded up during the last stages of rolling and could not be detected by superficial inspection.

Investigation shows that the breakage is not necessarily due to the lap as such, but is primarily due to a weakness in the region where failure occurs, due to the distortion of the flow lines in the metal, which may or may not be accompanied by an actual lap. This fold or distortion of the flow lines which constitutes the defect under consideration is clearly shown in the accompanying macrograph, and it will be noticed that although there is considerable distortion there is no actual lap. The distortion occurs on one side only of the web, the flow lines on the other side following the outline of the section. It will be obvious that this is a mechanical defect produced in the rolling of the rails and is quite different from the ordinary lap caused by a fin being rolled in, which usually occurs higher up the web. This defect could not be produced by chilling and could certainly not be removed by normalising the rails as Mr. Huddart suggested.

For the benefit of those of your readers who are not acquainted with this type of breakage of F.B. rails, I give below the peculiarities common to all the fractures that have come under my notice:—

(1) The fracture always starts at the end of the rail at the bottom of the web on one side of the rail at the junction of the web with the bottom radius and it runs along this line.

(2) The defect is always on the same side of the rail in any one consignment, *e.g.*, at one works it will always be on the side bearing the brand, whereas at another it may be on the opposite side, depending on the number of finishing passes.

(3) It requires a "shock" blow to produce fracture, such as the rail would receive in off-loading or when being nicked and broken for a closure rail.

(4) If a blow is given on the side of the head of a rail sample so as to put the defective side in compression, the rail appears to be sound, but if the blow is given on the other side so as to put the defective side in tension, the sample will break through with very little deflection.

(5) When a section of the rail is etched, a distortion of the flow lines is always apparent in varying degrees in the region where fracture occurs.

(6) Although a lap may sometimes occur along the line of the fracture, this is not visible by superficial inspection.

(7) In all cases of failure investigated the rails had satisfactorily complied with all the requirements of the B.S. Specification. The defect is not revealed by the drop test.

It has been generally asserted—and Mr. Huddart appears to agree with this view—that the defect is due only to incorrect design of the grooves in the rolls. If this were so, the defect would appear throughout the whole of the rolling, but this is not the case. Space does not permit the description of many other interesting features in connection with this type of breakage, but I hope to have an opportunity at a later date to go more fully into the matter. Suffice it to say that investigations to date show that the defect is apparently produced by a combination of circumstances of which roll design and rolling temperature appear to be the primary factors. A further investigation is now being carried out which I hope will bring to light the actual cause and the means of obviating the defect.

Mr. Wraight will no doubt be interested to hear that the hammer test he refers to—at the best a rule of thumb test—has been in use in this country in one form or another for many years, but it has now been reduced to a scientific basis as an impact test, and will, I hope, constitute one of the new tests he is seeking. The impact test has been generally approved by the rail manufacturers in this country and is under consideration by the British Engineering Standards Association, and it is more than a possibility that the test will be incorporated in the British Standard Specification.

J. W. NORRIS,
A.C.G.I., Assoc. M. Inst. C.E., A.M.I. Mech. E.

267, Burntwood-lane, S.W. 17, March 3rd.

BEESTON BRIDGE.

SIR,—We read with interest a paragraph on Beeston Bridge in the letter from your Sheffield correspondent in your issue of February 27th, but would like to point out that we made, supplied and erected the steel work in this bridge (Messrs. Swift Brothers and Haslam were the building contractors), and we were rather proud of having done the work in less than the schedule time.

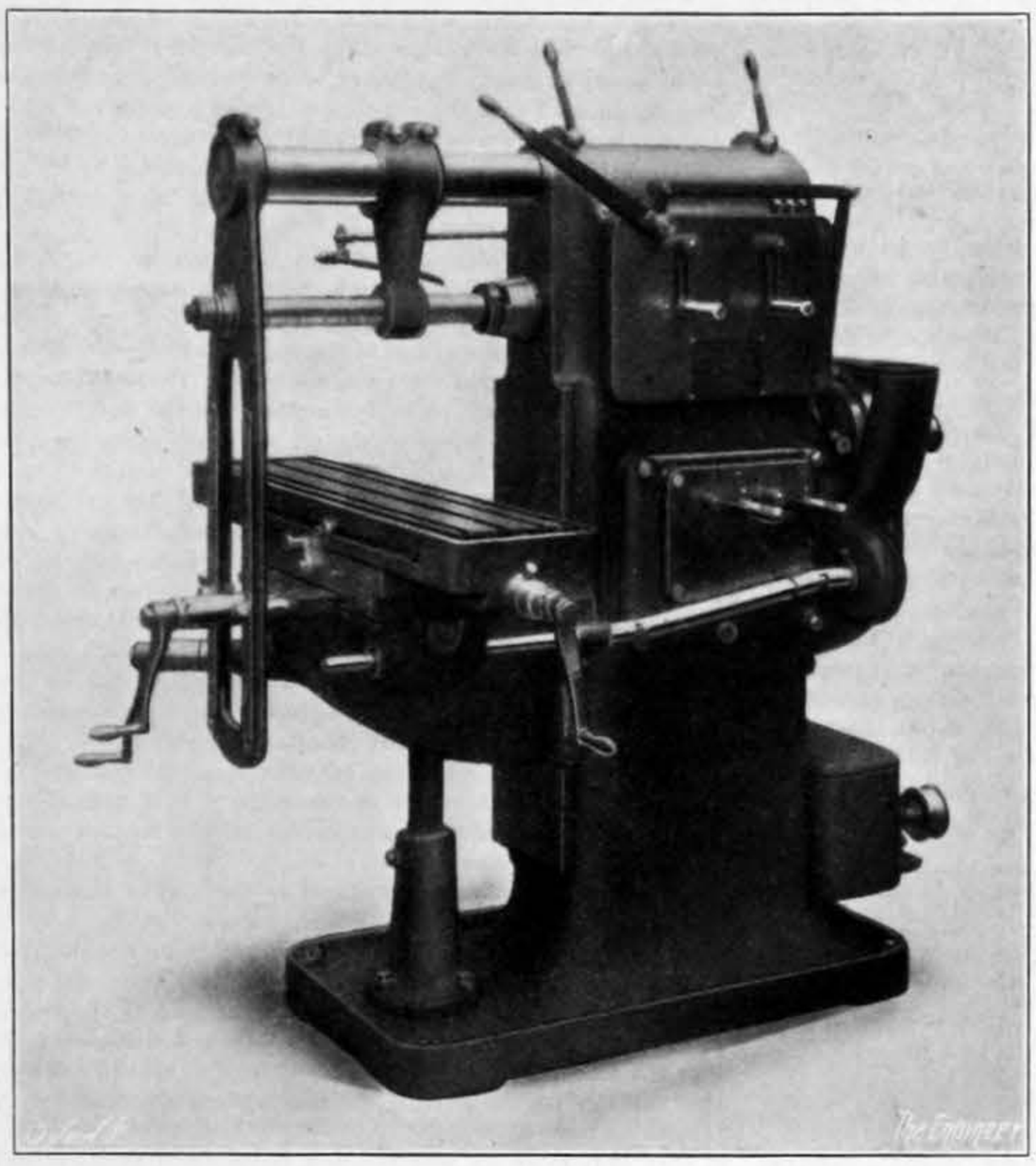
REDPATH, BROWN AND CO., LTD.,
JOHN G. EVANS, Manager.

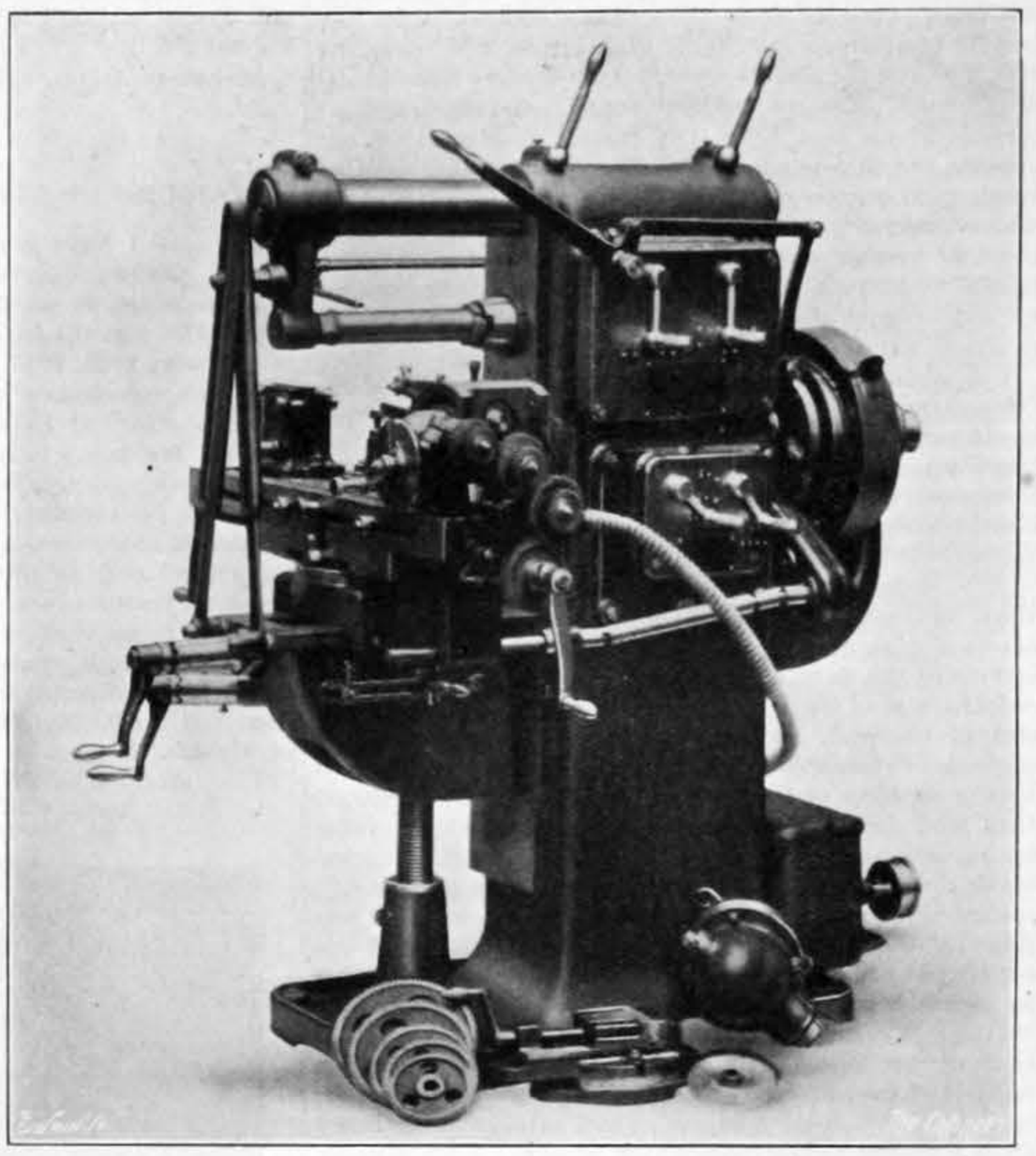
Manchester, March 2nd.

THE Council of the Iron and Steel Institute has awarded the Bessemer Gold Medal this year to Sir Harold Carpenter, Professor of Metallurgy in the Royal School of Mines Imperial College of Science and Technology, London.

A PLAIN AND A UNIVERSAL MILLING MACHINE

MIDGLEY AND SUTCLIFFE, BRADFORD, ENGINEERS





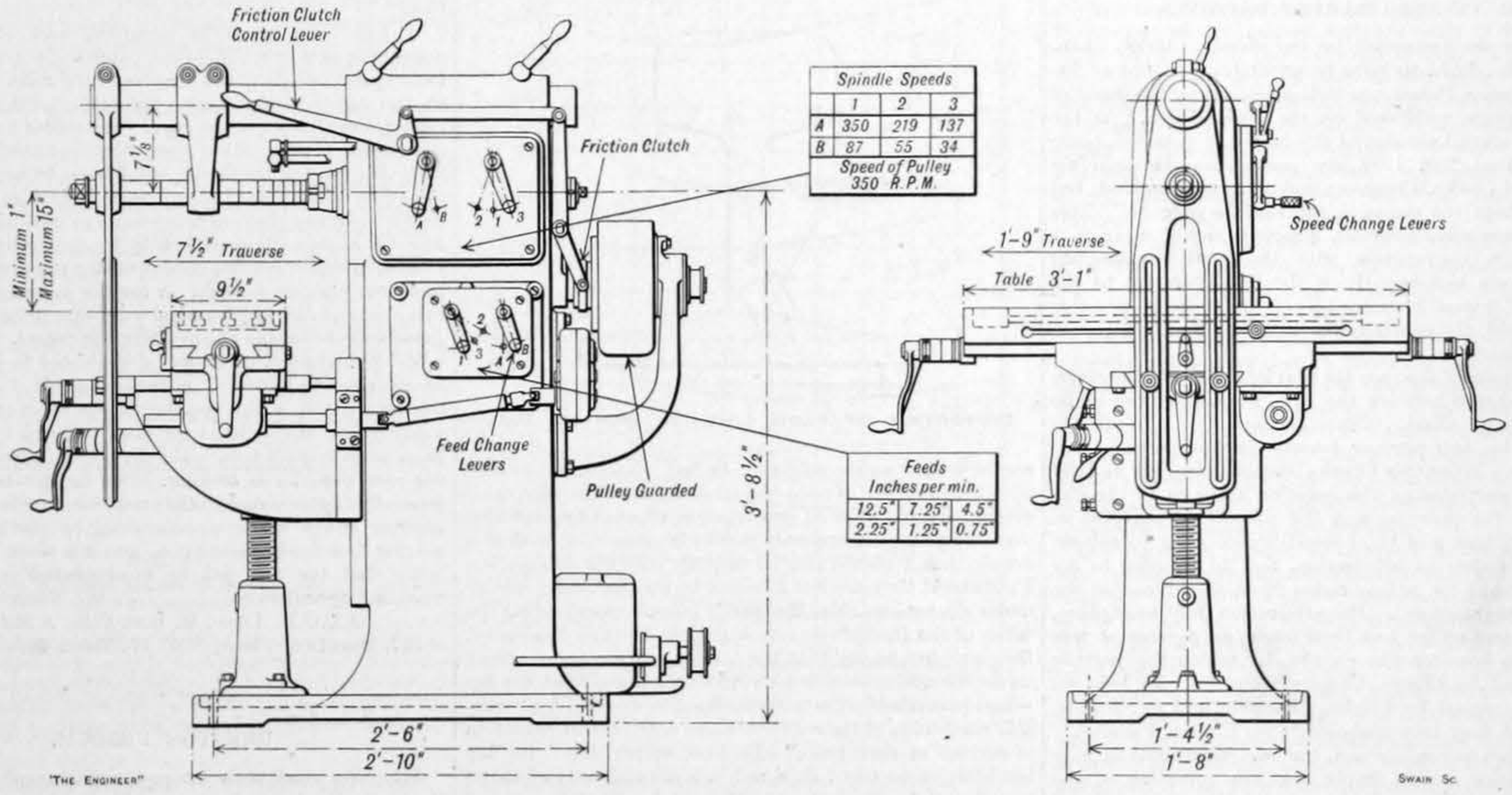
Two New Milling Machines.

Two new designs of milling machine which have been recently introduced by Messrs. Midgley and Sutcliffe, Richmond-road, Bradford, are illustrated herewith. One is an all-geared plain milling machine of the "manufacturing" class. The other is an all-geared universal milling machine.

The plain milling machine has a column cast in one piece and formed with a trough base to catch the overflow of oil and chips. A direct drive from a motor mounted on the side of the column may be arranged, but in the form illustrated the machine is shown with a single-pulley belt drive. The pulley is mounted on ball-bearings, and is provided with an outer bracket support and with a belt guard, which is adjustable to the angle of the belt. A friction clutch on the pulley spindle, operated from a lever at the front of the machine, controls the starting and stopping of the drive. Change-speed gearing completely enclosed inside the column and running in oil, gives, through the operation of two levers, six changes of spindle speed. With the belt pulley running at 350 r.p.m., the spindle speeds provided range from 34 to 350 r.p.m. An additional set of change gearing inside the column gives a range of six automatic feeds to the table in the longitudinal direction. These feeds extend from ¾in. to 12½in. per minute, and are independent of the spindle speeds. They are engaged and disengaged from the front of the machine by means of a lever with which a knock-off motion is associated.

The knee is raised or lowered by means of a telescopic screw. It carries a cross slide, on which the table is mounted. The table can be moved in both directions by hand, the handles for these motions being fitted with micrometer dials, reading to thousandths of an inch, and with clutch releases. An adjustable overarm projects from the top of the column. It carries a steady for the cutter arbor, and a stay brace, which ties it to the knee and which provides an additional support for the cutter arbor. The arbor is cut with a standard keyway to suit the milling cutters and is provided with a set of spacing washers. Its end fits into the taper bore of the spindle, the drive being transmitted through a collar which engages with a groove on the end of the spindle. An external taper is formed on the spindle nose to take face cutters, and the spindle is bored through to receive a draw bolt, which is fitted with release nuts to facilitate withdrawal.

The universal machine is closely similar in its general design to the plain miller. It differs principally in the table arrangement. The table is mounted to swivel through 45 deg. on each side of its normal position, and is provided with automatic feeds both in the longitudinal and in the transverse direction. The feed in each direction can be automatically tripped or reversed. Included in the equipment is a universal dividing head which can be geared up to the table feed screw for the purpose of milling spirals.



GENERAL ARRANGEMENT OF PLAIN MILLING MACHINE

SIXTY YEARS AGO.

Popular myths and their origin provide a fascinating subject of study. There is the myth of the Russian soldiers who passed through this country on their way to France in the autumn of 1914. Certain it is that the reader of The Engineer half a century hence will find no enlightenment on the subject in our pages of the time. We to-day are more fortunate, for turning over our issue of March 10th, 1871, we have encountered the true origin of another widely received myth. Who has not heard the story that the pennies of 1860 contained gold? To this day that story is believed. It has become embroidered with a tale of frantic effort on the part of the Government to recall the coins as soon as the accidental admixture was discovered. Many a coin of that date has been hoarded in the belief that it contained gold, and that the Government was anxious to purchase all available specimens at a price far in advance of the face value. The origin of the myth appears to date from about 1871. There was at first no suggestion that the coins of 1860 contained gold. That would seem to be the tradition of a later age. On the contrary, in 1871 the coins were commonly believed to be deficient in copper and it was said that their manufacturer, an alleged "unscrupulous Yankee" counterfeiter, had made £2000 by his misdeeds. Certainly the circumstances were suspicious. Bronze pennies and half-pennies bearing

the date 1860, but in a brand new state, began to appear in circulation about the beginning of 1871. In addition to their newness, suspicion fell upon them because they were somewhat different in design from the coins in common use. They had a beaded instead of a milled inner edge to the border, and there were some small differences in the design of the lighthouse and the ship. The workmanship was of an inferior order, and in particular Britannia's knee showed a disposition to come through and appear on the obverse side. The coins were, in actual fact, perfectly genuine. They had been made at the Royal Mint in London, and were of normal metal in all respects. Something had, however, gone wrong with their production. The Mint authorities were ashamed of them and would not issue them in this country. They represented, however, a face value of £5000, and rather than lose the sum spent on their production, the Mint authorities decided to put them into circulation in Ceylon. It was an unhappy choice, for the natives of that island had a prejudice against coins made of a mixture of metals. Comparatively few passed into circulation. The rest, to the value of £4340, were returned to this country. In their dilemma the Mint authorities no doubt welcomed an offer received from Ralph Heaton and Sons, of Birmingham, to purchase the despised pennies and halfpence. It is not disclosed whether Messrs. Heaton intended to melt the coins down or to use them otherwise in some manufacturing process. But whatever they may have originally intended to do with the money, only a small quantity of it entered their works. The rest was disposed of to people in Birmingham, Walsall, Redditch, Derby, Leicester, &c., and by them passed into circulation, no doubt profitably. That the Mint should subsequently seek to recall coins which, in spite of all efforts to dispose of them otherwise, had gone into circulation in this country, was but natural. Perhaps, too, it was only natural that a romantic story should be woven round the desire of the authorities to recover the coins.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

A Subdued Market.

IN face of the general trade depression there is not much movement in the basic industries of the Midlands and Staffordshire, and the demand for iron and steel continues poor. On 'Change in Birmingham to-day—Thursday—there was small evidence of life. The attendance was fairly good, but the business done was so small and restricted in its character as to provide but a poor idea of values. No alteration of importance appears to have taken place over the week. Many engineering firms in this area have benefited as the result of orders given at the Industries Fair, and the execution of these will call for reasonable tonnages of iron and steel. Short time is still the rule in many of the foundries, forges, mills, and workshops here. There is now little prospect of the first quarter of the year witnessing a revival of trade, but qualified hopes of a definite improvement during the second quarter are held by optimistic industrialists in the Midlands. In one or two sections of trade, such as the electrical and aluminium hollow-ware branches, though competition for business is very keen, the general position gives cause for less anxiety. The Birmingham, Coventry, and Wolverhampton automobile engineering industry remains rather unsatisfactory for the time of the year. It is in the small car and commercial vehicle branches that the lack of orders is most noticeable. Some of the factories are accumulating stocks, but it is expected that agents will shortly be taking deliveries for the new season, and that as the stocks are depleted production will be speeded up. Edge tools meet with a restricted demand, sluggishness characterises the nut and bolt trade in the Black Country, the boiler and tube industries are quiet, while foundrymen receive little support from the building trades. The consumption of iron and steel, alike raw and finished, is at a low level, a fact easily understood after reading the foregoing report on local trades.

Steel.

The steel industry in the Black Country is depressed almost to a state of dejection. Mills are working at no more than half capacity. The very small orders received amount at most to a moderate total tonnage. The necessity for frequent roll changing makes for uneconomic production, especially as the large mills have been specially laid out for continuous rolling. Manufacturers are making great efforts to secure specifications, but consuming engineering industries have little work on hand, and consider it inexpedient to take delivery in excess of current requirements under existing conditions. Engineers and manufacturers appear to have little fear of any increase in values, and it is thought that they are more likely to lose than to gain by buying forward just now. Constructional engineers in this area, many of whom have little on their books beyond the end of this month, are not enamoured with the prospects, and steelmasters are likely to have to look elsewhere for outlets for their production. This week it is reported that some of the light metal working trades of the district are buying half-products more freely, and this business is very welcome, especially as the call for automobile steels is at present quiet. Prices of heavy steel are unchanged at £8 7s. 6d. for angles, £8 15s. for joists, and £8 17s. 6d. for structural plates. They are all, of course, subject to rebate. Steel semis continue to weaken, and this week additional firms have quoted £7 5s. per ton for small steel bars rolled from foreign material. There are few, if any, rollers who now adhere to the £7 7s. 6d. minimum. English mild steel billets are cheaper by about half a crown per ton, ample supplies being available at £5 7s. 6d. It was rumoured on 'Change that Welsh sheet bars had changed hands at £5 per ton, a figure only 10s. above that quoted for foreign material. Inquiries for continental steel are very scarce, despite the very low prices at which merchants are offering supplies. They quote £4 7s. 6d. to £4 10s. for billets.

Pig Iron.

Pig iron demand is as precarious as ever. Foundrymen and forgemen alike are short of work, and as deliveries of raw material can be obtained at the shortest notice, there is no necessity for them to hold stocks. Moreover, for some time past they have intimated to Midland blast-furnacemen their intention of restricting purchases to consumptive requirements as a protest against the high level at which, they assert, the Central Pig Iron Producers' Association is artificially upholding selling rates. They claim, too, that buyers in other districts, where the control does not operate, are being given considerable preference in the matter of price. As no announcement has been made as to new price levels for March, it is assumed that they are to remain on the February basis of £3 11s. for Derbyshire and North Staffordshire No. 3 foundry iron, and £3 7s. 6d. for Northamptonshire. Forge grades are 5s. per ton less in each case. Although stocks of iron at the Northamptonshire blast-furnaces are not as large as they were some time ago, they are reported still to be heavy. There are no signs of a probable enlivenment of demand in the immediate future, though it is sincerely hoped that the coming "open" weather will stimulate the building trade and in time the Midland foundries.

Finished Iron.

The Staffordshire wrought iron industry remains under a cloud, and even in the best bar branch where a steady output is, with difficulty, being maintained, the volume of business is nothing like what it should be. Ironmasters who cannot foresee any stimulation of demand as the result of lower selling rates, maintain their price level of £12 10s. per ton at works. Poor demand and keen competition for orders has brought about irregular selling figures in the Crown bar and nut and bolt and fencing bar departments. Local makers do not appear to have gained much as a result; consequently this week they have shown decided reluctance to follow the market lower. In most cases they intimated that £9 15s. for Crown bars and £8 15s. for common bars must be regarded as rock bottom. Makers of wrought iron strip for the tube trade continue tolerably well employed, and the output is disposed of at £10 7s. 6d. or more per ton delivered.

Galvanised Sheets.

The galvanised sheet trade shows no alteration on the week, either as regards prices or demand. Conditions are most unsatisfactory, and mills are kept working only with difficulty. Twenty-four gauge galvanised corrugated sheets are quoted £11 per ton f.o.b.

Scrap.

There is very little movement in steel scrap. Prices are very low, and some merchants are inclined to hold material rather than accept the present unremunerative figures.

Unemployment.

The pendulum of unemployment in the Midlands continues to swing from one side to the other, with generally a little more power towards the unsatisfactory side, so that the total of workless gradually increases. Last week's reported decreases of 1014 is followed this week by an increase of 2149, bringing the total up to 361,841. This figure is 165,354 above that recorded for the corresponding week a year ago. No less than 245,088 of the workless are male adults. To the total, the Birmingham area contributes 64,453; Bilston, 5281; Coventry, 12,607; Cradley Heath, 8963; Derby, 11,011; Dudley, 6720; Kidderminster, 3255; Leamington and Warwick, 1686; Leicester, 15,449; Northampton, 5984; Nottingham, 15,408; Oldbury, 2717; Peterborough, 3288; Redditch, 2561; Smethwick, 6728; Stoke-on-Trent area, 34,352; Stourbridge and Brierley Hill, 6510; Tipton, 3819; Walsall, 10,466; Wednesbury, 4307; West Bromwich, 5782; Wolverhampton, 13,547; and Worcester, 2719.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

The Turn of the Tide?

PROBABLY, on the ancient principle that one swallow does not make a summer, there is a disposition not to attach too great an importance to the fact that unemployment in the industrial area of Lancashire, according to the latest official returns, shows a slight change for the better. At the same time there is, of course, a hope which is shared by everyone that the clouds of depression are passing. Lancashire has the unenviable distinction of being, with one exception, the most badly hit industrial county. This has been due almost entirely to the conditions prevailing in the cotton textile industry, which has dragged in its train pretty well all other industries centred in the county, including many branches of engineering. It is reasonable to assume, and this is what engineers and others are living in hope of, that any real improvement in the cotton industry must inevitably have a widespread effect. At the moment reports as to Lancashire cotton mill prospects are certainly more optimistic than they have been for some time, even after making adequate allowance for the exaggerated importance that has been attached in a good many quarters to the business booked at the British Industries Fair.

Engineering Trade Wages.

The proposals of the engineering trade employers regarding changes in wage and other conditions have been under consideration during the past few days at meetings of representatives of the trade unions concerned in the Manchester district. While, so far, nothing has been disclosed as to the policy to be adopted, there is strong reason to believe that opposition to the employers' proposals has been decided upon. In the meantime, reductions in the cost-of-living bonuses of Manchester engineering trade apprentices came into operation this week. The reductions range from 1s. to 3s., according to age, and become effective individually as from the date of the next birthday of each apprentice.

Fleetwood Improvements.

Interest has been aroused here this week by the news that a special general meeting of shareholders of the London, Midland and Scottish Railway Company has approved the Parliamentary Bill providing, among other developments, for the construction of new works and the acquisition of land at Fleetwood for the purpose of effecting port improvements. The Fleetwood programme, as has already been outlined in this column, provides chiefly for the construction of a new dock by enclosing the present open quayside and building concrete walls out into the river Wyre. The total estimated cost of the entire scheme is in the region of £750,000. When completed much bigger trawlers than can at present enter the port will be accommodated.

Further Economies at Crewe.

It has been decided further to reduce the staff at the Crewe locomotive works of the London, Midland and Scottish Railway Company by the discharge of 185 men. This step has been dictated by continued shortage of work. Altogether, during the past 18 months the Crewe personnel has been reduced to the extent of 1200 men, this figure including a number of employees who have been compulsorily retired at the age of 65 years.

Non-ferrous Metals.

Whilst for the moment the upward movement of non-ferrous metal values appears to have exhausted itself, continued steadiness has been in evidence during the past week, and market sentiment seems to be much more buoyant than it was a month or so ago. In the case of tin, buying operations during the week have been on a more restricted scale, both on speculative and consumptive account, most users on this side having probably filled their requirements for the time being. Developments in connection with the output restriction proposals, however, have tended to keep this section of the market reasonably steady, in spite of periodical fluctuations, and values have finished up the week almost exactly where they were at last report. Very little difference on balance can be reported in respect of copper, although here, also, there have been times when for one reason or another quotations have reacted. No perceptible improvement in the condition of the consuming industries in this country has occurred, but a more hopeful view of prospects in the United States is being taken by the market and producers are apparently less anxious than they were to press supplies. A moderate amount of interest has been displayed in spelter, and although prices have not been maintained at the highest point touched during the week, they are on balance about half-a-crown dearer than they were a week ago. Lead has made no further progress towards more remunerative levels, although, on the other hand, the metal has been able to resist efforts to bring it down again.

Iron and Steel.

Reports as to trading in foundry iron on the Lancashire markets this week have been conflicting to some extent, one or two sellers reporting a slightly better movement of Midland brands, with others recording continued dull conditions. In any event, however, there has been little sign of a return among buyers to forward operations beyond a few weeks ahead. Quotations have been fairly steady at 69s. 6d. per ton for Derbyshire and Staffordshire No. 3, 68s. for Northamptonshire, about 71s. for Cleveland, from 90s. to 91s. for Scottish, and about 82s. 6d. for West Coast hematite, including delivery in each case equal to Manchester. The demand for finished iron is on a relatively poor scale, with prices held at £10 5s. per ton for Lancashire Crown bars and £8 15s. for No. 2 material. Both British and imported varieties of steel have met with a very moderate demand, with, however, little change in the general price position to record. British rollers report only limited specifications, both as to the number and quantity involved, in the constructional, locomotive and boiler trades, with alloy and high-carbon steels being called for locally in smaller parcels than is the normal experience.

BARROW-IN-FURNESS.

Hematite.

There is nothing fresh to report as regards the hematite pig iron market. Business remains quiet both on home and foreign account and stocks are high, despite the fact that the steel departments are at work in Barrow and Workington. As regards special qualities of iron, trade is also limited. Most business is on account of immediate requirements, and there is little or no tendency to place orders for forward delivery. Business with America might develop, but there are no signs yet. Iron ore continues in restricted demand, and all the local mines are far below their maximum. Foreign ore is in steady, but moderate, demand. The steel market has not much life in it, and competition is keen. Fresh orders would be welcome.

Shipbuilding.

The new P. & O. liner, the first of two to be launched, is being fitted out in the Buccleuch Dock. This vessel had a very big launching weight—over 10,000 tons—this being due to the installation of the boilers before launching. When completed, the "Strathnaver" will have a very striking appearance with her three funnels, modern stem and cruiser stern.

SHEFFIELD.

(*From our own Correspondent.*)

The Tide Not Turned.

ALTHOUGH some firms are able to report a rather better demand for steel products in certain departments, and an increasing number of small orders, there is no evidence of a general improvement, or of a turn in the industrial tide. Certainly, there is nothing in the open-hearth department to warrant any such inference, but rather the contrary. At the Templeborough works of the United Steel Companies, it has been found necessary to close down four large furnaces. The production at these works was increased at the beginning of the year in order to clear off arrears which had accumulated during the Christmas stoppage, so that the present reduction does not indicate a corresponding fall in trade, but, nevertheless, there is some decline in the demand for crude basic steel, and inquiries continue on an unsatisfactory level. On the lighter side, things are somewhat better. There is, in fact, a good deal of activity in certain special lines, notably stainless, acid and heat-resisting steels. The motor trade is taking good supplies of various requirements, but these are not up to the average so far as touring cars are concerned. Purchases of tool steel and tools by British engineers keep up pretty well, but there is little doing in the export department, and the limited consumption of tungsten and other alloys indicates that the total production of these steels is on a reduced scale. The present position, unsatisfactory as it is on the whole, does not prevent many people from being optimistic; in fact, there is a growing feeling that next month will see a gradual increase in turnover.

The Tool Trades.

There is a rather better demand for farm and garden tools so far as the home market is concerned, but orders are being placed with caution, as distributors seem doubtful whether the public will buy the normal quantities. *Quality*, the organ of the Sheffield Chamber of Commerce, points out that "money has never been so short among the agricultural population for many years, and this condition may cause people to carry on as long as possible with their old tools and implements, and check sales of new ones. This season orders contain a larger proportion of second-grade tools than usual. Selling prices of tools have receded since last year." The export trade in tools of all descriptions continues very depressed. Foreign and colonial markets have been buying on a reduced scale for a long time, and stocks must have reached a very low level by this date. There is nothing cheering to say of the file trade, which has been in a very unsatisfactory state for more than twelve months. The consumption of these tools has been reduced by the increasing use of grinding and hacksaw work in engineering and other workshops. The hacksaw trade keeps up moderately well. The firms engaged in the production of tools of precision are well employed, and continue to make progress in securing trade which was formerly an American and German monopoly.

Cutlery and Plate.

There has been some increase of demand in these branches since Christmas, but the volume of orders on hand is much below the average for February, and the general condition is one of depression. A considerable amount of work is being provided for a few firms by Government contracts, orders from the catering trade, and the large demand for articles for coupon distribution. There is little call for silverware, in spite of the fact that it is at present remarkably cheap. Several of the firms who exhibited at the British Industries Fair at Olympia report good business, although, on the other hand, some have not done as well as last year. One cutlery firm booked an order for the home market valued at £10,000, and definitely secured new orders, particularly from South America. A new patented razor edge utility knife did very well, large orders were obtained from Canada, Holland, and Denmark, with inquiries from buyers in all parts of the world. There was a good demand for cutlery canteens and safety razor blades. One razor blade firm, which exhibited for the first time, booked an order worth £600 in the first half-hour, and also obtained an order for one country alone for 15,000,000 penny blades.

A Works Restarted.

It is satisfactory to be able to report that an old-established Sheffield works which has been in difficulty and has had to suspend operations for some time, has now been restarted and is doing well. It is the works of the Laycock Engineering Company, Ltd., which was purchased some months ago by Thos. W. Ward, Ltd., of Sheffield. Work was suspended in order that important improvements could be carried out, but now operations are in full swing again, and several hundred men are employed. The railway department has been mainly employed on the production of railway coach interior seats and fittings steam heating equipment, corridor coach connections, seats and fittings for tramcars and omnibuses, and has an extensive connection in this class of work. The chief products of the motor department are axles, gear-boxes, steerings, and engines for the motor car trade. The plant was purchased in 1918, and was first used for production on a large scale of aero-engines, and afterwards for the Charron-Laycock car. Among the articles which are being developed is a special type of industrial truck, which is petrol-driven and will turn in its own length. It was exhibited at the British Industries Fair at Birmingham.

A Striking Miniature Engine.

A miniature engine, to travel on one of the smallest public railways in existence, has just been completed by the Yorkshire Engine Company, Ltd., of Sheffield, for the Romney, Hythe, and Dymchurch Light Railway, and is one of two which the company has on order for that service. It is of American appearance, but is only one-third the size of locomotives familiar on railways in the United States, although it embraces all the latest features of locomotive engineering. The railway, which runs for 13¾ miles along the south-eastern coast of Kent, has a gauge of only 15in., but its accessories are, as far as possible, exact replicas of those on a full-size railway system. The engine and tender combined are 28ft. 6in. in length and 5ft. high. The weight of the engine in working order is 5 tons 10 cwt., and that of the tender in working order 3 tons 5 cwt. The outside cylinders are 5¼in. diameter by 8½in. stroke, and the driving wheels are 2ft. 1½in. diameter. The boiler pressure is 200 lb. per square inch. The equipment includes a vacuum-operated water scoop on the tender for collecting water from troughs laid between the rails, a provision which has never previously been made on a small engine. The tender is of the Vanderbilt type, and the tender bogies are fitted with roller bearings. There are vacuum brakes on the engine, and hand and vacuum brakes on the tender. The engine, which is capable of hauling a train of 300 passengers at 25 to 30 miles per hour, is complete with three-note chime whistle and cow-catcher. It carries 7½ cwt. of coal and 300 gallons of water.

Contracts for Tramway Supplies.

The Tramways and Motors Committee of Sheffield City Council is recommending acceptance of a large number of tenders, the largest of which are two placed with the Cargo Fleet Iron Company for 325 tons of titanium treated tramway rails at £10 5s. 3d. per ton and 700 tons of chromium-steel tramway rails at £13 10s. 3d. per ton. Among the other tenders are:—Hadfields, Ltd., 35 tons of mild steel tie bars at £14 17s. 6d. per ton, and six pairs of points, 12ft. 6in. long and 150ft. radius, at £120 per pair; Titan Trackwork Company, Ltd., track renewals, £626, and double junction renewals, £379; Edgar Allen and Co., Ltd., double junction renewals, £780. The Water Committee of the Corporation has accepted the tender of the Staveley Coal and Iron Company, Ltd., for the supply of cast iron pipes for £609 3s. 4d.

Armour Plate Grinders.

The last of four heavy armour-plate grinders, complete with electrical equipment, has just been despatched abroad by Tasker's Engineering Company, Ltd., Sheffield, and the firm has received a contract for four more machines. Messrs. Tasker are dismantling their Portmahon works, Sheffield, having acquired an interest in a Lancashire concern better equipped for building these machines, the largest of which weighs 70 tons. The gear-cutting department will also be transferred, but the offices will remain in Sheffield.

Excavators for Russia.

Ruston-Bucyrus, Ltd., of Lincoln, has received from Arcos, Ltd., a contract valued at over £100,000 for the supply of twenty-three excavators, including a number of machines of large sizes up to 3½ cubic yards capacity. The machines are to be of two types, for steam and oil engine operation, and deliveries are to be effected over the next three months. It is understood that they are to be employed on various projects in widely different parts of Russia. Another contract received by Rustons' is from the Great Western Railway for thirty sets of engine tanks and bunkers for 2–6–2 engines.

Mechanical Coaling Plants.

The London and North-Eastern Railway Company is pushing forward plans for the extension of a more efficient system of coaling railway locomotives by machinery. It has just placed contracts for three more mechanical coaling plants at Leeds (Neville Hill), Hull, and Selby. They will bring the number of such plants on the system up to fifteen.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Tees Industrial Developments.

FURTHER industrial developments are foreshadowed on the Tees. The Imperial Chemical Company, which has already established large works at Billingham with considerable river frontage, has opened negotiations with the Tees Conservancy Commissioners for an option on a stretch of foreshore of 265 acres, adjoining the land which has already been acquired by the firm on the north bank at Port Clarence. The land is required, it is understood, for the erection of a wet dock and additional chemical works.

Dwindling Trade.

The unsettled state of the world's markets and the disastrous repercussions on the iron and steel trade are reflected in the record of Tees exports for February. Not since the period of the coal strike in 1926 has the volume of shipments fallen to so low an ebb, and it must be confessed that there is not as yet any prospect of improvement. Adverse exchange rates have practically eliminated Australia as a buyer, the fall in silver restricts business openings in the Far East, monetary troubles are sapping at the root of the trade with South America, and the general collapse in values has restricted buying everywhere. Pig iron shipments fell from 14,222 tons in January to 11,380 tons in February, the foreign shipments averaging less than 1000 tons a week. Of 31,357 tons of manufactured iron and steel shipped during the past month nearly 50 per cent. went to London. Not a ton of material went to the Argentine, usually one of Cleveland's best customers, and only the Indian and South African trade showed any improvement.

Iron and Steel Imports.

A fall in the imports of iron and steel is revealed in the February returns for the Tees. During the month 6668 tons of crude sheet bars, billets, &c., were imported, as compared with 14,022 tons in January. Pig iron showed a jump forward, 4037 tons being imported as against 1682 tons in January. There were 2626 tons of plates, bars, angles, rails, &c., imported, as against 2738 tons, and the total imports for the month were 13,331 tons, as against 18,442 tons in January.

Cleveland Iron Trade.

Although buyers are still operating with extreme caution, a rather more hopeful feeling prevails. Stock markets are firmer, and a slight advance in commodity price levels suggests that some expansion of trade is at hand. Usually the iron market is amongst the last to feel the benefit of any such impetus, but there is more inquiry in the Cleveland market, and sellers are hopeful of negotiating bigger contracts for the second quarter of the year. Ironmasters are keeping the output of Cleveland iron on a scale that does not quite satisfy the present moderate needs, and stocks, already low, are being gradually depleted. Merchants have little opportunity to put through business, and sales are chiefly direct by ironmasters to consumers. Much of the limited make continues to go into direct use at producers' own foundries and steel works. Business with overseas customers is trifling, and transactions with firms in Scotland are few. For home purposes No. 1 Cleveland foundry iron is 61s.; No. 3 G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d., and No. 4 forge, 57s.

Hematite Pig Iron.

There is little change in the East Coast hematite pig iron trade. Merchants are handling a good deal of iron. They are getting rather anxious to unload their holdings and do not hesitate to sell at a little below the rates named by producers. Accumulations at certain makers' yards are still heavy. Recent sales by both second-hands and manufacturers include a few small parcels to customers on the Continent. Customers can readily cover their requirements on the basis of ordinary qualities at 69s., and report they have bought from second-hands at 6d. less.

Ironmaking Materials.

Imports of foreign ore are greatly below normal. Consumers have heavy quantities to accept against old contracts. The nominal price of best Rubio is 16s. c.i.f. Tees. Blast-furnace coke is in abundant supply, and weak in price. Local users are buying sparingly, and good medium qualities are no more than 16s. delivered to the works in this district.

Manufactured Iron and Steel.

Little new is to be learned concerning manufactured iron and steel. Contracts for most descriptions of material are difficult to arrange, but market rates are upheld. Producers of railway requisites are turning out a fair amount of work, and manufacturers of constructional steel are moderately well employed, but departments engaged on shipbuilding material are very short of specifications. Inquiries for sheets are just a shade better. Prices all round are unchanged.

The Coal Trade.

It is encouraging to learn that the latest ascertainments regarding coalmining proceeds and costs showed better results in Northumberland and Durham. The figures deal with January trading and indicate an improvement in the economic yield of 2·46 per cent. in Northumberland and 5·15 per cent. in Durham on the previous month—January. This period, of course, represents the height of the season for any class of coal, and this year the district benefited, too, by the Welsh stoppage. February trading, when it comes to be analysed, may tell quite a different story in Durham, because there has been so much lost time for lack of orders. Northumberland, on the other hand, has been well employed. March, however, has opened with rather better prospects than might have been anticipated, and with fairly good bookings under old contracts and a fairly large number of definite orders circulating for this month's shipment. Prices are very steady; best Northumberland steams for this and next month are understood to be well booked and amply supplied with tonnage, and full-time work at the pits is expected. Best qualities are quoted at 13s. 6d., with smalls at 10s. Special Durham steam qualites, which are well booked for prompt, and find a little increased forward demand, are quoted at 15s. for large and 12s. for small. For this month there is considerable pressure for special grade gas coal, 15s. 6d. being firmly quoted. For April and onwards the demand is moderate, but owners hold for recent prices. Secondary gas are just a shade easier at 13s. 6d. Durham coking unscreened are in slightly improved demand at 13s. 3d. to 13s. 6d., while Durham best bunkers are in good supply at 14s., with ordinary at 13s. 6d., and if anything demand shows a slight improvement. There is still a sustained demand for gas coke, and with small stocks prices are firm at 21s. Patent oven coke is in quiet demand and freely offered at 16s. 6d. Beehive and superior grade coke is dull and values nominal at about 24s. to 27s.

SCOTLAND.

(*From our own Correspondent.*)

Shipbuilding.

DURING the month of February the tonnage launched from Clyde yards only amounted to 15,080 tons, which is the lowest figure touched since February, 1927, when trade was just beginning to recover from the coal strike of 1926. For a considerable period, the true condition of the industry has not been shown by the output figure which has been maintained at a high level. Work in hand has steadily diminished, however, and with new orders few and far between, the future output figures will more accurately reflect the state of affairs for some time

to come. Only two orders were booked during February, while of the total output one vessel accounted for more than half, namely, an 8000-ton oil-carrying vessel built for the Empire Transport Company, Ltd.

Steel.

The shipbuilding demand for steel continues on a most modest scale, and with the export inquiry generally being at a low ebb the outlook holds little of an encouraging nature. It is said that overseas inquiries are increasing, and producers of certain commodities believe that, in view of the restricted buying during the past eighteen months, stocks abroad must be almost, if not quite, depleted, and that some buying movement cannot be long delayed. Sheet makers cannot hope for much from the Australian market, but are now more hopeful of a resumption of business on a larger scale with India and possibly South America. Tube makers report a slight improvement in certain branches, but very quiet conditions in butt-welded and small diameter lap-welded tubes.

Iron.

Bar iron makers have been through a very lean time, extending over many months, but are hopeful that the usual seasonal demand will develop in the nature of iron tube hoops for Canada. Steel re-rollers make little progress, despite the advantage of cheap continental billets. Competition from cheap continental steel bars and English re-rollers is very keen, while the depression in the tube trade has reacted against wrought iron and steel re-rollers, owing to greatly reduced demands for tube strip and fitting iron. Re-rolled steel is still quoted about £6 17s. 6d. home and £6 10s. per ton export.

Pig Iron.

The market for pig iron remains dull in the extreme, owing to poor home demands and continual imports from the Continent and India. Shipments of pig iron from Glasgow amounted to 464 tons, of which 150 tons went overseas, compared with 628 tons (162 tons foreign) in the same week last year.

Coal.

A continued decline in the export trade is the feature of the Scottish coal trade. Inquiries from abroad are for very limited quantities, and exporters are not in a position to quote for contracts ahead against the severe competition from Poland. Consequently, as a rule, despite restricted outputs, large coals are easily obtained and washed stuffs are plentiful. Prices as a rule still show a tendency to decline, best Fifeshire steams being the only exception at present. Aggregate shipments amounted to 204,647 tons, against 196,488 tons in the preceding week and 229,857 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

CONDITIONS in the steam coal trade have not improved during the past week. On the contrary, there is cause for some uneasiness, inasmuch as collieries are not working so regularly, and there is not such a demand for early shipment as to relieve the collieries of some of their stocks. The lack of inquiry does not affect any particular class of coals, but it is evident that all qualities are moving off less slowly. Part of the trouble of collieries is that large-sized tonnage for prompt positions is not on offer for employment with anything like the readiness which was apparent even a few weeks ago, and this causes some difficulty to merchants in working off orders which are already in hand. As illustrating the weakness of the loading position, it has only to be stated that at the end of last week returns showed that the number of idle tipping appliances at the various ports in this district was 36, while arrivals of tonnage over the week-end were so disappointing that on Monday the number, instead of being reduced, was increased to 42. This is an exceptionally high figure for the beginning of the week, so that it looks almost certain that shipments for the current week will prove unsatisfactory. Last week shipments, according to the Great Western Railway Company's returns, only came to 419,200 tons, as compared with 439,500 tons for the previous week, and with 557,593 tons for the corresponding period of last year. The day-to-day inquiry for coals is very meagre, and it cannot be said that there is very much business passing for delivery over a period. The Belgian State Railways are in the market for 30,000 tons of patent fuel, and the Swedish State Railway have asked for prices for 100,000 tons of locomotive coals for delivery from April to June; but this is business that is not likely to come to this district, as it is usually the case that more favourable prices are submitted for North Country coals and for continental supplies. As regards the requirements of the Brazilian Central Railway, no news has yet come to hand that this order has been placed for German coals, although it is expected. The inquiry was for 30,000 tons of patent fuel and for 80,000 tons of coals made up of two-thirds large and one-third small. Inquiries go to show that there was not much difference between the quotations sent in by South Wales firms and German producers, so far as the patent fuel was concerned. In fact, it was slightly less than 6d. per ton, but, in the case of the steam coals, there was a margin in favour of the German suppliers of nearly 2s. per ton. In the case of anthracite coals, there has been very little variation in the conditions prevailing. Some anxiety was felt as to the report that the Russians intend to export heavy quantities of anthracite coals into Canada during the coming season, but fears have been allayed by the announcement that an Order in Council has been issued by the Canadian Government prohibiting the import of Russian anthracite. Last year about 100,000 tons of Russian anthracite were sent to Canada, but the ban now placed on it should be to the advantage of South Wales anthracite.

Coalfield Wages.

Up to the time of writing the award of the independent chairman regarding wages for workmen engaged in the South Wales coalfield had not come to hand. In the case of colliery craftsmen, there was a special general conference of members of the Association at Cardiff on Saturday, when it was stated that application had been made on their behalf for a minimum of 8s. to 9s. per shift for skilled workers.

Works Items.

It is announced that the new owner of the Reliance Patent Fuel Works at Llanelly, the Alvah Towers Company, Ltd., of London, which intends to form an entirely new company to be known as the Alvah Towers (Reliance Fuels), Ltd., with a capital of £50,000, proposes to re-open the works immediately. Some satisfaction has been caused in the Dowlais district by the fact that the Big Mill section of the Dowlais—Merthyr—Iron and Steel Works has been re-started and will provide work for about 250 workmen for a month or more in the construction of colliery arches and sleepers. The Cwmbran Chemical Works have now been running on a much curtailed staff for several weeks past, but, so far, no news is forthcoming regarding the future of the works. Notices to the workmen at the British Mannesmann Tube Company's works at Landore expired on Saturday last, but finishing work is to proceed on a day-to-day basis, so that there will be work for a time for probably about 500 men.

The Tin-plate Trade.

The question of the provision of work for unemployed operatives was discussed at a special meeting of the Tin-plate Joint Industrial Council, held at Swansea on Tuesday. While nothing could be definitely decided, the employers left to the discretion of the various managements of the works now operating, in conjunction with the Welsh Plate and Sheet Association, to work six hours in mills and tin-houses where possible, without impeding efficiency, so as to provide employment for some of the men attached to works which are idle. The workmen's representatives appealed for a contribution based on output to the special unemployment fund, but the employers were unable to accede to this, owing to the state of trade.

Industrialists and the Public.

Two leading South Wales business men, Mr. Henry Bond, of Richard Thomas and Co., and Mr. Frank Rees—president of the Swansea Metal Exchange—have issued a circular convening a representative meeting to be held on the 24th inst. for the purpose of considering steps to fight the present industrial depression. In this circular they state that as direct representatives of important industries in South Wales, they feel it incumbent upon them to take immediate steps to create in the minds of the public generally an appreciation of the seriousnes of the industrial and national situation. They are satisfied that the situation is such as to demand urgent and serious attention from all who have the welfare of the country and its interests at heart, and they have come to the conclusion that steps should be taken immediately to form a body—representative of all industrial interests in South Wales and of all classes of the community—with the object of creating a public conscience and to exercise pressure on those in authority—both in our national legislature and in our local councils—to secure the formulation and adoption of policies which will help in the direction of the resuscitation of industry generally and the consequent creation of employment, at the same time reducing public expenditure, both of a national and local character.

Current Business.

Quietness prevails all round on the steam coal market. The inquiry from day to day displays no special feature and supplies of both large and small coals are in excess of the demand. Even sized descriptions are not in so much demand, and prices in all departments are on the minimum. Patent fuel show no improvement and coke moves off slowly. Pitwood meets with rather less inquiry and is quoted about 25s. to 25s. 3d.

CONTRACTS.

RICHARD DUNSTON, Ltd., of Thorne, near Doncaster, ask us to announce that they have received an order for a pontoon for the new fish dock at Grimsby. The pontoon is specially designed to withstand heavy work and rough usage, and will carry pile driving equipment.

THE PARSONS OIL ENGINE COMPANY, Ltd., of Southampton, has received an order for an 85/105 H.P. Parsons paraffin engine and dynamo set, as a standby lighting plant for the new yacht of H.M. the King of Denmark. The order also includes a smaller four-cylinder 10/20 H.P. unit of the same type.

THE LANCASHIRE DYNAMO AND MOTOR COMPANY, Ltd., of Trafford Park, Manchester, asks us to state that an order has been received from the Whitehall Securities Corporation, Ltd., 53, Parliament-street, Westminster, S.W. 1, for 900 motors and control gear in connection with the change over of the electricity supply in the city of Athens.

THE GREAT WESTERN RAILWAY COMPANY announces that the following orders have been placed:—(*a*) Extension of engine shed, new stores and other works at Laira, Plymouth, Ernest C. Jordan and Son, Newport. (*b*) Shops and living accommodation at Oxford-road, Tilehurst, Reading, Wm. L. Nicholls, Ltd., Gloucester. (*c*) Thirty sets of engine tanks and bunkers for thirty 2–6–2 T engines, Ruston and Hornsby, Ltd., Lincoln. (*d*) Excavation, piling and concreting for foundations of hoists and gantrees at South and Prince of Wales docks, Swansea, Christiani and Nielsen, London. (*e*) Supply of steel girders and other steel and ironwork, the Horsehay Bridge and Engineering Company, Ltd., Horsehay. (*f*) Supply and delivery of thirteen Venturi and one positial pressure water meters at South Wales ports, Geo. Kent, Ltd., Luton, Bedfordshire. (*g*) Overhaul of the twin-screw steamer "St. Julien," Cammell Laird and Co., Ltd., Birkenhead. (*h*) overhaul of triple-screw steamer "St. Andrew," C. H. Bailey, Graham and Co., Ltd., Barry. (*i*) combined plate bending and straightening rolls for new concentration yard, Swindon, J. Bennie and Sons, Glasgow. (*j*) Alterations to sheet shop for electrical maintenance stores at Paddington Goods Station, Wm. Brown and Sons (Builders), Ltd., London. (*k*) Overhaul of ferry steamer "The Mew," Willoughby (Plymouth), Ltd. (*l*) Running shed lathe for Oxford, Dean, Smith and Grace, Ltd., Keighley. (*m*) Steel girders and other steel work, Braithwaite and Co. (Engineers), Ltd., London. (*n*) Supply of one Butler crank-shaping machine, 20in. to 22in. stroke, Butler Machine Tool Company, Ltd., Halifax. (*o*) New kiosk on Nos. 2 and 3 platforms, Paddington Station, Maple and Co., Ltd., London. (*p*) Supply and erection of two 1-ton transporter cranes for Park Royal Goods Shed, Wharton Crane and Hoist Company, Ltd., Reddish.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. A. W. IRONSIDE recently business manager of the Harland Engineering Company, Ltd., Alloa and London, has returned to the Vaughan Crane Company, Ltd., Openshaw, Manchester, as director and general manager.

MR. J. M. DIXON informs us that he has left the services of W. J. Fraser and Co., Ltd., of Dagenham, having been appointed London sales manager of George Fletcher and Co., Ltd., of Derby, with offices at 73, Basinghall-street, London, E.C. 2. Telephone No., Metropolitan 2876.

CATALOGUES.

BEECROFT AND PARTNERS, Ltd., Mappin-street, Sheffield.—The firm's booklet of products, written in Japanese characters.

CHRISTIANI AND NIELSON, 70–74, Victoria-street, S.W. 1.—A brochure on cell concrete for heat, cold, and sound insulation.

REDFERN'S RUBBER WORKS, Ltd., Hyde, near Manchester.—Booklet A437 of ebonite goods for chemical and other industries.

ROBERT MACLAREN AND CO., Ltd., Crawford-street, Glasgow.—List No. 131 of thermostats for electricity, gas, oil, and steam.

RHODES, BRYDEN AND YOUATT, Ltd., Gorsey Mount-street, Stockport.—Two leaflets on "Mopump," a single-unit motor and pump.

GWYNNES PUMPS, Ltd., Hammersmith, W. 6.—Detailed specification of "F" type "Invincible" centrifugal pumps for heads up to 60ft.

BLACKSTONE AND CO., Ltd., Stamford.—Particulars of high-speed crude oil engines for lorries, omnibuses, tractors, marine and stationary uses.

EDGAR ALLEN AND CO., Ltd., Sheffield.—Two new catalogues, "Double-shell Rotary Dryers" and "Stag Pulverising Cylinders or Intermittent Ball Mills."

METROPOLITAN-VICKERS' LONG SERVICE ASSOCIATION.—The ninth annual meeting and supper of Metropolitan-Vickers Electrical Company, Ltd., Long Service Association was held in the staff canteen at the works at Trafford Park on Monday, February 23rd, when John Cameron, known as "Old John of the South Gate," was presented with a framed photograph and a gold watch on his retirement, after many years of service.

LT.-COL. CHARLES ROBERT JOHNSON.—We desire to express our sympathy with our contemporary *Engineering* in the loss of Lt.-Col. C. R. Johnson, who died suddenly on February 25th. Lt.-Col. Johnson joined *Engineering* in a junior post on the publishing side in 1879, when he was nineteen years of age; was promoted to manager and secretary in 1893, became a director in 1911, and a managing director in 1917. His chief interest outside the progress of the paper lay originally in the Volunteers, and subsequently in the Territorial Army. He was very well known in the engineering industry and was universally liked and respected.

ENGINEERING GOLFING SOCIETY.—The twenty-second annual general meeting of the Engineering Golfing Society was held, by permission of the Institution of Mechanical Engineers, in the Institution building on Thursday, February 26th, the retiring Captain, H. P. Allison, in the chair. Office bearers for the current year were elected as follows:—President, Sir R. A. Hadfield; Vice-Presidents, D. A. Stevenson, E. L. Mansergh, F. J. Walker, S. Price-Williams, W. H. Shortt, E. W. Timmis, K. A. Wolfe Barry and W. L. Mansergh; Captain, H. E. Midgley; Honorary Secretary and Treasurer, G. H. Hopewell; Honorary Auditor, S. C. Lewis; Members of Committee, B. Hall Blyth, H. G. Hale, W. W. Hughes, P. V. Hunter, R. J. M. Inglis, E. E. Lloyd, E. C. Mackellar, C. W. Myddleton, and E. S. New.

UNIVERSITY COLLEGE, LONDON.—The annual report of the Committee of University College, London, for the year ending in February, 1931, has just been issued. It shows that the number of students on the books of the College was 3150; 2513 came from the British Isles, 330 from different parts of the Empire overseas, 199 from various countries in Europe, and 108 from countries outside Europe, of whom 49 came from the United States of America. There were 1584 students in different stages of their degree course. Of these, 239 obtained First Degrees (193 with Honours) and 76 Higher Degrees. There were 457 post-graduate and research students. Of the other students, 141 obtained Diplomas and 49 Certificates. Evening courses were attended by 398 students, and 406 students of other colleges came to Inter-collegiate Lectures. Out of these totals, 132 men and three women took the regular engineering course.

INSTITUTION OF CIVIL ENGINEERS: ANNUAL DINNER.—The annual dinner of the Institution of Civil Engineers was held at the home of the Institution, Great George-street, on Wednesday evening last, March 4th, when close upon three hundred members and guests assembled in the Institution Hall under the chairmanship of the President, Sir George W. Humphreys. After the loyal toasts had been given and duly honoured, Sir Brodie H. Henderson, a Past-president, proposed the toast of "Science and Education," which was responded to by the Rev. J. Scott Lidgett, Vice-Chancellor of London University, and Sir John Rose Bradford, Bart., the President of the Royal College of Physicians. The Earl Peel, who proposed the toast of the "Institution of Civil Engineers," referred to the great work which had been done for London by its President, Sir George Humphreys, who had recently retired from the office of chief engineer to the London County Council. In his reply, Sir George spoke on the high educational standard set by the Institution, with regard to the qualifications of student and corporate members. In 1900, he said, 29 per cent. of the 176 applicants possessed exempting degrees, whereas, in 1930, no less than 60 per cent. of the 336 applicants were in possession of such degrees. That increase in exemptions had not, however, affected the number of candidates sitting for the Institution's examinations, which, in 1919, was 109, and last year rose to 1087 candidates. An increasing number of candidates were connected with Local Authority work. The toast of "The Guests" was proposed by Sir Frederick Palmer, a Past-president, and replies were made by Mr. Justice McCardie, who made a characteristically witty speech, and was followed by Sir John Anderson, Permanent Under-secretary of State, Home Office. The evening was a most enjoyable one.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	16/– to 20/6
(1) Spanish	16/–
N.E. COAST—	
Native	18/– to 21/–
Foreign (c.i.f.)	16/–

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 14 0	—
No. 1 Foundry	3 16 0	—
No. 3 Foundry	3 13 6	—
N.E. COAST—		
Hematite Mixed Nos.	3 9 0	3 9 0
No. 1	3 9 6	3 9 6
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
MIDLANDS—		
(e) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 6 0	—
" " Foundry	3 11 0	—
(e) Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
(e) Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 1 6 (*a*)	—
	4 3 6 (*b*)	—
	4 8 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
LANCS.—		
Crown Bars	10 5 0	—
Second Quality Bars	8 15 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	10 5 0	—
Best Bars	11 0 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	9 15 0 to 10 7 6	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	8 15 0 to 9 0 0	—
Gas Tube Strip	10 17 6 to 11 0 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	10 10 0	10 10 0
" " (Land)	10 10 0	10 0 0
Ship Plates, ⅜in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ½in.	8 0 0	8 0 0
Sheets (Gal. Cor. 24 B.G.)	11 7 6	11 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
" " (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
" (Small Round)	7 2 6	—
Hoops (Baling)	10 0 0	9 15 0
" (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
" (Lancs. Boiler)	9 5 0	—
SHEFFIELD—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	8 12 6 and 9 2 6	—
Intermediate Basic	7 2 6 and 7 12 6	—
Soft Basic	6 5 0	—
Hoops	10 5 0	—
Soft Wire Rods	7 15 0	—
MIDLANDS—		
Small Rolled Bars	7 5 0 to 8 0 0	—
Billets and Sheet Bars	5 7 6 to 5 15 0	—
Galv. Sheets, f.o.b. L'pool	11 0 0	—
(2) Staffordshire Hoops	9 10 0	—
(*d*) Angles	8 7 6	—
(*d*) Joists	8 15 0	—
(*d*) Tees	9 7 6	—
(*d*) Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 5 0	—

NON-FERROUS METALS.

SWANSEA—		
Tin-plates, I.C., 20 by 14	f.o.b.	15/3 to 15/6
Block Tin (cash)		122 7 6
" (three months)		123 17 6
Copper (cash)		46 13 9
" (three months)		46 18 9
Spanish Lead (cash)		14 2 6
" " (three months)		14 5 0
Spelter (cash)		12 17 6
" (three months)		13 7 6
MANCHESTER—		
Copper, Best Selected Ingots		49 10 0
" Electrolytic		50 0 0
" Strong Sheets		77 0 0
" Tubes (Basis Price), lb.		0 0 11
Brass Tubes (Basis Price), lb.		0 0 9¾
" Condenser, lb.		0 1 0
Lead, English		15 12 6
" Foreign		14 7 6
Spelter		13 10 0
Aluminium (per ton—raw ingot)	£95	

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/3 per lb.	
Ferro Tungsten	2/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22 15 0	7/–
" " 6 p.c. to 8 p.c.	£21 12 6	7/–
" " 8 p.c. to 10 p.c.	£21 10 0	7/–
" " Specially Refined		
" " Max. 2 p.c. carbon	£32 0 0	10/–
" " " 1 p.c. carbon	£36 0 0	12/–
" " " 0·70 p.c. carbon	£37 15 0	14/–
" " " carbon free	10d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
" " "	£11 10 0 for export	
" Silicon, 45 p.c. to 50 p.c.	£11 0 0 scale 5/– per unit	
" " 75 p.c.	£16 0 0 scale 7/– per unit	
" Vanadium	12/9 per lb.	
" Molybdenum	4/2 per lb.	
" Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170	
Ferro Cobalt	9/3 per lb.	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	14/6
" " Ell	15/6
" " Splint	16/– to 16/9
" " Trebles	13/–
" " Doubles	11/9 to 12/–
" " Singles	11/–
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/6
" " Jewel	17/–
" " Trebles	12/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	12/– to 13/6
Screened Navigation	16/6 to 17/6
Trebles	12/– to 13/–
Doubles	11/–
Singles	10/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	13/–
Secondary Steam	12/9
Trebles	12/– to 13/–
Doubles	11/9
Singles	10/6

ENGLAND.

	Inland.	Export.
(5) N.W. COAST—		
Steams		20/–
Household		30/– to 51/–
Coke		20/– to 20/6
NORTHUMBERLAND—		
Best Steams		13/6
Second Steams		12/6
Steam Smalls		10/– to 10/6
Unscreened		12/6 to 13/–
Household		27/– to 39/–
DURHAM—		
Best Gas		15/–
Second		13/3 to 13/6
Household		25/– to 37/–
Foundry Coke		26/– to 28/–
SHEFFIELD—		
Best Hand-picked Branch	25/6 to 27/6	—
Derbyshire Best Bright House	20/– to 22/6	—
Best House Coal	20/6 to 21/6	—
Screened House Coal	18/– to 19/–	—
" " Nuts	15/6 to 16/6	—
Yorkshire Hards	14/– to 15/6	—
Derbyshire Hards	14/– to 15/6	—
Rough Slacks	8/6 to 9/–	—
Nutty Slacks	6/6 to 7/–	—
Smalls	3/– to 5/–	—
Blast-furnace Coke (Inland)	12/– on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b. 15/– to 16/–		

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	20/– to 20/3
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 19/6
Ordinary Dry Large	17/9 to 18/–
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/–
Best Eastern Valley Large	17/6 to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/6 to 14/–
Ordinary Smalls	12/– to 13/6
Washed Nuts	18/– to 22/–
No. 3 Rhondda Large	19/9 to 20/3
" " Smalls	15/6 to 16/–
No. 2 " Large	17/– to 17/3
" " Through	15/6 to 16/–
" " Smalls	14/– to 14/3
Foundry Coke (Export)	22/– to 36/6
Furnace Coke (Export)	17/6 to 18/–
Patent Fuel	21/6
Pitwood (ex ship)	24/9 to 25/3
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	35/– to 37/6
Seconds	27/– to 31/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 45/–
Nuts	43/– to 46/–
Beans	24/9 to 28/3
Peas	19/9 to 21/–
Breaker Duff	9/6 to 10/6
Rubbly Culm	8/6 to 9/6
Steam Coals :	
Large	20/– to 21/–
Seconds	18/– to 20/–
Smalls	12/– to 13/–
Cargo Through	16/– to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (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. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate : Joists (minimum), 22/6 ; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Trade Outlook.

THE belief that iron and steel prices had reached a level at which any movement must necessarily be in an upward direction has not been justified by the experience of the past few weeks when prices abroad have been quoted still farther down as the result of the lower wages which are being enforced almost everywhere. On the Brussels Exchange bars were priced at £3 17s. per ton f.o.b. Antwerp, a fall of 7s. since the beginning of the year. Joists to English dimensions were £3 11s. and angles £3 17s. A similar state of things exists in the Saar. This movement is naturally affecting the French market, which is obliged to receive the Saar products, and there has been some trouble through the importation of Belgian iron and steel contrary to the stipulations of the Steel Cartel. While prices are weak there is hope of some improvement in demand as the result of the measures being put in hand to hasten the revival of industrial activity by means of the colonial loan and the voting of the first instalment of the programme of public works, which, it is expected, will be done almost immediately. These measures will provide employment to the metallurgical trades, but there can be no general activity unless the railway companies and the Local Government bodies are able to give out work, the amount of which is likely to be limited by the present financial stringency. In the constructive engineering trades, the crisis is felt more keenly by the smaller firms. The big companies are still able to keep their hands employed, though on shorter time, and it is, therefore, hoped that the distribution of work under the national scheme will place the engineering trades on a relatively satisfactory basis. The motor car industry is the only one which is passing through a very bad period, this being due mainly to the failure of the export trade. The wagon builders have plenty of work, and the future of this industry seems to be assured by the reconstitution of the International Wagon Builders' Union into a company so that the Cartel, which was to have expired at the end of the year, will be replaced by a permanent organisation. This development has only been rendered possible by the granting of a larger quota to Germany, and it is also understood that France will help to finance some of the foreign railway undertakings which will provide orders to German wagon builders.

Unemployment.

The conditions of unemployment in this country are far from being so serious as they are, for example, in Great Britain. In the absence of reliable figures, the actual number of men out of work cannot be stated, and there is a tendency to minimise it in order to check any feeling of pessimism, but there is no doubt that the ranks of the unemployed are steadily increasing. For the moment, the Government does not find the problem so difficult to deal with as it is elsewhere. Nevertheless, its attitude towards unemployment relief is interesting. In the first place, it is accepted as a principle that a man out of work shall not receive an amount of relief that will tempt him to remain in idleness. He gets 7f. a day with a maximum of 18f. for a family. This allowance implies a frugality far below the standard of living of the British worker. The Government has decided that the amount payable for relief shall be within the limit of the Budget possibilities, and has only increased the total credits for relief to 100 million francs under Socialist pressure. Meanwhile, it is hoped that the works to be put in hand will prevent unemployment from spreading until such time as there is a recovery in the world's industrial activity.

Finance and Trade.

The acceptance by the Rumanian Government of an offer by Germany to supply agricultural machinery in return for produce which will be sold in Germany to pay for the machines, has aroused some feeling amongst French manufacturers, who argue that they have a prior claim to the business from the fact that Rumania is largely financed with French capital. In many cases the French have financed railway and public works undertakings in Eastern Europe for the sake of the work available, and they have benefited from some important engineering contracts. So long as the money is advanced for the carrying out of specified works, the material for which must be supplied by France, the practice is perfectly normal, but there is a tendency to claim that the granting of loans by France to Rumania and other countries implies an obligation on those countries to place their orders among French manufacturers. In a word, loans to foreign countries are regarded as a lever for trade. The arrangement between Rumania and Germany, however, shows that the system of barter is quite practicable within limits, and that, under present conditions, countries which have to import agricultural produce have an opportunity to extend their business with buyers of machinery who cannot pay for it otherwise than in kind.

Colonial Exhibition.

The buildings of the International Colonial Exhibition, to be held in the Bois de Vincennes, Paris, in two months' time, do not offer special interest from a structural point of view, but it is doubtful whether anything so good has been done in the way of reproducing oriental palaces and native edifices of all kinds. The French Colonial Section, with the famous Temple of Angkor, is on one side of the lake and the foreign sections are on the other side, one of the most extensive and interesting of which is the Dutch, while Belgium has built a Congo village and the United States has reproduced George Washington's house. There is no special British section, though, presumably, the British participation in the Exhibition of colonial products will be fully representative. In the construction of the four principal palaces more timber is used than iron. The Palace of Engineering covers 452,000 square feet. It will comprise railways, land and sea transport, aviation, electricity, civil engineering, mining and metallurgy. Machines will be shown in motion. The Palace of Arts and Industry covers 150,000 square feet, and there will be a Palace of Agriculture and a Palace of Colonial Timber. A series of congresses will be held dealing with all aspects of colonial development.

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.

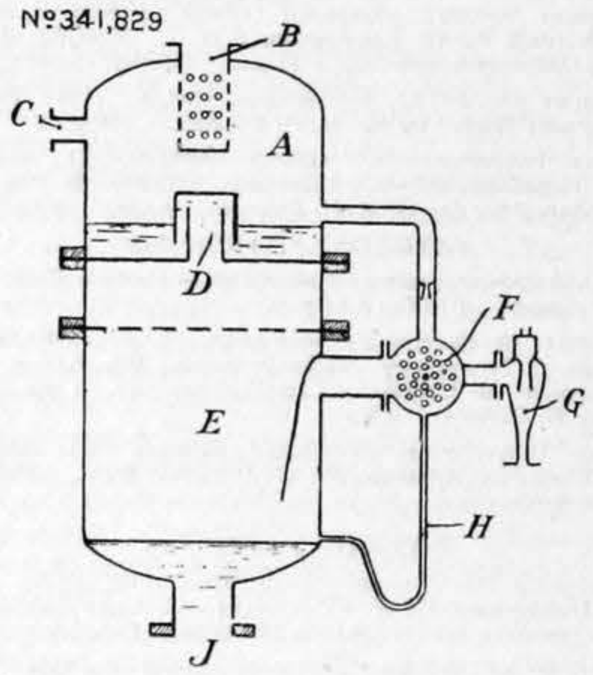
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

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.

CONDENSERS AND FEED-WATER HEATERS.

341,829. May 19th, 1930.—DE-AERATING FEED WATER, Société des Condenseurs Delas, 103, rue Saint Lazare, Paris.

The feed water is sprayed into the chamber A by the perforated pipe B and is heated by steam from C. It escapes by the seal D and showers down into the second chamber E. It

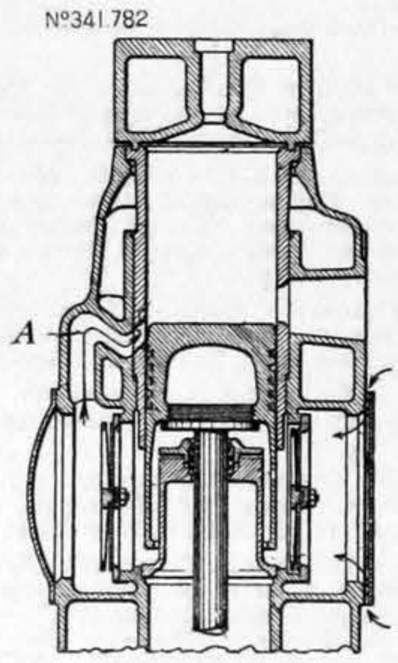


is there partially evaporated and the steam carries away any dissolved air. The mixture is sucked into the condenser F by the ejector G. The steam is condensed and returns to the chamber E by the pipe H, while the air is discharged by the ejector. The outlet for the de-aerated water is shown at J.—*January 22nd*, 1931.

INTERNAL COMBUSTION ENGINES.

341,782. March 21st, 1930.—TWO-STROKE ENGINES, Sulzer Frères Société Anonyme, Winterthur, Switzerland.

In order to improve the scavenging action in two-stroke engines the inventors make the scavenging port of the zig-zag form

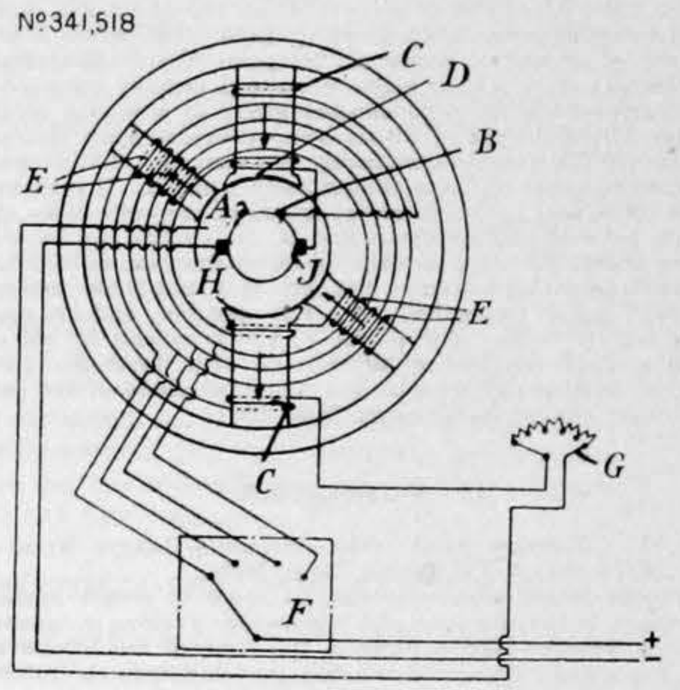


shown at A. They claim that in this way a layer of air travelling at a high velocity is delivered from the lower edge of the port, while the remainder travels at a comparatively low speed. The air is deflected into the upper part of the cylinder and does not immediately escape by the exhaust port.—*January 22nd*, 1931.

DYNAMOS AND MOTORS.

341,518. October 17th, 1929.—GENERATING MACHINES TO GIVE DROOPING VOLTAGE CHARACTERISTICS OF THE SAME NATURE AT VARYING OUTPUTS, Greenwood and Batley, Ltd., of Albion Works, Leeds, and John Hayton Carrick, of 7, Hyde Park-road, Harrogate.

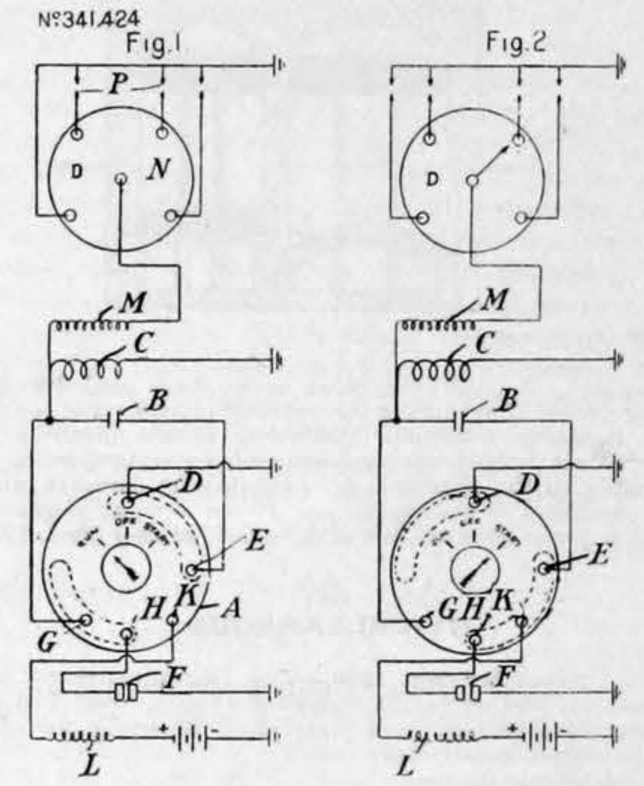
This invention relates to electric generating machines and has for its object to provide an improved D.C. generator suitable for use in electric arc welding, in which a drooping load characteristic and a definite drop in voltage for a given ampère output are required. The machine comprises a special field system having main poles and auxiliary poles. In the cases illustrated there are two main poles and two auxiliary poles. A and B are auxiliary brushes for shunt field excitation, C represents shunt field coils, D series field coils and E series auxiliary field coils. The auxiliary field coils E are preferably tapped or arranged in sections and leads from the tappings or ends of the sections are taken out to a multiple contact switch F, which is adapted to vary the number of turns effectively in circuit in the auxiliary field windings. G is a shunt field regulator of usual construction. The main poles carry cumulative compound windings and the auxiliary poles series windings which oppose the main pole flux. The main brushes H and J are diametrically opposite one another on the commutator and are so positioned as to collect the voltage due to the main pole flux less that due to the auxiliary pole flux. At no load the auxiliary poles which carry series windings only will, of course, be unexcited, and the voltage between the brushes H and J will be that due to the main pole flux only. When, however, current is taken from the machine, the auxiliary poles will become excited and the voltage at the main brushes is reduced by an amount corresponding to the amount of the auxiliary pole flux. By suitably dimensioning the auxiliary field system a drooping characteristic may be obtained. The shunt field is excited from the brushes A B, which are so positioned in relation to the shunt field system as to be removed from the influence of the auxiliary field and to pick up voltage which is approximately constant at all loads, since it depends wholly, or at any rate mainly, upon the main load flux. The result of this



is that variations of voltage with load are reached very rapidly and the machine is stable.—*January 19th*, 1931.

341,424. October 14th, 1929.—IGNITION APPARATUS, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C. 2; William Hewitt, of 39, Radford-road, Coventry, and Leonard Griffiths, of "Kennington," Biggin Hall-crescent, Coventry.

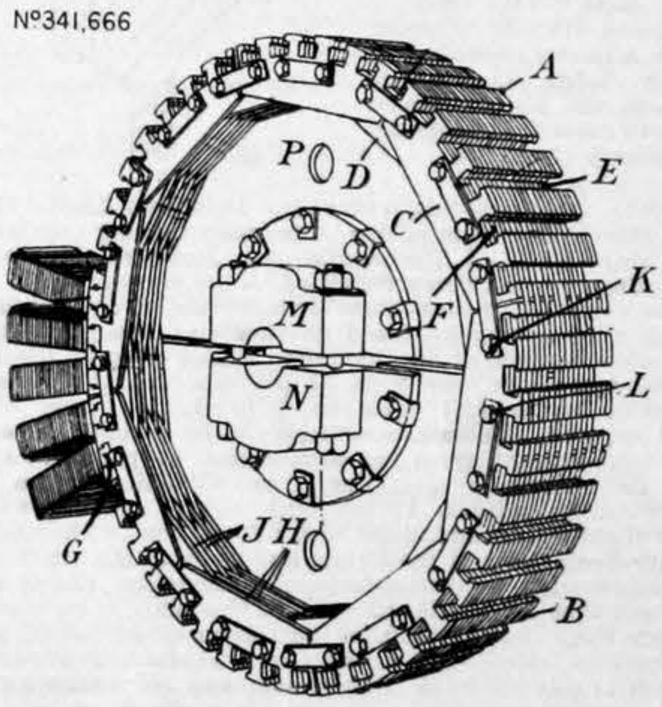
According to this invention, the magneto condenser and an inductance are utilised to supplement the action of the magneto at starting and slow speed. In the case of Fig. 1, the three-way ignition switch A is set in the normal running position and the usual magneto circuit is thereby provided, the condenser B being connected in parallel with the primary winding C, and one side being earthed through the switch contacts D, E, the other side being connected to the contact breaker F through the switch contacts G, H. There is no connection from the switch terminal K of the inductance L and battery. The connection



from the secondary M through the distributor N to the sparking plugs P and earth are as usually arranged and remain unchanged in the starting position of the ignition switch A. Fig. 2 shows the changed connections of the same devices resulting from moving the ignition switch to the "start" position. In this position of the switch the terminals E, K and H are bridged, and the condenser B is connected in series with the primary C and the parallel paths through the contact breaker F to earth and through the inductance L and battery to earth. Hence, when the contact breaker opens the energy stored in the induction coil by the battery is discharged through the primary winding of the magneto, giving rise to high voltage in the secondary winding, and this voltage is distributed to the sparking plugs as before. In the "off" position of switch A the contact breaker is disconnected from the primary and the inductance coil.—*January 4th*, 1931.

341,666. December 13th, 1929.—ROTORS FOR DYNAMO-ELECTRIC MACHINES, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C. 2.*

The object of this invention is to provide a rotor construction



of the type which is separable into two or more sectors to facilitate shipment. The central supporting structure or spider comprises separable sectors A and B. The sector A is formed

of groups of plates C, which interleave with respect to another group of plates D, these groups of plates C and D being arranged about the periphery of the sector with their edges presented radially outward and with their ends in substantial alignment with each other to form a continuous sector. The groups of plates C and D are provided with dovetailed notches E and F, which form dovetailed grooves in which the dovetailed portions G of the pole pieces are secured by keys. The sector B is also formed of groups of plates H, arranged about the periphery of the sector with their edges presented radially outward and in interleaved relation to another group of similarly arranged plates J, the groups of plates being provided with dovetailed notches. The plates constituting the sectors A and B may be secured together by bolts having locking plates. Upon removal of bolts K and L, which are arranged on opposite sides of the joints between the sectors A and B, the sectors can be readily taken apart. In order to make the entire rotor separable into two parts to facilitate shipment the sectors A and B are secured to parts M and N respectively of a hub member, and are secured together by bolts. The plates P, which extend to the outer periphery of the sectors are formed with dovetailed notches aligned with the grooves on the outer periphery of the sectors and with bolt holes.—*January 22nd*, 1931.

FURNACES.

341,721. January 22nd, 1930.—SIEMENS-MARTIN FURNACES, F. Fiorelli, 5, Via Tacito, Terni, Italy.

The inventor points out that in order to secure maximum efficiency in the operation of a regenerator working in connection with a Siemens-Martin furnace, the mass of the brickwork in the regenerator should have a definite relation to the volume of

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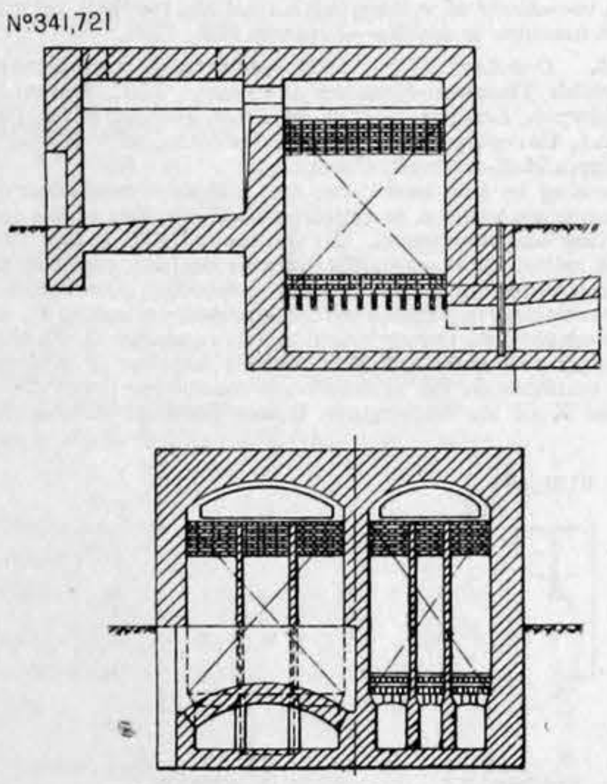

gas handled. As, however, much more gas is used during the melting period than during the refining process, this condition is not normally obtained. According to the invention, the regenerator is divided into compartments by vertical walls. The gas supply to the chambers is controlled by dampers, and so many chambers as are appropriate to the amount of gas being used at any one time are put in action.—*January 22nd*, 1931.

MISCELLANEOUS.

341,174. November 9th, 1929.—THE LUBRICATION OF BEARINGS, A. Steinmetz, 37, Ashwood-avenue, West Didsbury, near Manchester; and Associated Electrical Industries, Ltd., Bush House, Aldwych, Westminster.

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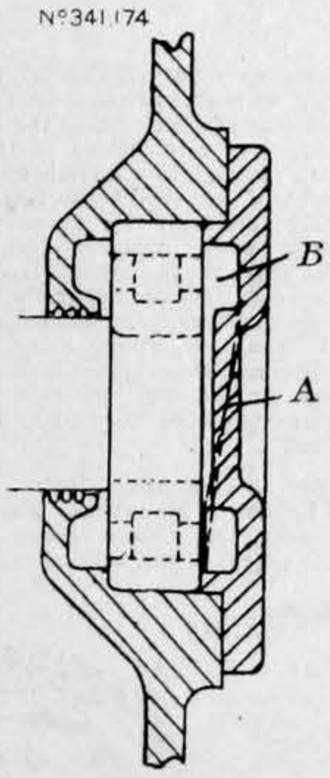

It is suggested in this specification that difficulty may be experienced in the lubrication of roller bearings on account of temperature effects on the viscosity of the lubricating grease. That is to say, at low temperatures the grease may not be sufficiently fluid to run into the bearing, while there should be a substantial margin between the melting temperature of the grease and the temperature of the bearing under normal conditions. In order to meet these conditions the inventor proposes to arrange the bearing so that the grease is constantly led in between the rollers and, by being churned up, is kept in a more or less fluid state. This effect is produced by an inclined plane A in the grease box B, which feeds the grease towards the space between the two races of the bearing.—*January 15th*, 1931.

342,152. February 7th, 1930.—AN IMPROVED LIGHT METAL ALLOY, The Birmingham Aluminium Casting (1903) Company, Ltd., of Dartmouth-road, Smethwick, near Birmingham, and Percy Pritchard, of the same address.

The object of this invention is to provide an aluminium and silicon alloy having improved physical and casting properties. The alloy consists of an aluminium silicon alloy in which the silicon content is from 8 to 13 per cent., to which is added nickel in an amount equal to ½ to 3½ per cent. of the total content. These percentages are by weight. The preferred proportions are 3 per cent. nickel, 11 per cent. silicon and the remainder aluminium. An aluminium-silicon alloy is first made, with a 13 per cent. silicon content, and an alloy of aluminium and nickel with a 20 per cent. nickel content. Eighty-five pounds of the former and 15 lb. of the latter, when melted together, gives the preferred proportions indicated. It is found that the tensile strength of this alloy is considerably greater than that of ordinary aluminium-silicon alloy, whilst its ductility is eminently satisfactory. Further, its yield point is raised; its hardness is increased, and its machining properties, which are usually poor in silicon alloys, are said to be greatly improved. The casting properties of the alloy are also much better, chilling, generally speaking, being entirely eliminated. The alloy lends itself very well to the well-known modification process.—*January 29th*, 1931.

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, St. James's Park, London, S.W. 1. Informal meeting. Lantern lecture, "The Netherlands East India State Railways and Electrification," by Mr. A. M. Hug. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Science Museum, South Kensington, S.W. 7. Lecture on "The Historic Locomotives at the Museum." Inspection of exhibits. 7.30 p.m.

OLD CENTRALIANS.—Connaught Rooms, Great Queen-street, London, W.C. 2. Twenty-eighth annual dinner. 7.15 for 7.30 p.m. Applications for tickets to Mr. W. F. Simonson, 61, St. Mildred's-road, Lee, S.E. 12.

PHYSICAL SOCIETY.—Imperial College of Science, Imperial Institute-road, South Kensington, S.W. 7. Meeting at 5 p.m. Editing Committee meeting, 3.30 p.m. Council meeting, 4 p.m.

RAILWAY CLUB.—57, Fetter-lane, E.C. 4. "My Favourite Railway and Why," by Mr. R. F. Appach. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "Ozone in the Upper Atmosphere," by Dr. G. M. B. Dobson. 9 p.m.

SATURDAY, MARCH 7TH.

BELFAST ASSOCIATION OF ENGINEERS.—Carlton Hall, Belfast. Annual dinner. 6.15 for 6.45 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—College of Technology, Sackville-street, Manchester. "The Blast-furnace, its Limitations and its Relation to the Cupola," by Major H. G. Scott. 4 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, London, W. 1. "Alpha Rays, Lecture I.," by Lord Rutherford. 3 p.m.

MONDAY, MARCH 9TH.

CHARTERED SURVEYORS' INSTITUTION.—12, Great George-street, Westminster, S.W. 1. "Suggested Amendments of the London Building Acts, 1930," by Mr. Gilbert Lovegrove. 8 p.m.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—In the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Annual general meeting. Open discussion. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Queen's Hotel, Birmingham. "Pressings for Automobiles," by Mr. J. E. Arrowsmith. 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH-EASTERN CENTRE.—At Armstrong College, Newcastle-upon-Tyne. "Heavy Duty Rectifiers and their Application to Traction Sub-stations," by Messrs. J. W. Rissik and H. Rissik. 7 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Cantor Lecture, "The Recording and Reproducing of Sound" (Lecture I.), by Mr. A. G. D. West. 8 p.m.

TUESDAY, MARCH 10TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, BURNLEY SECTION.—Municipal Technical College, Ormerod-road, Burnley. Open discussion, introduced by Mr. W. Barnes. 7 p.m.

INSTITUTE OF MARINE ENGINEERS.—The Minories, London, E.C. 3. "The Efficiency and Steering Effect of Inward and Outward Turning Screws," by Mr. G. S. Baker. 6 p.m.

INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION.—In the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. Annual general meeting. "The Longmaid-Henderson Process for the Extraction of Copper," by Mr. R. D. Burn. 7.30 p.m.

INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—At the Y.M.C.A., Swansea. "Some Researches on the Wire-drawing Process," by Professor F. C. Thompson. 6.15 p.m.

INSTITUTION OF ENGINEERS-IN-CHARGE.—St. Bride Institute, Bride-lane, Fleet-street, E.C. 4. Annual general meeting. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH MIDLAND STUDENTS' SECTION.—At the Hotel Metropole, Leeds. "Power Factor Correction," by Mr. J. H. B. Raw. 7.15 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—At the Engineers' Rooms, 39, Elmbank-crescent, Glasgow, C. 2. "High-voltage Testing Equipments," by Messrs. E. T. Norris and F. W. Taylor; "Dielectric Phenomena at High Voltages," by Messrs. B. L. Goodlet, F. S. Edwards, and F. R. Perry. 7.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C. 2. "Motor Yachts," by Mr. J. R. Barnett. 7.30 p.m.

MANCHESTER GEOLOGICAL AND MINING SOCIETY.—Queen's Chambers, 5, John Dalton-street, Manchester. "Gob Stowing," by Mr. H. Jenkins. 4 p.m. The Council will meet at 3 p.m.

WEDNESDAY, MARCH 11TH.

INSTITUTE OF FUEL.—At the Chemical Society's Rooms, Burlington House, Piccadilly, W. 1. "The Formation of Coke," by Mr. John Roberts. 6 p.m.

INSTITUTE OF METALS.—Trocadero Restaurant, Piccadilly Circus, London, W. 1. Annual dinner and dance. 7 for 7.15 p.m.

INSTITUTION OF ENGINEERS-IN-CHARGE.—St. Bride Institute, Bride-lane, Fleet-street, E.C. 4. "A.C. Motors and their Application to Industry," by Mr. P. W. Richardson. 7.30 p.m.

INSTITUTION OF ENGINEERING INSPECTION.—At the Rooms of the Royal Society of Arts, John-street, Adelphi, London, W.C. 2. "Motor Racing and its Influence on Technical Design," by Lieut.-Col. J. T. C. Moore-Brabazon. 5.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Bolbec Hall, Newcastle-on-Tyne. "The Automatic Stabilisation of Ships," by Mr. R. Harding. 7.15 p.m.

WEDNESDAY AND THURSDAY, MARCH 11TH AND 12TH.

INSTITUTE OF METALS.—In the Hall of the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. Annual general meeting. 10 a.m. each day. (For programme see page 154.)

THURSDAY, MARCH 12TH.

BRITISH ENGINEERS' ASSOCIATION.—Hotel Victoria, Northumberland-avenue, London, W.C. 2. Monthly luncheon meeting. Sir Henry Strakosch will speak on "Gold, in Relation to Industrial Prosperity." 1 p.m.

INSTITUTE OF MARINE ENGINEERS: JUNIOR SECTION.—The Minories, London, E.C. 3. "Experiences of a Junior Engineer on his First Voyage," by Mr. H. R. Tyrrell. 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—In the Lecture Theatre of the Institution, Savoy-place, Victoria Embankment, W.C. 2. "Heavy Duty Rectifiers and their Application to Traction Sub-stations," by Messrs. J. W. Rissik and H. Rissik. 5.30 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS: NORTHERN IRISH DISTRICT.—Carlton Restaurant, Donegall-place, Belfast. Paper and discussion, "Roads and Public Works in County Down," by Mr. J. G. Wilkin. 3 p.m.

INSTITUTION OF WELDING ENGINEERS.—At the Institution of Mechanical Engineers, Storey's-gate, St. James's Park, London, S.W. 1. "Cast Iron To-day," by Dr. A. B. Everest. 7.45 p.m.

OPTICAL SOCIETY.—Imperial College of Science and Technology, Imperial Institute-road, South Kensington, S.W. 7. "The Measurement of Optical Density and a Demonstration of a Photo-electric Density Meter," by Mr. F. C. Toy; "The Tavistock Theodolite," by Mr. E. Wilfred Taylor; "On Absolute Refractive Indices in Geometrical Optics," by Mr. T. Smith. 7.30 p.m.

FRIDAY, MARCH 13TH.

CHEMICAL ENGINEERING GROUP.—In the Rooms of the Chemical Society, Burlington House, Piccadilly, W. 1. "The Manufacture of Lime," by Mr. W. J. Rees. 8 p.m.

INSTITUTE OF FUEL: NORTH-WESTERN SECTION.—At the Engineers' Club, Manchester. "The Industrial Application of Pulverised Fuel," by Dr. G. E. K. Blythe. 7 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS: MANCHESTER CENTRE.—Manchester Literary and Philosophical Society, 36, George-street, Manchester. "Steam Storage in Relation to the Locomotive," by Dr. E. G. Ritchie. 7 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—City Chambers, Edinburgh. Scottish District meeting. 11.30 a.m. "The Proposed National Standard Practice for the Employment of Structural Steel in Building, as Delegated by the British Steel Work Association," by Mr. W. Basil Scott. 12.30 p.m. Inspection of new river Almond bridge at Newbridge. 2.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. "Phenol Formaldehyde Moulding Compositions, Manufacture and Use," by Mr. Leonard Clegg. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—In the Mining Institute, Newcastle-on-Tyne. "Some Factors Influencing the Sizes of Crank Shafts for Double-acting Diesel Engines," by Mr. S. F. Dorey. 6 p.m.

SATURDAY, MARCH 14TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. "Alpha Rays," by Lord Rutherford, F.R.S. 3 p.m.

MONDAY, MARCH 16TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, Westminster, S.W. 1. Graduates' Section annual lecture, "Heavy Oil and Diesel Engines," by Mr. Charles Day. 6.45 p.m.

TUESDAY, MARCH 17TH.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—Chamber of Commerce, New-street, Birmingham. "The Metallurgy of Some of the Rarer Metals," by Dr. C. J. Smithells. 7 p.m.

WEDNESDAY, MARCH 18TH.

NEWCOMEN SOCIETY.—At Caxton Hall, Room 13, Westminster, S.W. 1. "John Nuttall's Sketch Book and Notes on Wrought Iron Detail for Early Locomotives," by Mr. J. G. H. Warren. 5.30 p.m.

OVERHEAD LINES ASSOCIATION.—At the Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. Discussion, "Overhead Line Difficulties," opened by Mr. Wm. C. Bexon. 5.30 p.m.

THURSDAY, MARCH 19TH.

ILLUMINATING ENGINEERING SOCIETY.—At the Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. "Modern Domestic Lighting," by Mr. H. T. Young. 7 p.m.

FRIDAY, MARCH 20TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, Westminster, S.W. 1. Discussion, "Modern Methods of Raising Water from Underground Sources," by Mr. Rupert S. Allen and Mr. W. E. W. Millington. 6 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Merchant Venturers' Technical College, Unity-street, Bristol. Joint meeting with the Institution of Automobile Engineers. "An Experimental Investigation into Induction Conditions, Distribution and Turbulence in Petrol Engines," by Dr. S. J. Davies. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. "Some Token Systems of Railway Signalling," by Mr. W. S. Roberts. 7.30 p.m.

SATURDAY, MARCH 21ST.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Joint meeting, Yorkshire and North-Western Districts, at the College of Technology, Sackville-street, Manchester. "The Building of the New Tyne Bridge," "The Building of Imperial Chemical House," and "The Sydney Harbour Bridge," by Messrs. Dorman, Long and Co., Ltd., to be followed by a discussion on any matters of general interest. 2.30 p.m.

MONDAY, MARCH 23RD.

INSTITUTE OF FUEL.—At the Institution of Civil Engineers, Great George-street, London, S.W. 1. "Self-help in the Coal Industry," by Mr. R. A. Burrows. 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, Westminster, S.W. 1. Graduates' Section annual meeting. Short papers for discussion. 6.45 p.m.

WEDNESDAY, MARCH 25TH.

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX.—At the Institution of Mechanical Engineers, Storey's-gate, London, S.W. 1. "George Stephenson's Institute and its Library." 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—The Engineers' Club, Albert-square, Manchester. "Pressings for Automobiles," by Mr. J. E. Arrowsmith. 7 p.m.

INSTITUTION OF NAVAL ARCHITECTS.—Grand Hall, Connaught Rooms, Great Queen-street, Kingsway, W.C. 2. Annual dinner. 7.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "The Kent Coalfields," by Professor Patrick Abercrombie. 8 p.m.

WEDNESDAY TO FRIDAY, MARCH 25TH TO 27TH.

INSTITUTION OF NAVAL ARCHITECTS.—In the Lecture Hall, Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Annual meeting.

THURSDAY, MARCH 26TH.

INSTITUTE OF FUEL: SOUTH WALES BRANCH.—At the South Wales Institute of Engineers, Park-place, Cardiff. Joint meeting. "Local Generation of Electrical Power plus the Grid," by Major E. Ivor David. 6 p.m.