THE G2 4,500-S.H.P. NAVAL GAS-TURBINE.

THE designers and builders of the gas-turbine which was the first in the world to propel a ship—the Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester—have completed four larger naval gas-turbines, which are now undergoing sea trials. The power/weight ratio has been improved; so, too, have the performance figures, as shown by the curves of specific fuel consumption, etc. Among the notable features of the new design are the use of the turbine exhaust to create an ejector effect to cool the power-unit casing; lubrication of the principal bearings by an oil mist, the air for which, and for several other services, is tapped from the compressor; and the provision made for keeping the two rotors turning, to prevent damage to the bearings due to vibration, during the long periods when the ship's Diesel engines are providing the power for cruising and manœuvring, since the gas turbines are used only at high speeds. A G2 gas turbine, with its aluminium casing, is shown in Fig. 1; a longitudinal section through the plant is given in Fig. 8, on Plate II.

It is understood that similar turbines are being fitted in a new class of light warship, the first of which, the patrol boat Bold Pioneer, is shown on trials in the English Channel in Fig. 4, on page 130. The Bold Pioneer, the first operational warship powered by gas turbines, was launched in 1951 at the Cowes yard of Messrs. J. Samuel White and Company, Limited, and is of hard-chine construction, 121 ft. length overall by 25 ft. 6 in. A sister-ship, the Bold Pathfinder, has been constructed by Vosper, Limited, Portsmouth, but is of round-bilge construction, 122 ft. 8 in. length overall by 20 ft. 5 in. Each vessel has a peace-time complement of two officers and 16 ratings. The Admiralty have stated that the gas turbines enable the boats to carry an abnormally heavy armament at unusually high speeds.

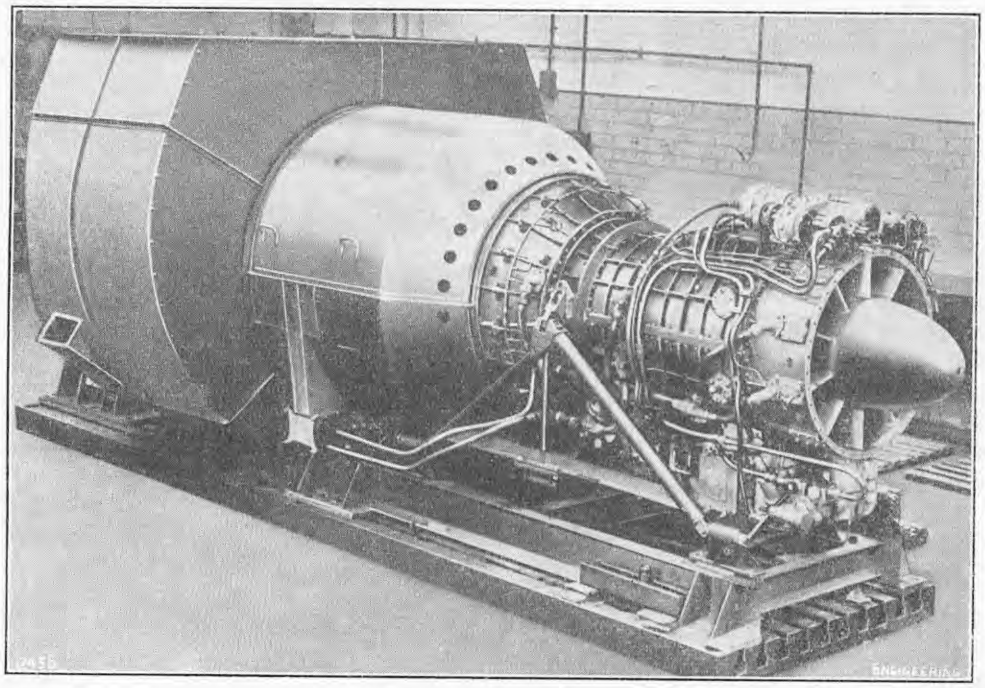


FIG. 1. "G2" GAS-TURBINE.

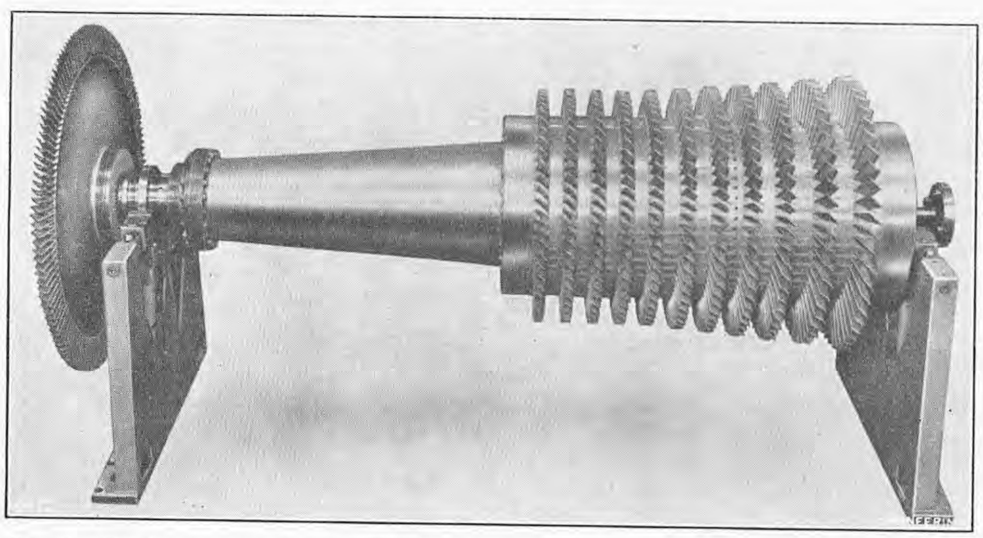
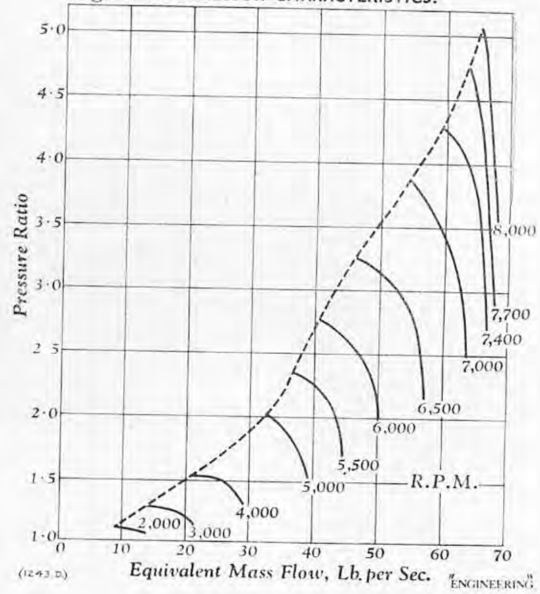


FIG. 2. GAS-GENERATOR ROTOR: ELEVEN-STAGE COMPRESSOR AND SINGLE-STAGE TURBINE.

The first ship to be propelled by a gas turbine, the Royal Navy's motor gunboat 2009, was fitted with the "Gatric" gas-turbine,* which was rated at 2,500 shaft horse-power. The turbine was of the open-cycle type without heat exchanger, and consisted of a gas-generator, based on the design of the F2 jet engine, and a separate power turbine. Following the successful operation of the Gatric at sea, an order was placed with Metropolitan-Vickers for the four larger gas-turbines, known as the "G2," employing the same cycle as the Gatric engine. The G2 gas-generator (compressor, combustion chamber, compressor turbine and auxiliaries) is, with certain modifications, that of the Beryl jet engine. The G2 units were originally designed to develop 4,800 shaft horse-power, but, pending operational experience at sea, the maximum power has been declared at 4,500 shaft horse-power, with a maximum continuous rating of 4,000 shaft horse-power. As in M.G.B. 2009, the gas turbines are used only at high speeds and are designed for a total life of 1,000 hours, of which 300 may be run at maximum power. A complete G2 unit consists of a gas generator, a power turbine with exhaust duct, and a reduction gear. The power turbine,

Fig. 3. COMPRESSOR CHARACTERISTICS.



which is mechanically independent of the gas generator, drives the propeller shaft through a single-helical side-pinion reduction gear.

The following figures show the much better power/weight ratio of the gas turbines compares with that of the Gatric unit.

—	Gatric.	G2.
Rating .. .. s.h.p.	2,500	4,500
Gas-turbine unit (excluding gears), weight, lb.	4,350	6,949
Gears .. .. .. weight, lb.	2,600	2,772
Total weight .. .. lb.	6,950	9,721
Power/weight ratio, gas-turbine only, lb. per s.h.p.	1·74	1·54
Power/weight ratio, complete unit, lb. per s.h.p.	2·78	2·16

GAS GENERATOR.

The gas generator, shown in Fig. 11, on Plate II, is supported by a built-up frame each side of the compressor and bolted to the engine bearers; the frames are pivoted so that they can swing outwards to allow for radial expansion. The forward end of the compressor is supported under the inlet branch by a small pivoted frame which permits axial expansion. Alignment of the unit is maintained by a sliding key under the compressor outlet branch.

The compressor has 11 axial-flow stages, giving an overall pressure ratio of 4·03 at an air-mass flow of 62·6 lb. per second for a maximum speed of 7,830 r.p.m. The rotor, illustrated in Fig. 2, on this page, consists of an inlet end-piece of manganese-molybdenum steel, a drum front extension, a drum centre portion and drum conical extension pieces of aluminium alloy, and a turbine-end shaft of nickel-chromium-molybdenum steel. The compressor casing is of aluminium alloy. The rotor is carried by two bearings, one ball and one roller, which are lubricated by an oil mist in a manner described later. The moving and fixed compressor blades are of aluminium alloy; the moving blades are carried in longitudinal serrated grooves in the

* See ENGINEERING, vol. 164, page 271 (1947).

4,500-S.H.P. GAS-TURBINE FOR THE ROYAL NAVY.

METROPOLITAN-VICKERS ELECTRICAL CO., LTD., TRAFFORD PARK, MANCHESTER.

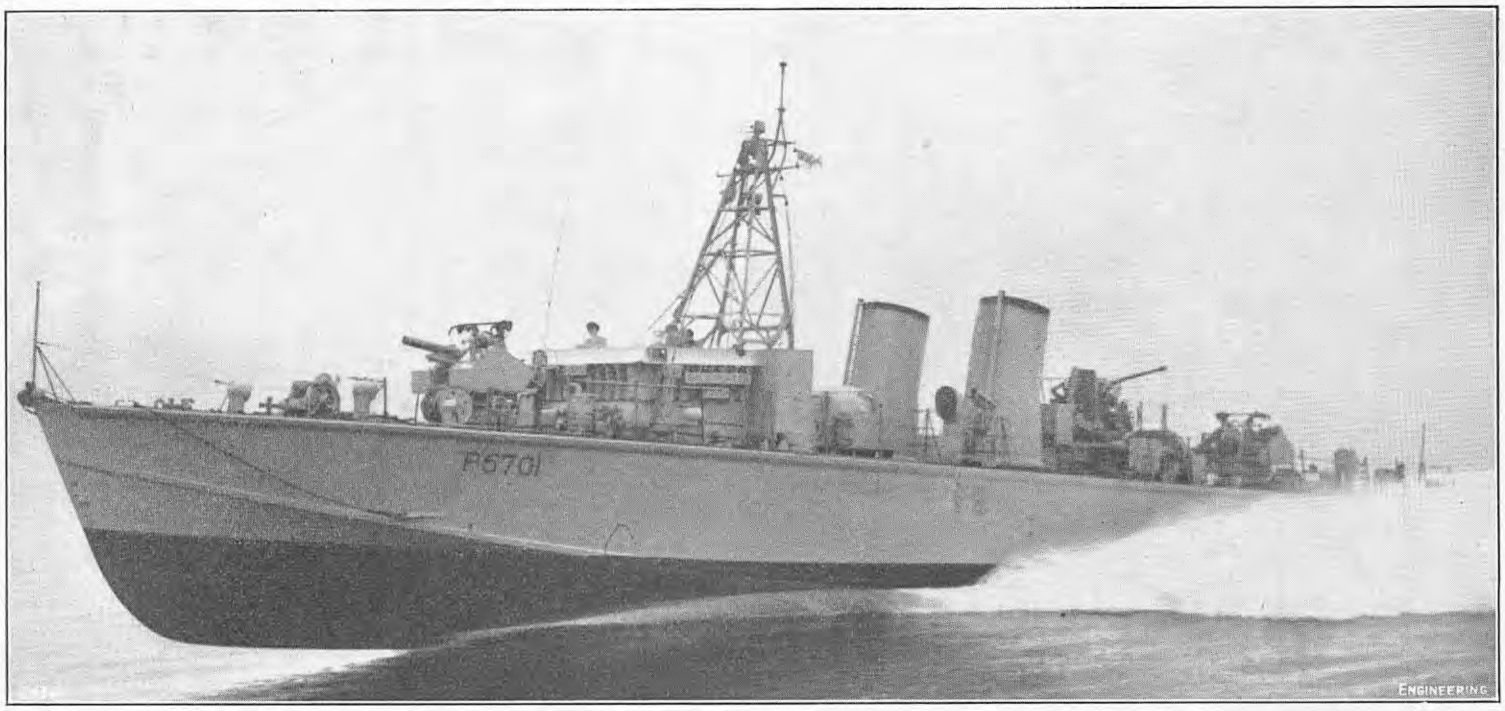


FIG. 4. H.M. PATROL BOAT "BOLD PIONEER."

Fig. 5.

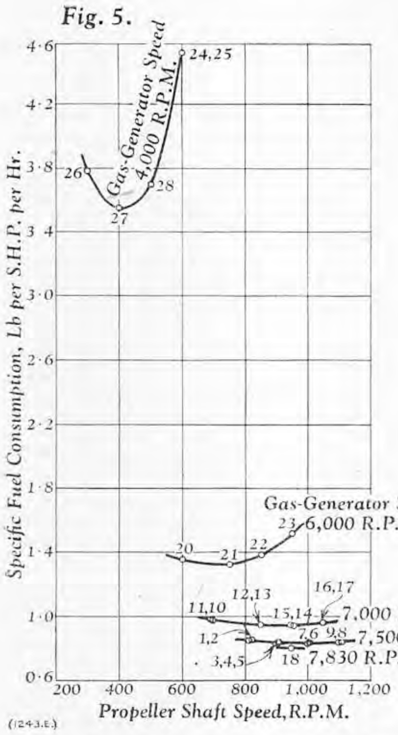


Fig. 6.

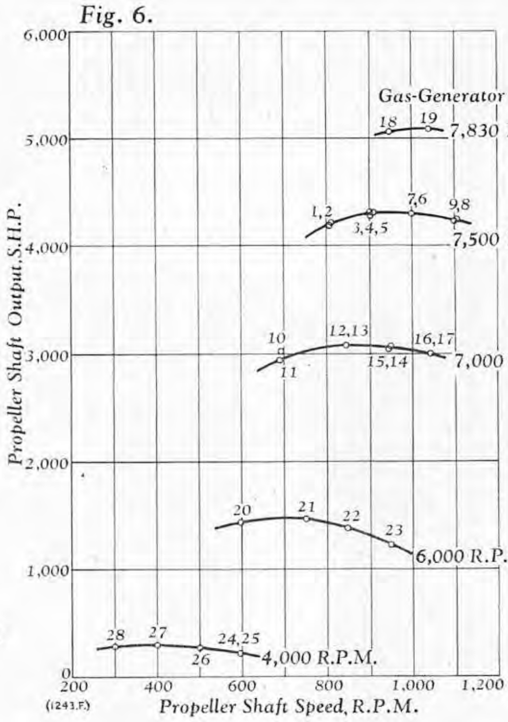
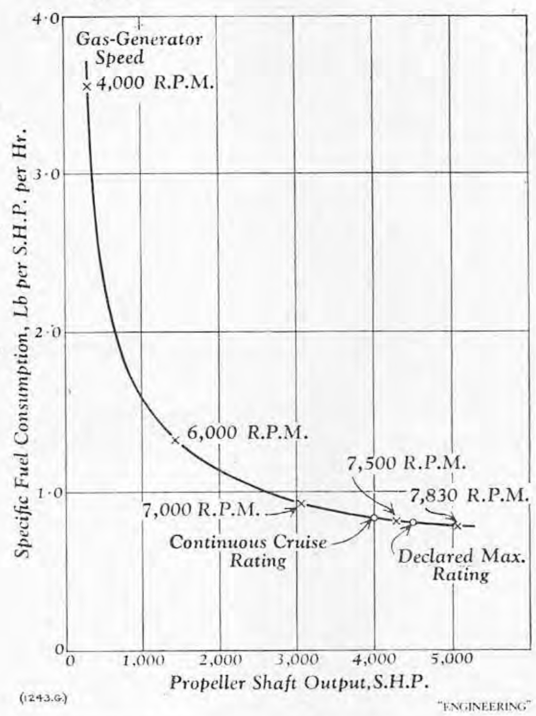


Fig. 7.



rotor and the fixed blades in dovetail grooves in the casing. Provision is made for the removal of salt deposits from the compressor blading. The general characteristics of the compressor are shown in Fig. 3.

The annular combustion chamber, of Firth-Vickers Immaculate 5 stainless steel with fixing rings of Firth-Vickers FCB(T) austenitic steel, is designed to give "straight-through" axial flow. The fuel, in a finely atomised state, is injected upstream through 20 fixed orifices into the primary chamber. The single-stage gas-generator turbine has a molybdenum-vanadium steel disc mounted on a steel shaft attached to the compressor-drum conical extension piece. The moving blades, which are secured to the disc by "fir-tree" fastenings, are made of Nimonic 80A alloy; the fixed diaphragm blades are made of Nimonic 80 alloy. Air is tapped from the compressor for cooling the turbine disc. The maximum gas temperature at the inlet to the nozzle guide vanes of the gas-generator turbine is 806 deg. C.

POWER TURBINE.

The forward end of the power turbine is carried by two semi-flexible legs attached to brackets on the outlet branch and mounted on a cross beam bolted to the engine bearers; the aft end of the turbine is supported from the gearbox. To maintain alignment, a sliding key is provided on the turbine bottom centre-line. The rotor, which consists of three Firth-Vickers FCB(T) austenitic-steel forgings welded together, is carried by one ball bearing and one roller bearing, each lubricated by an oil mist. The moving blades, secured to the discs by fir-tree fastenings, are of Firth-Vickers FCB(T) austenitic steel; the fixed diaphragm blades are of molybdenum-vanadium steel. The FCB(T) austenitic-steel turbine casing and the mild-steel exhaust casing, which have greatly different coefficients of expansion, are joined by an expansion piece of a material with an intermediate coefficient of expansion.

The maximum designed speed of the power turbine is 5,200 r.p.m. The mean gas temperature at the power-turbine inlet, measured by four thermocouples, is 660 deg. C. Due to stratification of temperature across the annulus, this figure is some 20 deg. C. higher than the average temperature calculated from fuel flow. From the forward flange of the combustion chamber to the aft end of the exhaust casing, the engine is lagged and encased in a sheet-aluminium casing built in easily-removable sections. The ejector effect of the turbine exhaust draws air into the aluminium casing, and the cooling effect of this air stream is such that at full power the casing can be touched by hand without ill-effect; the casing serves also to remove vapour and fumes from the engine room. All controls,

4,500-S.H.P. GAS-TURBINE

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Fig. 8.

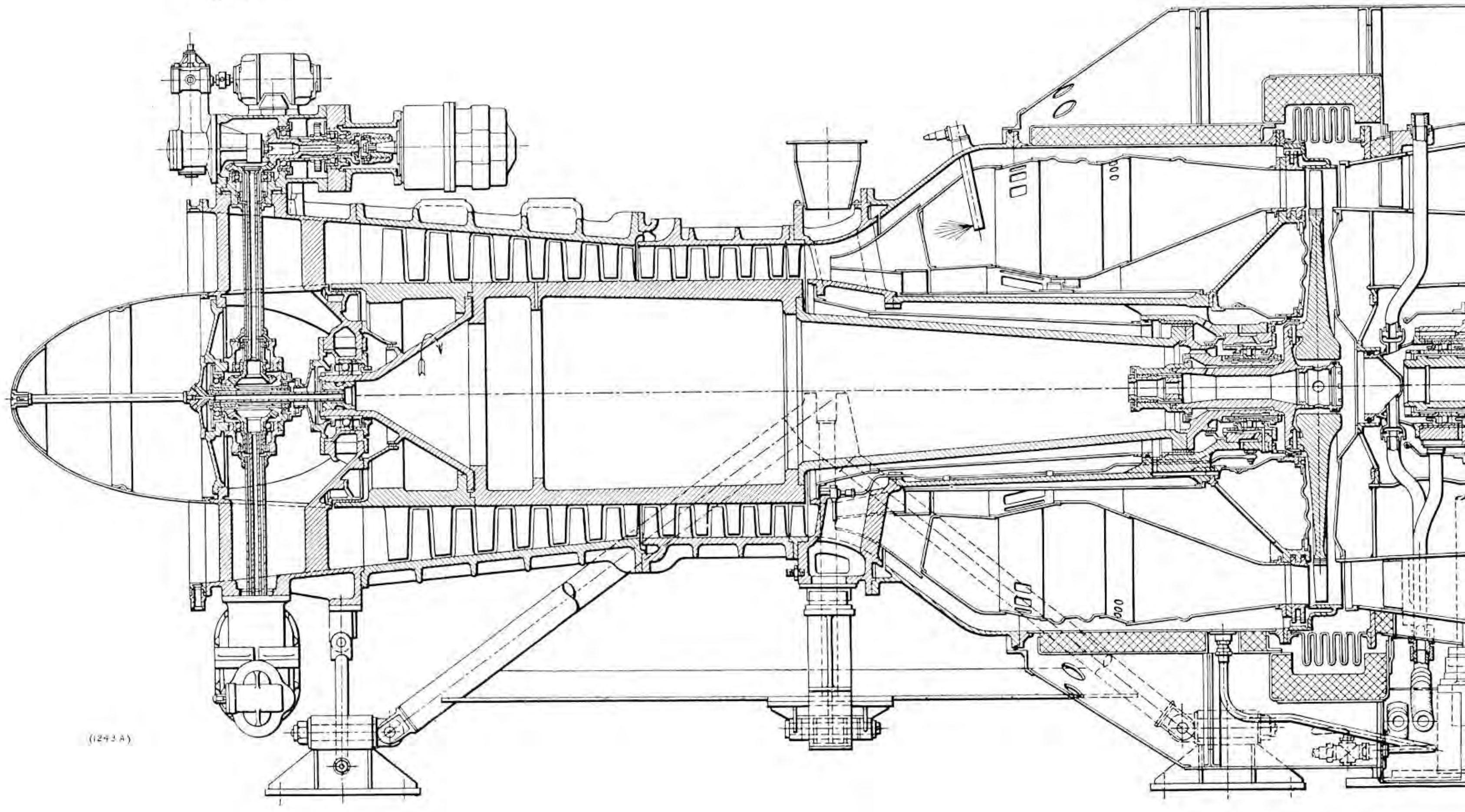


Fig. 9. FUEL SYSTEM.

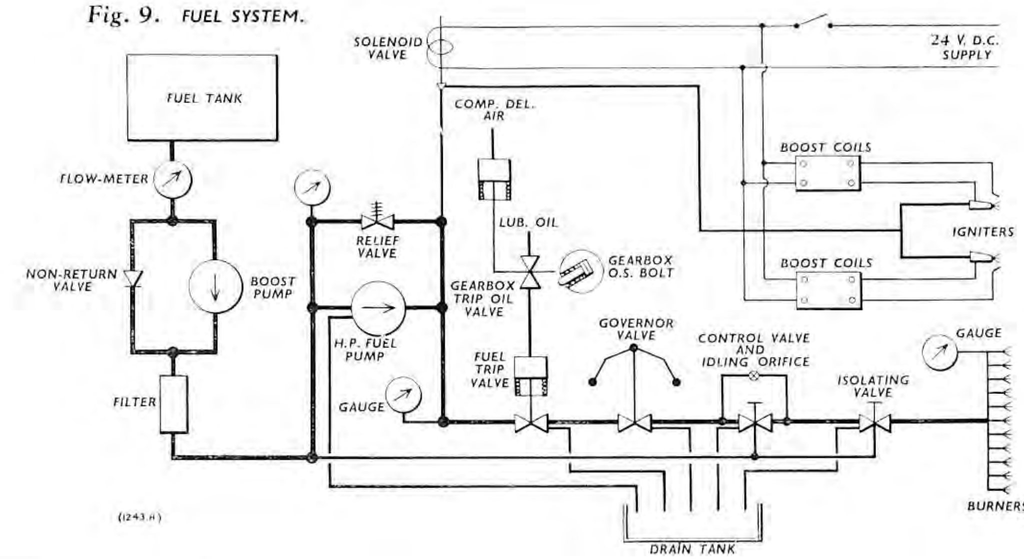
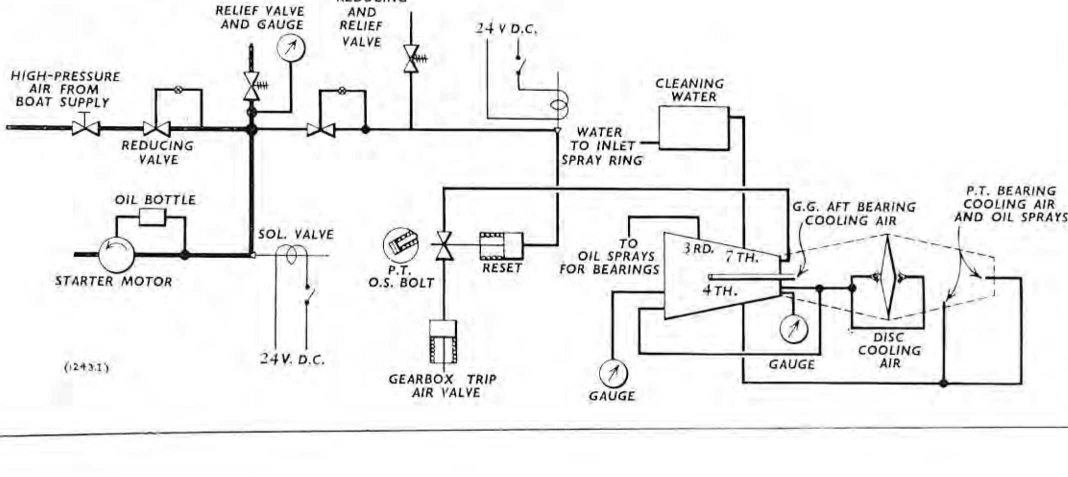


Fig. 10. AIR SYSTEM.



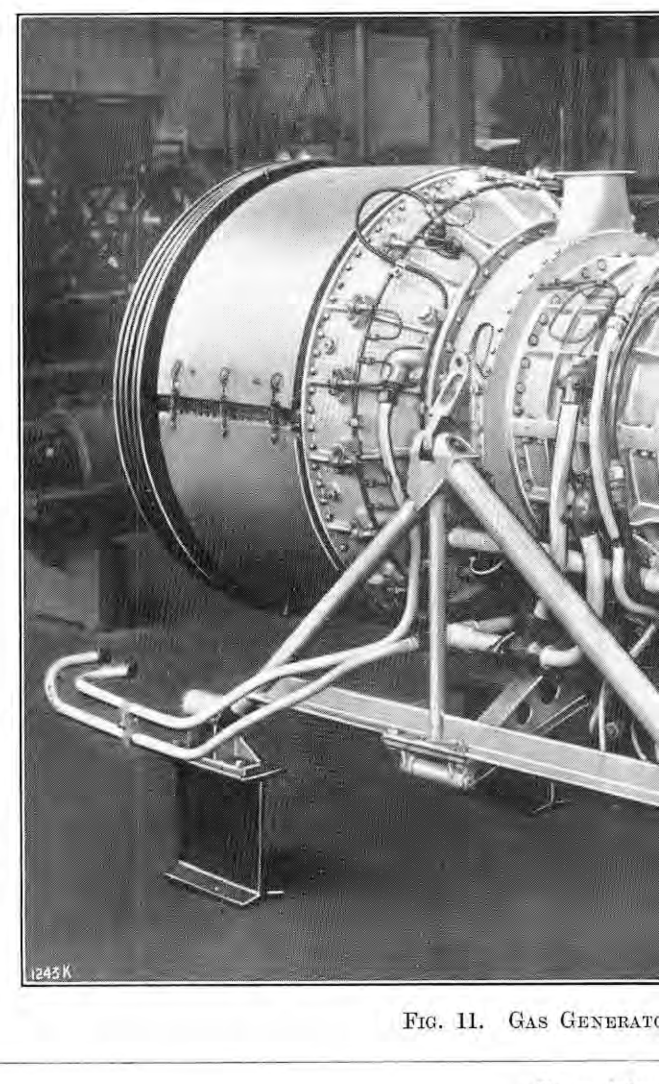


FIG. 11. GAS GENERAT

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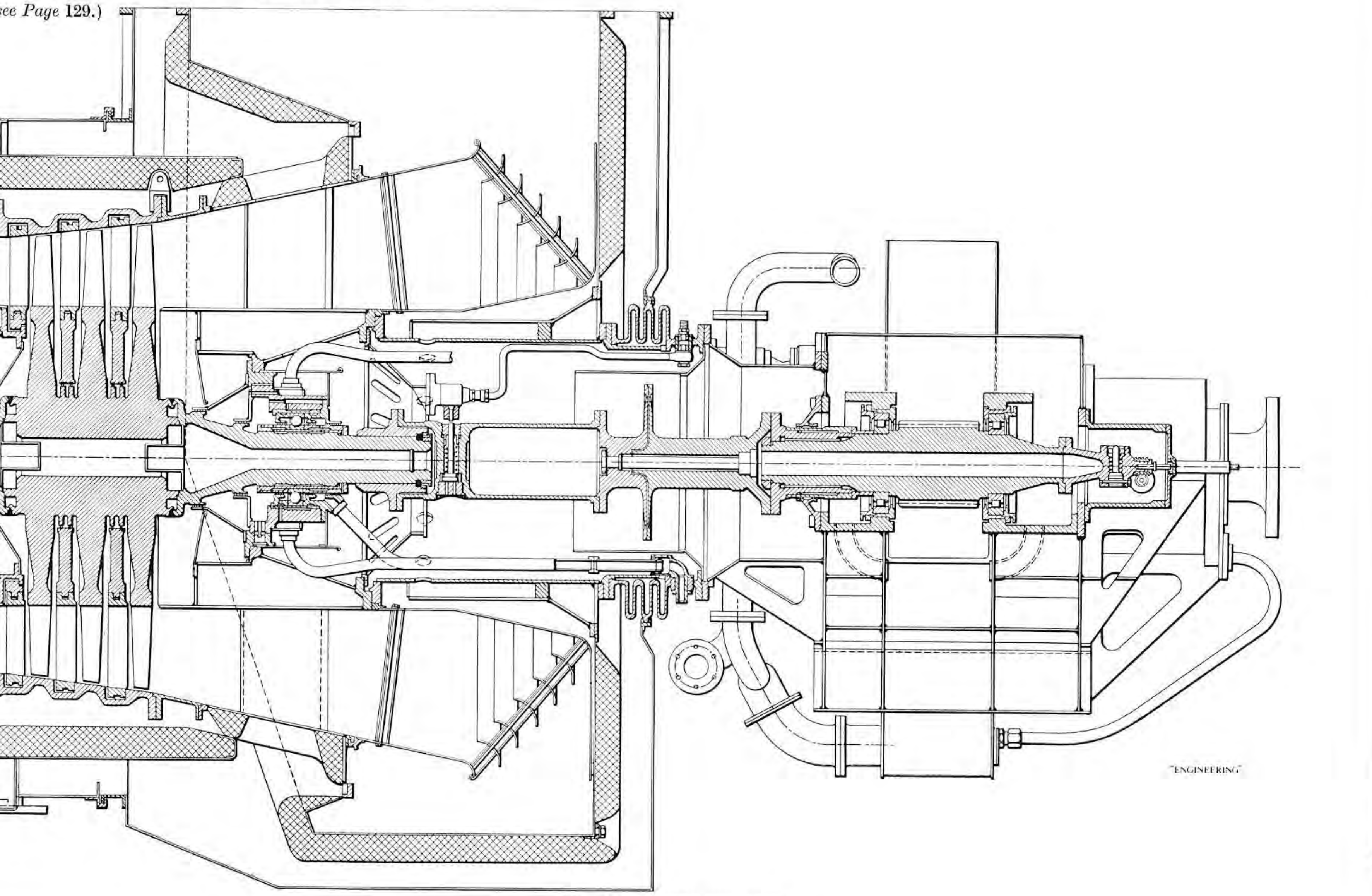
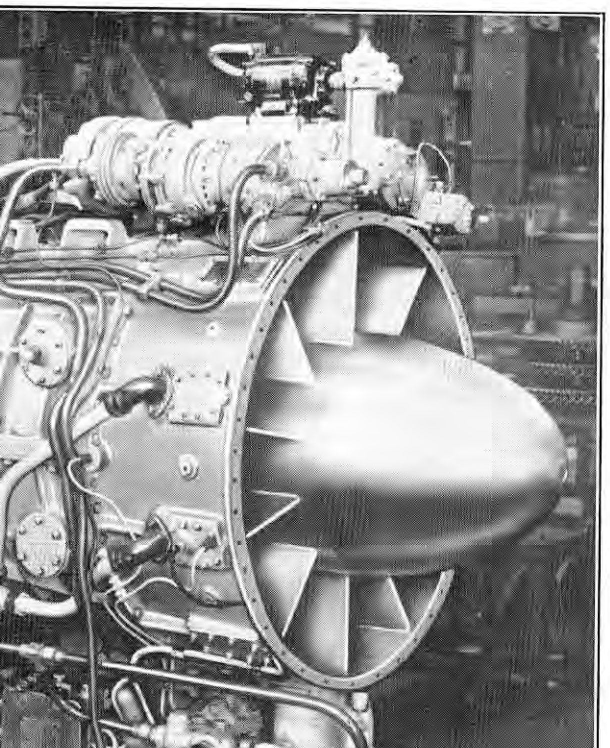




BLED IN WORKSHOP.

Fig. 12. LUBRICATING SYSTEM.

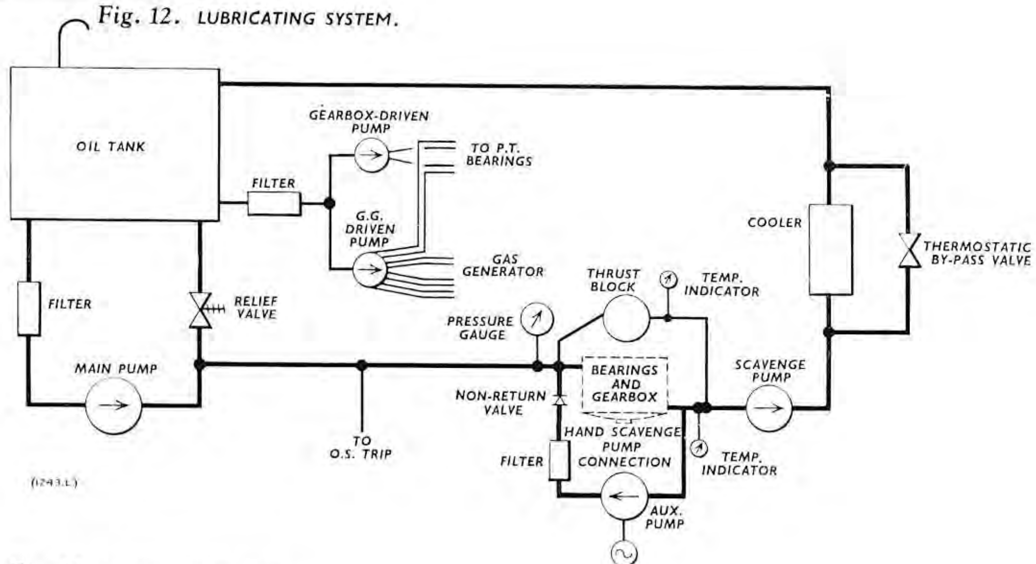
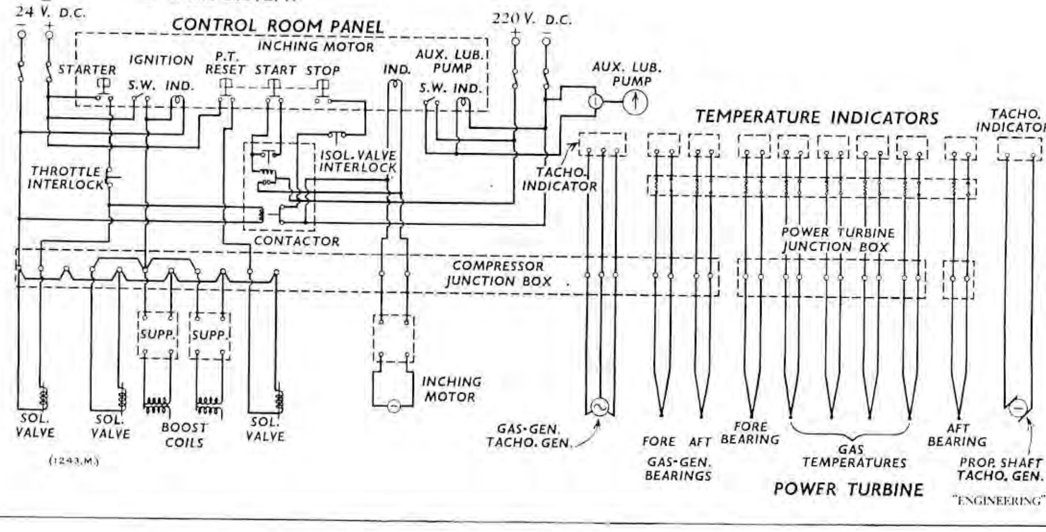


Fig. 13. ELECTRICAL SYSTEM.



130 and 131.)

valves, burners, electrical equipment, etc., are arranged outside the casing so as to be readily accessible.

The power turbine drives the propeller through a side-pinion single-reduction gear enclosed in a light-weight rigid casing of all-welded steel construction. The overall gear ratio is 4·73 and the maximum propeller shaft speed is 1,100 r.p.m. The gearwheel and pinion are machined from nickel-chromium-alloy steel forgings, and the single-helical gear teeth are hardened and ground. The bearings for both the pinion and wheel shafts are of the roller type; a Michell thrust block is incorporated in the aft end of the gearcase. Solid-flange couplings join the pinion shafts to the power-turbine shafts, and the shaft of the slow-speed wheel to that of the propeller.

FUEL AND LUBRICATING-OIL SYSTEMS.

The engines are designed to operate on Pool gas-oil. The fuel control system is shown diagrammatically in Fig. 9, on Plate II. The control of power output is effected solely by regulating the quantity of fuel delivered to the combustion chamber of the gas-generator; the speed of the gas-generator, which depends on the fuel quantity, determines the temperature, pressure, and flow rate of the gas at the inlet to the power turbine. The high-pressure fuel pump, which is driven from the gas-generator rotor, delivers 630 gallons of oil an hour at a pressure of 600 lb. per square inch (gauge) at the maximum pump speed of 3,620 r.p.m.

The method of starting and running-up the gas-generator to the idling speed of 3,000 r.p.m. is described later. For speeds greater than 3,000 r.p.m., the fuel supply to the burners is regulated by the main control valve. This valve consists of a servo-operated calibrated needle which moves in an orifice. The movement of the needle is such that a sufficient quantity of oil is passed through the orifice to the burners, by way of the trip valve, over-speed governor valve and isolating valve, to give as high a rate of acceleration as is possible without stalling the compressor. As a prevention against over-speeding, the gas-generator is fitted with a ported-sleeve centrifugal governor which reduces, by throttling, the fuel quantity passing to the burners. The speed of the power turbine, which is mechanically independent of the gas-generator, is controlled under normal conditions by the relationship between the power input from the gas-generator and the power absorbed by the propeller. However, if the speed rises to a predetermined value above the normal operating speed, either of two emergency trip governors of the bolt type, one on the turbine shaft and one on the gearbox pinion shaft, automatically closes the fuel trip valve to stop the supply of fuel to the gas-generator and, consequently, the flow of gas to the power turbine. The tripping mechanism is reset by an electrically-controlled air piston. The maximum output of the engine is limited by the maximum permissible gas temperature at the inlet to the power turbine.

A diagrammatic arrangement of the lubricating oil system is shown in Fig. 12, on Plate II. When starting, an electrically-driven auxiliary lubricating pump circulates the oil, in a closed circuit, from the gearbox sump to the gear teeth and thrust block. When the propeller shaft attains a speed of about 350 r.p.m., the main pump, which is driven from the turbine shaft, comes into operation and supplies oil from the oil tank to the gearbox; the auxiliary pump can then be switched off. The oil in the gearbox sump is returned through an oil cooler to the oil tank by a scavenge pump. Oil is supplied to the gas-generator and power-turbine ball and roller bearings by the gas-generator oil pump, driven through reduction gearing from the gas-generator shaft. These ball and roller bearings are lubricated by an oil mist formed by spraying into the bearing a small quantity of oil with compressed air tapped off from the compressor; the oil is not recovered. Mist lubrication is also used to lubricate the over-speed governor.

During the long periods of cruising when the gas plant is out of service, the trailing of the propeller causes the power-turbine shaft to rotate, and an auxiliary lubricating pump driven from the turbine shaft supplies oil to the power-turbine bearings. The compressor rotor of the gas-generator is rotated slowly by an electric inching motor. In this way damage to the bearings by vibration is prevented.

AIR SYSTEM.

A diagrammatic arrangement of the air system is shown in Fig. 10, on Plate II. A lightweight compressed-air motor, supplied with high pressure air at 450 lb. per square inch (gauge) from storage bottles by way of a reducing valve, is used for starting the gas-generator. At a speed of about 2,000 r.p.m. the unit becomes self-sustaining and the motor is no longer required. After ignition, it is possible to accelerate the gas-generator from standstill to 2,000 r.p.m. in approximately 30 seconds. To increase the speed of the gas-generator from the self-sustaining speed of approximately 2,000 r.p.m. to the idling speed of 3,000 r.p.m., fuel is passed by the boost and high-pressure fuel pumps through a fixed orifice by-passing the main fuel-control valve. A further supply of high-pressure air, reduced in pressure to 100 lb. per square inch, is used to operate the power-turbine trip and reset mechanisms.

Air is tapped from the gas-generator compressor at various stages for many purposes: for oil-mist lubrication and cooling of the various gas-generator and power-turbine bearings; for cooling the gas-generator turbine disc; to force the distilled water, for blade-cleaning, from the storage tank to the compressor spray ring; as a servo-medium for operating the gearbox over-speed trip mechanism; and to balance the compressor thrust.

ELECTRICAL SYSTEM.

The electrical system is shown diagrammatically in Fig. 13, on Plate II. It is divided into three sections: 24-volt direct-current circuits, 220-volt direct-current circuits, and the various instrument circuits. Three solenoid valves and two ignition boost coils operate on 24-volt circuits. One solenoid valve controls the supply of fuel to the igniters. Of the other two, one controls the supply of high-pressure air to the starting motor, and the other controls the air supply to the power-turbine emergency-governor reset piston. The two ignition boost coils supply the high-tension current to the spark plugs used to ignite the two torch igniters. The control systems for the inching motor and the auxiliary lubricating-oil pumps are the main 220-volt direct-current circuits.

In both the 24-volt and 220-volt direct-current circuits, suppressors are supplied to prevent interference by the boost coils and the inching motor. Limit switches, mechanically connected to the fuel control and isolating valves, are interlocked electrically with the solenoid valve for the starting motor, and with the inching motor and its contactor; this arrangement ensures that the starter-motor solenoid valve cannot be energised if the fuel control valve is open, and also that the inching motor cannot be started when either the starting-motor solenoid is energised or the fuel isolating valve is open. The instrument circuits relate to the following items: a gas-generator electrical tachometer, thermocouples for temperature indicators for the gas-generator and power-turbine bearings, and for measuring the gas temperature at inlet to the power turbine, and a propeller-shaft electrical tachometer.

TESTS.

Extensive bench tests were carried out on the G2 engines, and the information obtained regarding specific fuel consumption/propeller-shaft speed, propeller-shaft output/propeller-shaft speed, and specific fuel consumption/propeller-shaft output, at various gas-generator speeds, is given in Figs. 5, 6 and 7, respectively. These performance figures are considerably better than those of the 2,500 s.h.p. gas-turbine; they show a greater output with a much smaller specific fuel consumption.

LITERATURE.

Traité d'Irrigation.

Vol. I (Text), Vol. II (Atlas). By V. BAUZIL. Éditions Eyrolles, 61, Boulevard Saint-Germain, Paris, (5e.) [Price 5,500 francs the two volumes.]

THE older civilisations of the Middle and Far East were largely based upon irrigation, and the present rate of population increase in countries such as China and India makes extended and improved schemes of land reclamation by irrigation even more imperative. The primitive system of basin irrigation, developed in Egypt, does not employ the water available to the best advantage; a more regular distribution is secured by impounding the flood water in the upper reaches of a river and releasing it as required to regions below the catchment area through a system of main canals, branch canals and distributaries. Though the present treatise is concerned mainly with the engineering rather than the agricultural aspects of the problem of perennial irrigation, it opens with two chapters showing the present extent of areas under irrigation in different countries, with tables of the water requirements of a large variety of crops at different stages of their growth. The chief factors that have to be taken into account to ensure an adequate storage of water and its regular supply throughout a given irrigation area are then considered.

Chapter IV contains a collection of hydraulic formulæ required in drawing up an irrigation project. These formulæ relate to uniform and variable flow in open channels of various sections and of mild or steep slopes, to the hydraulic jump resulting when the flow passes from a rapid to a tranquil state below a regulating sluice or at the foot of a weir. After discussing the factors affecting the siting of a system of main and branch canals and the excavation of canals of different cross-sections, alternative methods of lining to minimise loss of water by seepage are described. A lengthy chapter is occupied with an account of the principal constructional works involved in an irrigation project, e.g., head works, weirs, silt clearance, trough and pipe aqueducts, inverted siphons, regulators and flow meters. This is followed by a short chapter on drainage, which is important as any undue rise in the height of the water table may lead to water logging of plant roots, and by another on the use of subterranean supplies from springs and wells. Chapter XII deals with the apportionment of water among the individual users and with alternative methods of applying water to the land by flow over its surface, by delivery below the surface and by spraying. The final chapter is devoted to the organisation and administration of an irrigation area.

The first section of Volume II consists of 19 tables giving numerical values of parameters, coefficients and functions occurring in the main hydraulic and structural formulæ referred to in Volume I. The second part contains 11 large-scale nomograms which will materially lessen the labour of computations relating to flow in canals, while the eight plates of the third part consist of working drawings of typical irrigational construction works. This comprehensive manual contains a wealth of information and practical data relating to the planning and execution of schemes designed to utilise water for the reclamation of the land.

STROBOSCOPIC IMAGES AND THE DETERMINATION OF ANGULAR SPEED.

By J. A. MACINANTE, B.E., and W. DOLLAR.

THE use of stroboscopic techniques in the determination of angular speed is well established in engineering practice. The simplest effect, in which a rotating object appears stationary when viewed in light interrupted at the rotational frequency of the object, is easily understood, but "multiple" and "drifting" effects obtained by varying the frequency of interruption of the light and the geometry of the object are not so obvious. This article gives a simple general treatment of stroboscopic effects which may be used in the determination of rotational frequency, and draws attention to the convenience of applying a similar technique to the study of oscillatory motion. While some papers have been published on the use of stationary and drifting images for particular applications, the general treatment here given has not, to the best of the authors' knowledge, been published previously.

The stroboscopic phenomena to be considered occur when a disc, on which is drawn a regular geometrical figure, is made to rotate about a normal axis through the centre of the figure and is viewed in regularly recurrent flashes of light. When the rotational frequency is equal to the frequency of interruption, or the flash frequency, the figure will appear stationary. If the frequencies of flash and of rotation are slightly different, the image of the figure will rotate slowly, or "drift," at a speed and in a direction dependent upon the relative values of these frequencies. The image may be "multiple" in the sense that it may have two or three (or other integral multiple) times the number of points on the figure. For example, a double image of a square has eight points and a treble image of a pentagon fifteen points. Thus a stationary or drifting single or multiple image of the figure may be seen. Equations will be derived relating the flash frequency and the rotational frequency of the disc with the geometry of the figure and of the image and with the speed of rotational drift of the image.

As far as the authors are aware, the earliest paper dealing with the stroboscopic determination of angular speed in engineering applications is by C. V. Drysdale, in 1905.* More recent work has been published by G. E. Moore, in 1925,† and by D. A. MacInnes, in 1943.‡ The object of the present article is to give a more complete general treatment of the interpretation of stroboscopic images than has been published previously. A tachometer calibrator and a technique for testing the efficacy of its speed control are also described.

In what follows, it is assumed that the frequency of light interruption will be sufficiently high (about 10 per second) to enable the observer to perceive, through the effect of persistence of vision, the phenomena described. It is also assumed that the duration of each flash of light is sufficiently short to ensure that the image of the figure will not be appreciably blurred.

STATIONARY IMAGES.

Let n = true speed of disc, in revolutions per minute; p = an integer representing the number of "points" on a regular plane figure (e.g., for a square, $p = 4$); and f = frequency of light flashes (flashes per minute). It should be noted that the unit of angle is taken to be one complete revolution (2π radians) throughout.

In Fig. 1, herewith, the rotating disc is shown in an instantaneous position illuminated by a flash of light, and A, B, C and D are four of the p points of the figure. For a single image of the figure to appear stationary, the next flash of light must occur when D has rotated to C or to B or to A, etc., when C has rotated to B or to A, etc. For the image to appear stationary, therefore, the time interval between flashes, $\frac{1}{f}$, must equal the time required for D to rotate to C $\left(\frac{1}{np}\right)$, or for D to rotate to B $\left(\frac{2}{np}\right)$, and so on. This is expressed in the form

$$\frac{1}{f} = \frac{k}{np}, \text{ or } f = \frac{np}{k} \quad (k = 1, 2, 3 \ldots) \quad . \quad (1)$$

Fig. 1.

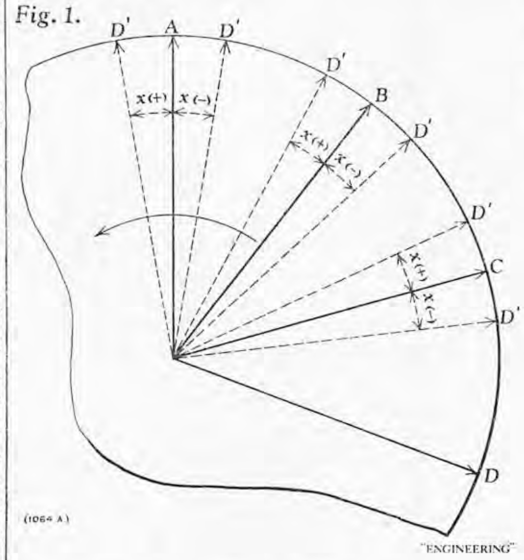


Fig. 2.

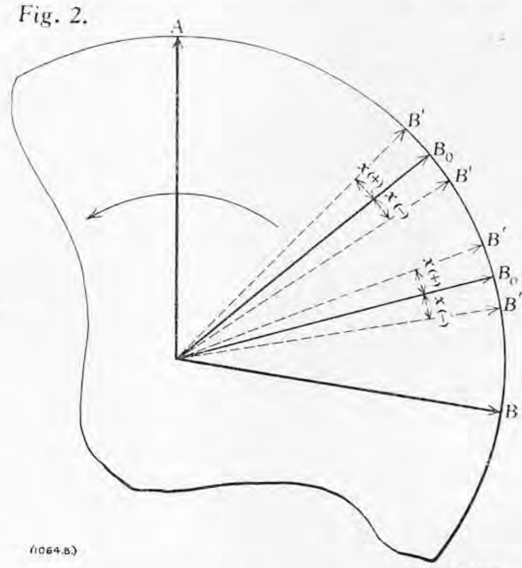
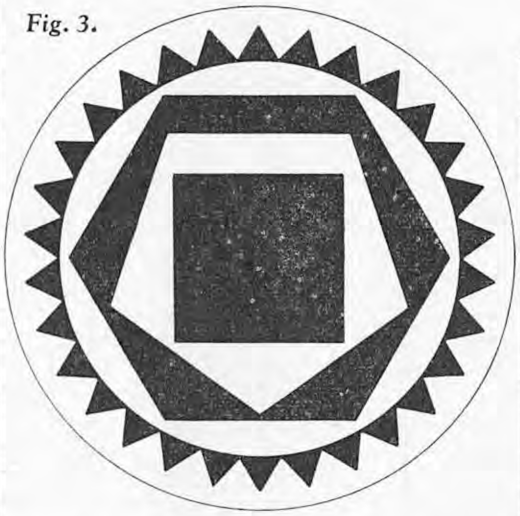


Fig. 3.



where k (in this first case, an integer) represents the number of "angular pitches" through which a given point moves during the interval between two consecutive flashes. By "angular pitch" is meant the angle between two adjacent points on the figure.

The maximum flash frequency at which a given figure will appear as a single stationary image is that for which k is unity, and this maximum frequency is numerically equal to the product np. This will be evident if it is supposed that the frequency is made two or three times this value, in which case a double or treble image will be seen, because, in the interval between flashes, a given point will have time to move through only a half or a third of a pitch. This may be expressed by equation (1) by admitting fractional values ($\frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \ldots$) for k.

A multiple image is also formed when the disc moves through an integral multiple of the fraction ($\frac{1}{2}, \frac{1}{3}, \frac{1}{4} \ldots$) of the pitch, except when the product of an integer and the fraction is itself an integer, in which case the image reverts to a single one (i.e., $k = \frac{1}{2}, \frac{3}{2}, \frac{5}{2} \ldots \frac{1}{3}, \frac{2}{3}, \frac{4}{3}, \frac{5}{3} \ldots$). This aspect of the formation of multiple images is illustrated in an example below.

To sum up, equation (1) represents the relationship between flash frequency, disc speed and figure geometry in the case of the single or multiple stationary image. The factor k, whether integer or fraction, represents the angular displacement of the figure during the interval between flashes, measured in units of the angular pitch as defined above. When k is an integer, the image has the same geometry as the figure; when k is a fraction, the image has ap points, where a is the denominator of the fraction.

As an example of the application of equation (1) to a particular case, consider at what speeds the four figures of the disc illustrated in Fig. 3 will appear stationary when viewed with a stroboscope operating at 3,000 flashes per minute. This form of disc, which is in general use, appears to have been introduced by Drysdale (1905). Under such conditions, $f = 3{,}000$ and p has values 4, 5, 6 and 30. The results of the application of equation (1) are given in Table I, opposite, in which S, D and T represent single, double and treble images, respectively.

It will be obvious that the observation of a stationary image of a certain figure is not sufficient to identify the speed of a disc. Each figure appears stationary at each of a series of related values of the speed. When a variable-frequency stroboscope is used to measure an unknown speed, the speed is given by the maximum flash frequency for which a single image of a single-point figure is obtained. E. L. Thomas* has described devices intended for use with stroboscopes to minimise the possibility of mistaking a multiple or sub-multiple speed for the true speed.

As an illustration from Table I, suppose it is desired to know at what speeds a treble image of the pentagon will occur. To obtain a treble image, k must equal $\frac{1}{3}, \frac{2}{3}, \frac{4}{3}, \frac{5}{3}, \ldots$ as explained above. Substituting these values of k in equation (1), and the values of $p = 5$, $f = 3{,}000$, it is found that $n = 200$, 400, 800, etc., as given in Table I.

While it is seldom necessary in practice to make use of the treble images, they may usually be recognised without difficulty. Thus, treble images of the 30-point figure would be seen at $33\frac{1}{3}$, $66\frac{2}{3}$, etc., revolutions per minute.

It may sometimes be desirable to determine a rotational frequency much greater than the maximum flash frequency of an available stroboscope. The basis of the method used is as follows:

Assume that the flash frequency has been adjusted

* "Stroboscopy," *Trans. Optical Soc.*, 1905-6, London: paper read on November 16, 1905.

† "The Stroboscopic Determination of Speeds and Frequencies," *The Engineer*, vol. 139, page 209 (1925).

‡ "Use of Stroboscopic Patterns in the Determination of Speeds of Rotation," *Rev. Sci. Inst.*, vol. 14, page 14 (1943).

* "Aids to Stroboscopic Measurement," *Electronic Engineering*, vol. 18, page 369 (1946).

TACHOMETER CALIBRATOR.

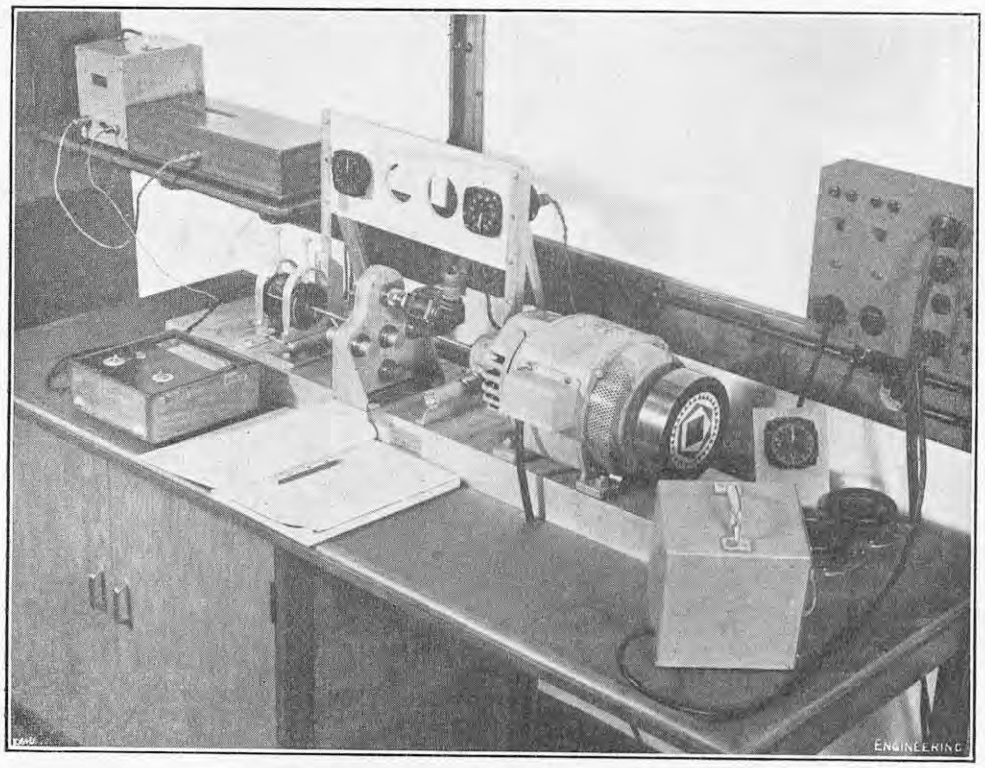


FIG. 4. GENERAL VIEW OF CALIBRATOR.

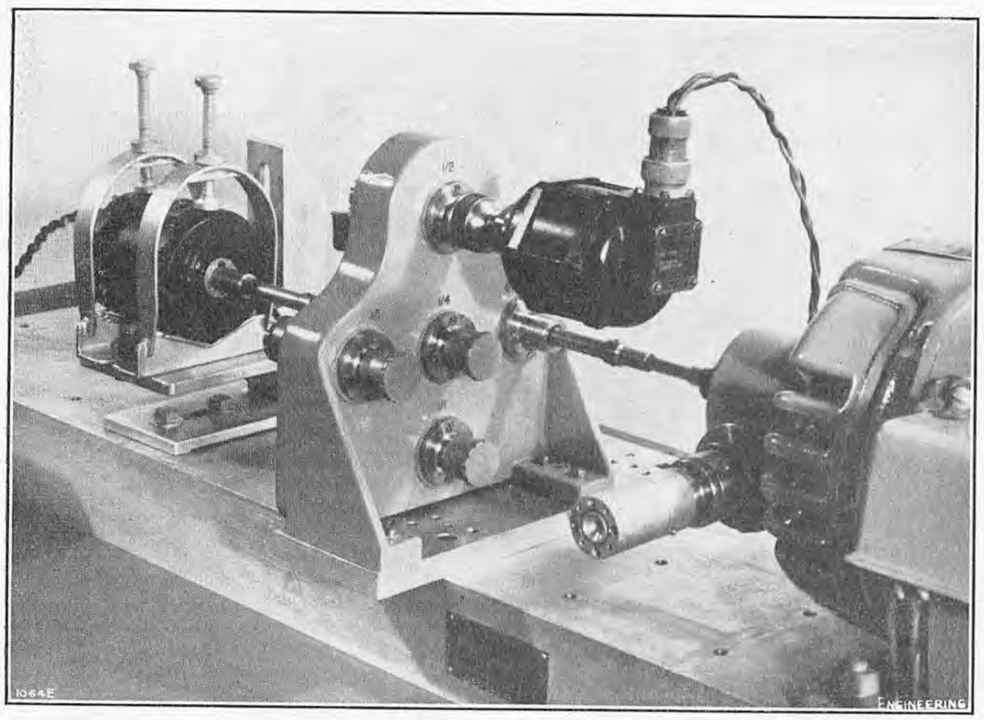


FIG. 5. GEARBOX.

to a value f, which gives a stationary image of a single point on a disc rotating at a constant frequency n. It is required to determine n. Since n is known to be much higher than f, it would not be known how many complete revolutions the disc made during the interval between flashes; it would only be known that n was an integral multiple of f. Since $p = 1$, equation (1) gives $n = f k$, where k is an integer.

Let the flash frequency be adjusted continuously to the next value f_1, for which a single image of the point is stationary. In this case,

$$n = f_1 (k \pm 1) . \quad . \quad . \quad (2)$$

and the disc has made $k \pm 1$ revolutions between flashes according as $f_1 \lesseqgtr f$. Or, if the frequency is adjusted to a value f_m through a known number m of re-appearances of the stationary single image (i.e., the disc has rotated through $k \pm m$ revolutions between flashes), then

$$n = f_m (k \pm m) \quad . \quad . \quad (3)$$

according as $f_m \lesseqgtr f_1$.

Substituting $k = \frac{n}{f}$ into equation (3), then

$$n = \frac{\pm m f_1 f_m}{f_1 - f_m}.$$

Hence, by observation of two flash frequencies separated by a known number of transitions through the stationary condition, it is possible to determine a rotational frequency higher than the maximum flash frequency of any particular stroboscope.

DRIFTING IMAGES.

Retaining the symbols already used, in addition let r = angular speed of drift of image (revolutions per minute). This will be taken to be positive when the drift is in the same direction of rotation as the disc. Let x = a small angle through which the image moves during the interval $\frac{1}{f}$ between two consecutive flashes. It follows that

$$x = \frac{r}{f} \quad . \quad . \quad . \quad (4)$$

Referring to Fig. 1, let A, B, C, and D be the positions of four adjacent points of the figure when illuminated by a given flash of light. In the time $\frac{1}{f}$ that elapses before the next flash, D may have revolved to one of the positions D′, separated from C or from B or from A by an angle x. Since the figure is regular, the effect being described for the point D will apply to every other point of the figure. Thus, during the interval $\frac{1}{f}$ the disc moves through an angle given by $\left(\frac{k}{p} + x\right)$ revolutions, where k is an integer, in the case of the drifting single image.

TABLE I.—*Relationship Between Stationary Images and Speed of Stroboscopic Disc.*

Disc Speed, n Rev. Per Min.	Number of Points, p.				Disc Speed, n Rev. Per Min.	Number of Points, p.			
	4	5	6	30		4	5	6	30
100	—	—	—	S	1,600	—	T	—	S
200	—	T	—	S	1,700	—	—	—	S
250	T	—	D	D	1,750	T	—	D	D
300	—	D	—	S	1,800	—	S	—	S
400	—	T	—	S	1,900	—	—	—	S
500	T	—	S	S	2,000	T	T	S	S
600	—	S	—	S	2,100	—	D	—	S
700	—	—	—	S	2,200	—	T	—	S
750	S	—	D	D	2,250	S	—	D	D
800	—	T	—	S	2,300	—	—	—	S
900	—	D	—	S	2,400	—	S	—	S
1,000	T	T	S	S	2,500	T	—	S	S
1,100	—	—	—	S	2,600	—	T	—	S
1,200	—	S	—	S	2,700	—	D	—	S
1,250	T	—	D	D	2,750	T	—	D	D
1,300	—	—	—	S	2,800	—	T	—	S
1,400	—	T	—	S	2,900	—	—	—	S
1,500	S	D	S	S	3,000	S	S	S	S

To extend the argument to include the drifting multiple image, reference is made to Fig. 2, on page 132, in which A and B represent two adjacent points of the figure when illuminated by a given flash of light. If, in the interval $\frac{1}{f}$ that elapses before the next flash, the point B moves to one of the positions B_0 through a fraction k of the angle between B and A, a stationary multiple image will result. If, however, B moves to some position B′ separated from B_0 by the small amount x, a drifting multiple image will result, and during the interval $\frac{1}{f}$ the figure will have moved through an angle $\left(\frac{k}{p} + x\right)$ of a revolution. Therefore, for single and multiple drifting images, since the angle through which the disc turns during the interval $\frac{1}{f}$ between flashes is $\frac{n}{f}$ of a revolution, it follows that

$$\frac{n}{f} = \frac{k}{p} + x \quad . \quad . \quad . \quad (5)$$

Substituting the value of x from equation (4), equations for n and f are

$$n = \frac{kf}{p} + r \quad . \quad . \quad . \quad (6)$$

and

$$f = \frac{p}{k}(n - r) \quad . \quad . \quad . \quad (7)$$

As an example of the drifting pattern, consider the case in which a single image of a disc carrying a single point is observed to drift in a positive direction at the rate of 3 r.p.m. when illuminated by a stroboscope operating at 1,000 flashes per minute.

In such circumstances, $f = 1{,}000$, $r = +3$, $p = 1$; and, if the nominal speed of the disc is 1,000 r.p.m., $k = 1$, or, if it is 2,000 r.p.m., $k = 2$, and so on. By substitution of the appropriate values in equation (6), the true speed of the disc is obtained as $n = 1{,}003$ for $k = 1$, and 2,003 for $k = 2$, and so on.

As a further example, consider the case in which a disc carrying a 30-pointed pattern is rotating at 300 r.p.m. The disc is illuminated by a stroboscope flashing at a nominal frequency of 3,000 per minute. A single image of the figure is observed to drift at the rate of one revolution in 23 seconds in a direction opposite to the direction of rotation of the disc, and it is desired to determine the true frequency of the stroboscope, assuming the disc speed of 300 r.p.m. to be correct.

In such circumstances, $p = 30$, $n = 300$, $r = \left(\frac{-60}{23}\right)$, and, since it is known that f is approximately 3,000, the value of k may be found from (1) by ignoring the drift of the image, thus:

$$k = \frac{np}{f} = \frac{300 \times 30}{3000} = 3$$

Substituting the above values for p, n, r and k in equation (7), the value of f is found to be 3026·1 flashes per minute.

Oscillatory Motion.

Consider a single reference point to be oscillating linearly at frequency n and viewed in intermittent light of frequency f. If $f = n$, the point will appear to be stationary, being viewed at the same position in the cycle as each flash occurs. The oscillation frequency is therefore identified as that corresponding to the maximum flash frequency for which a single image of the point is seen.

At a flash frequency $2n$, flashes will occur at intervals of half an oscillation cycle and two images will be seen, unless the phase relationship is such that the flashes occur when the point is in the mid-position. At a flash frequency $3n$, in general, three images will be seen, the relative positions depending upon the phase relationship between the flash of light and the motion of the point. Corresponding drifting images will be seen if the flash frequency differs slightly from the above values.

The stroboscopic technique has been found very convenient for observation of vibration amplitude. For such work, the vibrating object is viewed through a microscope fitted with a measuring graticule. Some suitable mark or point on the vibrating object is viewed in stroboscopic light, which is adjusted to differ slightly from the vibration frequency so that the point appears to oscillate slowly across the scale in the optical field. The movement is measured by noting the extreme positions of the image. Amplitudes as small as 0·001 in. have been determined in this way, and no doubt much smaller amplitudes could be observed by the use of a microscope of higher power.

While the use of stroboscopic light is not necessary if it is desired only to determine the double amplitude of a vibration, it has the advantage that the same setting of the stroboscope is a measure of the frequency of vibration, and complex motion of the reference point may be more conveniently studied.

Tachometer Calibrator.

The essential elements in apparatus required for the calibration of tachometers by stroboscopic techniques are a driving unit for driving the tachometers under test and a stroboscopic lamp, flashing at a frequency determined by a suitable timing device, the lamp being arranged to illuminate a patterned disc mounted on a shaft of the driving unit.

The driving unit should have a suitable speed range and adequate power for driving the various types of tachometer which it is intended to calibrate, and should be provided with means for adjusting and maintaining chosen speeds within its range. Tachometers vary greatly in speed range, drive ratio, type of driving shaft (e.g., flexible, solid, friction cone), configuration of dial and method of mounting, angle of entry of driving shaft into body of tachometer, etc. Provision must be made for holding the tachometer (or the generator of electrical tachometers) so that it may be mechanically driven from a shaft running at the desired speeds. Means must also be available for holding electrical tachometer indicators, which are connected by electrical cables to the generators.

Fig. 6.

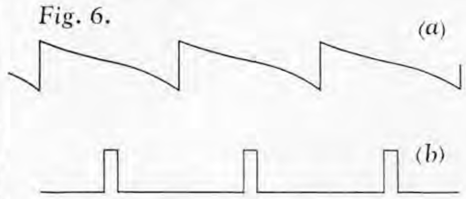


Fig. 7.

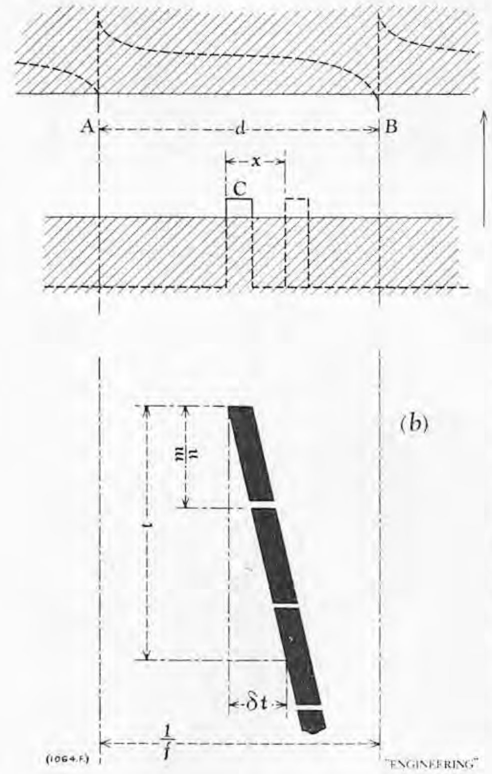


Fig. 8.

The choice of a timing device is governed by the accuracy required; ordinary supply mains frequency is sufficiently accurate for many commercial purposes. Tuning forks or crystal oscillators may be used if warranted, the former offering accuracy of the order of a few parts in 10,000, and the latter a few parts in a million.

Descriptions of tachometer calibration apparatus designed for particular purposes, such as the production testing of particular types of tachometer, have been given by M. A. Princi,* H. F. Storm,† and A. B. Kaufman.‡ In designing the apparatus described below, it was considered important to provide a flexible arrangement having maximum accessibility, so that any of the usual types of electrical or mechanical tachometer likely to be submitted for verification to the National Standards Laboratory might be supported and driven with, at most, the provision of a special adapter or a supporting bracket.

The tachometer calibrator developed at the National Standards Laboratory, in which task the authors had the collaboration of Mr. A. J. Carmichael, is illustrated in Figs. 4 and 5, on page 133. Referring to Fig. 4, a motor is mounted on a machined face of a rolled-steel channel-sectioned base, on which is also mounted a gearbox containing five gearwheels, driving shafts at a quarter, half, and full motor speed; an enlarged view of these drives is given in Fig. 5. The ratios of the pitch-circle diameters of the central gear, designated a, those to the right and left and below it, which will be referred to as b, d and c, and the topmost gear, e are, respectively, 4 : 1 : 2.

All shafts project through both sides of the gearbox and are finished with $\frac{3}{16}$-in. square ends. Because of the great variety of tachometer drives, it was not possible to select a form of outlet universally suitable. The square-end shaft was adopted as being one of the more common connections, and adapters are used as required for driving tachometers with different driving connections. Screwed flanged fittings surround each shaft outlet, the thread being $\frac{7}{8}$ in. outside diameter and 18 threads per inch, which is a form commonly used for tachometer generators in aircraft.

The generators of electrical tachometers may be screwed directly to the gearbox outlets, using a suitable drive-adapter or coupling and, if necessary, a thread-adapter. Alternatively, the generator may be driven by a flexible or a solid shaft while being held in the adjustable support seen on the left of Fig. 5, which has been designed to accommodate generators up to $3\frac{1}{2}$ in. in diameter. It may occupy any of three positions across the base, and at each of these positions the generator is adjustable vertically for alignment with a chosen gearbox outlet. The indicators of electrical tachometers may be mounted on a wooden panel (to be seen above the gearbox in Fig. 4) which is supported on two brackets screwed to the base. The panel is removable so that it may be cut or, if necessary, a new panel inserted to suit the dimensions of any particular indicator.

For driving any type of hand tachometer, an outlet is provided on a shaft driven through a right-angled gear drive from the motor shaft; this can be seen projecting from the motor on the right of Fig. 5. A friction-cone adapter of a form to suit the tachometer drive cone or tip is fitted over the square end of the shaft.

Mechanical tachometers requiring a horizontal drive and vertical panel mounting may be supported on a bracket (not shown in the illustration) at the end of the base remote from the motor and observed from that end of the bench. Mechanical tachometers requiring a vertical drive shaft may be driven from the outlet shown in Fig. 5, after the housing has been reset through a right angle so that the shaft is vertical, or from any of the main gearbox outlets by use of an accessory mitre gearbox. In such a case, the tachometer would be held from a bracket or brackets erected from the base. A series of tapped holes has been provided along the base for use when brackets must be set up for such purposes.

In the illustrations, the motor is shown coupled to the right-hand 1 : 1 shaft of the gearbox. Since the motor speed range is 0 to 3,000 r.p.m., the speed ranges of shafts a, (b, c, d), e are 0 to 750, 3,000, 1,500 r.p.m., respectively. The gearbox may occupy a second position on the base so that the motor shaft aligns with the central shaft a; then the speed

* "Precision Testing of Electric Tachometers," *Trans. Am.I.E.E.*, vol. 64, page 504 (1945).

† "Production Testing of Tachometers," *Electronics*, vol. 20, page 92 (March, 1947).

‡ "Stroboscopic Tachometer," *Machine Design*, vol. 26, page 157 (February, 1951).

ranges of the shafts a, (b, c, d), e are 0 to 3,000, 12,000 and 6,000 r.p.m. The gearbox is suitable for operation at the maximum speed only for short periods, with three shafts running at 12,000 r.p.m. For the calibration of a single tachometer, for which only one shaft need operate in a higher speed range, it is obviously preferable to drive the main gearbox in the lower speed range and to use an auxiliary gearbox coupled to one of the outlets to attain the higher speed range. All shafts run in ball bearings and the large centre gear is made of a noise-reducing material. A cover is screwed on any outlet not in use.

The motor, which is $\frac{1}{4}$ h.p., 110 volts, direct-current compound-wound for speeds of 0 to 3,000 r.p.m., is controlled manually by handwheels which operate variable resistances in the armature and the field of the motor. The motor may be driven from the Laboratory direct-current generator, or, if greater voltage stability is required, the Laboratory battery supply is available. Outlets connected to both sources are mounted on the switch-board beside the operator, who is seated at the end of the bench facing the controls. A stroboscopic disc of the form illustrated in Fig. 3 is fixed to a flywheel, which was provided to improve the speed stability of the driving unit. Speeds are interpreted from the disc, using the principles developed in the section on "Stationary Images" and summarised in Table I for a stroboscope operated at 3,000 flashes per minute.

Having initially examined a tachometer by observing its reading at each of a series of speeds identified by following a sequence of stationary images from zero speed, it is convenient to make use of a reference tachometer (visible at the right of the Stroboscopic disc in Fig. 4) to facilitate the taking of check readings, particularly when further confirmatory readings are required at a particular speed. The motor speed may be brought approximately to the particular speed by observing the reference tachometer, the exact speed then being adjusted until the appropriate stroboscopic image is stationary. The reference tachometer, of course, is itself checked during the initial observations. Speed stability tests with the motor manually controlled have shown this simple form of adjustment and control of motor speed to be adequate for the calibration of tachometers. The technique for speed-control testing of the unit is described below.

The stroboscope, contained in the cubical box in the right foreground of Fig. 4, is a neon-tube stroboscope designed and constructed at the Laboratory by the Division of Electrotechnology. It is used in conjunction with the amplifier, to be seen in the top left corner of Fig. 4, and may be controlled at 25 or 50 flashes per second from a tuning fork, contained in the flat box between the amplifier and the indicator panel (Fig. 4). The tuning fork and amplifier are mounted on a wall bracket to isolate them from vibration from the rotating elements. Alternatively, the stroboscope may be controlled by signals from the Laboratory crystal oscillator, for which the frequency is known to better than one part in a million, so that error in frequency is quite negligible from the point of view of tachometer verification.

Commercially available stroboscopes of the continuously variable frequency type are also used and may be controlled from the ordinary electrical supply mains, from a tuning fork, or from a crystal oscillator. On the subject of stroboscopes, reference may be made to a recent paper by F. G. Spreadbury.*

SPEED-CONTROL TESTING TECHNIQUE.

In the course of the development of the tachometer calibrator, consideration was given to the adequacy of the speed control possible by manual variation of the armature and field resistances. Manual control offered great simplicity and flexibility in comparison with any method of electronic control. Other important factors influencing the acceptance of simple manual control were that, in the checking of tachometers, the speed usually need not be held constant for more than 10 or 15 seconds, and that a very stable voltage was available from the Laboratory batteries for supply to the motor.

To check the adequacy of manual control, tests were made in which the operator was required to hold the speed at a particular value by correcting manually any drift of the stroboscopic image, which is stationary at that speed. Departure of the speed from the desired value was due to small variations in the supply voltage and to changes in the resistances resulting from temperature changes. A technique arrived at for obtaining a permanent record of the variation of the speed from the nominal value is described below.

The timing signal controlling the flash frequency of the stroboscope was displayed on a double beam oscilloscope; this timing trace is illustrated diagrammatically in Fig. 6 (a), opposite. The make and break of an electrical contact, once per revolution of the motor, was also displayed on the oscilloscope screen; this motor trace is illustrated in Fig. 6 (b) on page 134.

If the motor speed is constant (i.e., the stroboscopic image does not drift) and if it is equal to the flash frequency, there will be one contact mark for each cycle of the timing trace, and there will be no relative motion between the two traces. The position of the contact mark on the motor trace with respect to the timing trace will depend on the angular position of the shaft at which contact is made, and this is easily variable if required.

If the motor speed varies from the nominal value, there will be relative motion between the traces and between the contact marks on the motor trace. When the time sweep of the oscilloscope is synchronised with the timing trace signal, the latter remains steady and the contact mark on the motor trace will move to the left if the motor speed is greater than the flash frequency, and to the right if the motor speed is less than the flash frequency, it being assumed that the oscilloscope has a linear sweep from left to right. If the motor rotates at a constant frequency different from the flash frequency (and not a sub-multiple or multiple of the flash frequency), the contact mark will move at a constant speed to the left or to the right.

Let it be assumed that the oscilloscope is adjusted —see Fig. 7 (a)—to give one complete cycle A B of the timing trace, and that the contact mark C is moving uniformly across the screen. If C moves to the right through a distance x in time t, the motor will complete exactly $f\,t$ revolutions in time $t + \delta t$ minutes, where δt is the fraction of the period $\frac{1}{f}$ corresponding to the distance x, i.e.; $\delta t = \frac{x}{f\,d}$, where d is the wavelength of the timing trace as measured on the oscilloscope screen. Thus the motor speed is given by $n = \frac{f\,t}{t + \delta t}$. If C moves to the left, δt becomes negative.

To utilise this conclusion, the values of t and δt were obtained from a photographic record made in the following way. The screen of the oscilloscope was masked over the areas shaded in Fig. 7 (a) and a photographic film was arranged to move continuously in the direction of the arrow. The uncovered peaks, A, B, caused the film to be exposed along the parallel lines, Fig. 7 (b), and the portion C of the contact mark wrote the broad line which is seen between the parallel lines in Fig. 7 (b), the interruptions in this line being explained below. This broad line shown in the illustration is the type of record which would be obtained if the motor speed were uniform and slightly less than the flash frequency. The time δt was obtainable from this trace as the fraction $\frac{x}{d}$ of the period $\frac{1}{f}$ of the timing trace, where d is the distance between the parallel lines.

To record, at the same time, a scale for t, the electrical contactor circuit was mechanically interrupted once per revolution of a shaft driven at a fraction $\frac{1}{m}$ of the motor speed n r.p.m.; thus the interruptions in the photographed trace of the contact mark are separated by a distance representing the time $\frac{m}{n}$ minutes. A photograph of a typical record made in this way is reproduced in Fig. 8, on page 134.

In general, the motor speed may be an integral multiple or sub-multiple of the flash frequency. Thus the contact mark may appear two, three, etc., times during each cycle of the timing trace, or it may appear during every second, third, etc., cycle of the timing trace. Or, if the oscilloscope be adjusted so that only one cycle of the timing trace is displayed, for sub-multiple motor speeds the contact mark will appear during every second, third, etc., sweep of the oscilloscope. For practical reasons, it may be desirable to operate the contact marker at an integral multiple of the motor speed by the use of gearing in order to obtain a satisfactory record when the motor speed is much smaller than the flash frequency.

Suppose, now, that the speed be uniform, but slightly different from the multiple or sub-multiple value $\frac{f\,k}{p}$ as given in equation (1). Assume the mark C moves to the right through a distance x in time t. During this time, the shaft rotates through exactly $\frac{f\,k\,t}{p}$ revolutions, and the time taken is $t + \delta t$, where $\delta t = \frac{x}{f\,d}$.

When the motor speed is an integral multiple of the flash frequency, the same argument may be applied in relation to the movement across the screen of any one particular contact mark. Therefore, if the motor speed differs slightly from the nominal value $n = \frac{f\,k}{p}$ by an amount which causes the contact mark to move uniformly to the right across the screen through the distance x in t seconds, the motor makes $\frac{f\,k\,t}{p}$ revolutions in time $t + \delta t$, where $\delta t = \frac{x}{f\,d}$, and δt and x are taken to be positive if the contact mark moves to the right (motor speed slower than nominal value) and negative if the contact mark moves to the left (motor speed faster than nominal value).

Thus the speed of the shaft is given by

$$n = \frac{f\,k}{p}\left(\frac{t}{t + \delta t}\right)$$
$$= \frac{f\,k}{p}(1 + \alpha)$$

where

$$\alpha = \frac{-\,\delta t}{t + \delta t} = \frac{-\,x}{f\,t\,d + x},$$

i.e., n differs from the nominal speed by $\frac{100x}{f\,t\,d + x}$ per cent.

The work described in this paper was carried out as part of the research programme of the Division of Metrology, Commonwealth Scientific and Industrial Research Organisation.

* "Electronic Stroboscopes, Tachometers and Flash Lamps," Assoc. Eng. and Shipbldg. Draughtsmen, London, Session 1948-49, page 79.

THE ENGINEERING OUTLOOK.

II.—THE MAN-POWER SITUATION.

THE change in industrial outlook which has become apparent in the past few months is seen very clearly in relation to man-power. At the beginning of 1952, most companies in the engineering industry were unable to find sufficient labour; at the beginning of 1953, many are having difficulty in keeping their workpeople fully employed. At the end of 1951, Sir Walter Monckton, the Minister of Labour, stated that half a million workers were required in defence and essential export industries. Movement on this grand scale has never, in fact, taken place; on the contrary, falling exports and reduced defence commitments have caused redundancy even in essential industries.

Figs. 1 to 7, opposite, show that there has been little change in the distribution of the working population of Great Britain during 1952. The metals, vehicles and engineering industries gained labour strength, but the increase of 1 per cent. in their total force was much less than had been planned. With the exception of food and tobacco, all the manufacturing industries lost workers, and, since few were absorbed in defence and other "essential" industries, the numbers in civil employment fell by 205,000. The increase in the number of unemployed was somewhat less—only about 115,000—partly because of an increase in the size of the armed Forces, but mainly because many redundant women apparently ceased to register as unemployed and dropped out of the working population. These results in no way reflect adversely upon the measures taken by the Government to secure a redistribution of the working population, but are sad evidence of a lack of appreciation of economic conditions, and of the scale of re-armament which was practicable.

Apart from the general policy of credit restriction, designed to reduce inflationary pressure, which, since the war has seriously hampered the mobility of labour, the Government's main weapon to facilitate a movement of man-power into "essential" industries was the Notification of Vacancies Order, which came into operation at the end of February. As a result of this Order, under which persons changing their jobs must pass through the Employment Exchanges, the number of placings by the Exchanges increased remarkably. (See Tables I and II, herewith, taken from the *Ministry of Labour Gazette.*) In the 44 weeks to October 22, 1952, placings were one-third higher than in the corresponding period of 1951. For the first few months of the operation of the Order they almost doubled, and placings in "first preference" work in defence and export industries more than doubled. A higher degree of mobility is probably not feasible under comparable conditions in a free economy; though this, of course, is a matter of opinion for which there can be no statistical support.

Despite this movement of man-power, however, it seems unlikely that the needs of the re-armament programme on the original scale envisaged could have been met by the measures adopted. The programme required not only a large number of additional employees, who would be hard enough to get, but also those with appropriate types of engineering skills, who, despite all the offers of the Ministry of Supply to arrange for training, would be almost impossible to get. Even with the re-armament programme at a reduced level, many factories on defence work are finding it difficult to get workpeople of certain grades. This, at a time when factories on high-priority export work and on defence work have been paying people off, makes nonsense of the Notification of Vacancies Order.

The failure to attain the original targets set for re-armament is brought out very clearly by the employment statistics of the aircraft industry. About 15 months ago, Air Marshal Sir Guy Garrod declared that the industry required about 150,000 workers in 18 months. Not more than 60,000 have been recruited so far. Comparatively few sections of the engineering industry, in fact, gained workers in 1952. (See Table III, herewith, taken from the *Ministry of Labour Gazette.*) Only in the manufacture of machine tools, ordnance and small arms does re-armament appear to have been responsible for increasing the labour force significantly. Some other industries, notably shipbuilding, locomotive and wagon building, and constructional engineering gained workers, but this was largely because increased steel supplies helped to raise the level of output. These industries which were scheduled to lose some of their personnel, due to the fall in demand for consumer goods, lost more than had been expected. Makers of electrical appliances were very badly hit, and the re-armament demand has not prevented a substantial fall in the number employed in the manufacture of radio and radar apparatus. The motor-vehicle and the cycle industries, particularly vulnerable because of their dependence on the export markets, have had their labour forces reduced by 4 per cent. in 12 months.

TABLE I.—*Great Britain: Placings by Employment Exchanges,* 1951/1952.

—	December 21, 1950, to October 24, 1951.*	December 20, 1951, to October 22, 1952.*
Men aged 18 and over	1,169,538	1,609,311
Boys under 18 ..	184,795	203,772
Women aged 18 and over	571,764	748,905
Girls under 18 ..	185,307	218,740
	2,111,404	2,780,728

* 44-week period.

TABLE II.—*Great Britain: Placings in the Metal-Using Industries by Employment Exchanges.*

—	1951.	1952.
Metal manufactures	4,048	6,867
Engineering, shipbuilding and electrical goods	22,317	25,738
Shipbuilding and ship repairing ..	4,387	4,976
Engineering	12,669	14,498
Electrical goods	5,261	6,264
Vehicles	7,818	12,247
Metal goods, not elsewhere specified	5,799	7,739
Precision instruments	1,287	1,770
Total: metal and engineering industries	63,586	80,099
Total: all industries..	186,609	253,136

Government measures have at least succeeded in cutting the numbers employed in public administration. A reduction of 30,000, or 5 per cent., in the number of civil servants does not, of course, yield savings which will affect the national fortunes one way or the other. Nevertheless, the Government policy derives from a cost consciousness which is of some importance in present conditions; tight budgeting can be justified, if only as an example to industry.

THE IMPLICATION OF REDUNDANCY.

Unemployment is not yet serious and, though it has doubled in the metal-producing and metal-using industries during the last 12 months, it is still only about 50,000.

There are many who would contend that the country is still in a state of "over-full" employment. In their view, a limited increase in unemployment would improve industrial discipline and the standards of performance. If this were so, the arrival of the buyers' market might prove a blessing for the British economy. Unfortunately, however, there is a good deal of substance in the contrary view that the threat of unemployment results in a slackening of effort, which derives as much from the general feeling of insecurity as from any deliberate policy of the artisan not to work himself out of a job. Few, apparently, now favour the individual solution to redundancy of commending themselves to the employer by hard work (or by any other means) in the hope that, when others are discharged, they will be retained. Combined action is now universally favoured, preferably through official union channels, though not necessarily so. All this shows a spirit of loyalty to workmates which is wholly admirable; but, unfortunately, such an emphasis on security of employment can seriously hamper productivity. In the docks, where there has been chronic insecurity of employment, there have been some flagrant examples of opposition to reorganisation and improved methods. That engineering has been more fortunate is perhaps due only to the high level of employment in the industry.

It is, or should be, one of the skills of management to obtain the co-operation of the workpeople in carrying out changes. Failure of the management to seek the workers' confidence is as common a cause of industrial strife as resistance to change on the part of the employees. The need for mutual confidence will be greater in 1953 than at any time since the war, if productivity is to be raised and British industry is to remain competitive.

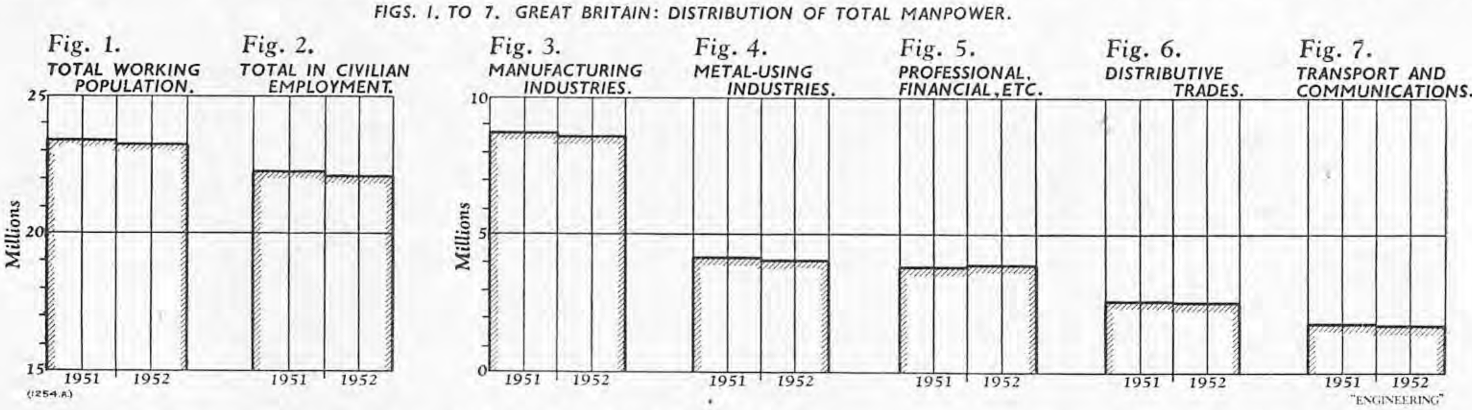
TABLE III.—*Great Britain: Employment in the Metal Manufacturing and Engineering Industry. (Estimated: Thousands.)*

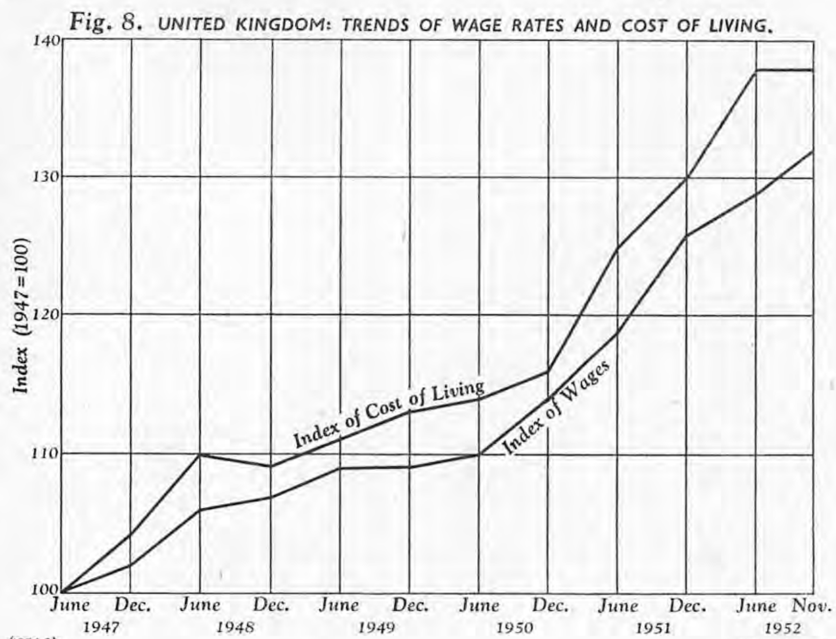
—	June, 1948.	October, 1951.	October, 1952.
Metal Manufacture	496·0	538·9	555·9
Blast furnaces	20·0	20·3	20·3
Iron and steel melting, rolling, etc.	194·7	213·6	217·5
Iron foundries	106·4	119·1	126·9
Tinplate manufacture ..	17·0	18·0	18·9
Steel sheet manufacture ..	18·5	19·1	18·2
Iron and steel tubes (incl. melting and rolling in integrated works) ..	39·3	43·7	46·9
Non-ferrous metals, smelting, rolling, etc. ..	100·1	105·1	107·2
Engineering, Shipbuilding and Electrical Goods ..	1,820·2	1,922·2	1,898·0
Shipbuilding and ship repairing	225·9	202·8	207·6
Marine engineering ..	78·0	74·8	74·3
Agricultural machinery (excl. tractors)	40·4	42·7	41·4
Boilers and boiler house plant	17·5	26·0	28·9
Machine tools	76·7	81·7	97·3
Stationary engines ..	23·3	27·1	26·0
Textile machinery and accessories	67·2	69·2	70·2
Ordnance and small arms	41·2	46·4	51·2
Constructional engineering	71·1	74·1	78·2
Other non-electrical engineering	664·8	685·6	636·8
Electrical machinery ..	164·9	180·2	186·3
Electric wires and cables..	62·2	65·0	63·3
Telegraph and telephone apparatus	44·4	50·2	53·8
Wireless apparatus (excl. valves) and gramophones	67·2	100·9	98·0
Wireless valves and electric lamps	36·6	43·6	40·5
Batteries and accumulators	19·3	21·1	19·1
Other electrical goods ..	119·5	130·8	125·1
Vehicles	878·9	982·9	1,052·7
Manufacture of motor vehicles and bicycles ..	285·4	308·2	296·4
Motor repairers and garages	205·8	231·4	256·5
Manufacture and repair of aircraft	141·6	168·2	202·4
Manufacture of parts and accessories for motor vehicles and aircraft ..	72·6	108·5	127·1
Railway locomotive shops	59·1	59·2	58·8
Other locomotive manufacture	25·5	22·2	25·7
Manufacture and repair of railway carriages and wagons and trams ..	76·6	76·7	77·9
Carts, perambulators, etc.	12·3	8·5	7·9
Metal Goods not elsewhere specified	491·4	505·6	492·7
Tools and cutlery ..	53·2	55·3	49·5
Bolts, nuts, screws, rivets, nails, etc.	40·6	38·2	41·9
Iron and steel forgings, not elsewhere specified	33·3	36·5	40·0
Wire and wire manufactures	37·3	36·8	38·2
Hollow-ware	50·5	56·3	54·8
Brass manufacturers ..	37·9	40·8	47·8
Metal industries not elsewhere specified ..	238·6	241·7	220·5
Precision Instruments, Jewellery, etc.	124·3	137·4	128·4
Scientific, surgical and photographic instruments, etc.	72·0	85·0	80·5
Manufacture and repair of watches and clocks ..	14·7	16·3	14·3
Jewellery, plate and refining of precious metals	29·5	27·8	25·8
Musical instruments ..	8·1	8·3	7·8

On the whole, the approach to redundancy in the engineering industry has been fairly reasonable in the last few months. The recent reorganisation at the British Motor Corporation's Morris engine works at Coventry created a potentially dangerous situation. Because of the decision to use Austin engines in the Morris Minor, about 1,000 of the 3,000 workpeople were threatened with redundancy. These, in a very typical reaction, made it clear that they preferred short-time working for all to the dismissal of some of their number. As a result of negotiation with union leaders, a reasonable compromise has been reached under which redundancy has been reduced and short-time working introduced temporarily. This will allow time for those who will become redundant to be re-absorbed, as a result of reorganisation within the company, or in other occupations.

Whether or not it is evidence of growing understanding in the industry, it is welcome to note that time lost through industrial disputes in the engineering trades in 1952 was considerably less than in 1951. In the eleven months to November, 1952, about 480,000 working days were lost in all the metal-using industries, compared with 787,000 in the corresponding period of 1951. The record in engineering was much better than for industry as a whole, since the aggregate number of working days lost—1·7 million—was roughly the same as in 1951. The total for 1952 is swollen, however, by the serious loss of time in the transport industry, which accounted for more than a third of the total time lost. The maintenance of good labour relations in 1952, the first year of Conservative Government, is a most encouraging portent; despite wide idealogical differences, the Government and the unions appear to have established a working understanding.

FIGS. 1. TO 7. GREAT BRITAIN: DISTRIBUTION OF TOTAL MANPOWER.





Wages and Prices.

Moderation is still the attitude of organised labour to wage-bargaining. Delegates to the Trades Union Congress in September approved by a majority of more than six million votes a statement by the General Council on the economic situation, which contained warnings about the consequences of substantial wage increases. Mr. Lincoln Evans, who introduced the statement, made it clear, however, that they were not being asked to accept the policy of wage restraint which operated from 1948 to 1950. On the other hand, he pointed out that substantial wage increases would only raise prices, and higher export prices would cause unemployment. "The position broadly is that we pay for each other's wage increases," said Mr. Evans, who deprecated the futility of the workers chasing their own tails. Of course, the principle of moderation has not been accepted without opposition, more especially since the unions are strongly opposed to the Government's policy of cutting food subsidies and removing price controls. At the same session, the T.U.C. passed, by a big majority, a resolution that the General Council should reject attempts to restrict "justifiable" wage increases.

In September, the engineers' claim for 2*l*. a week was outstanding and, whether justifiable or not, this was certainly substantial. Other claims put forward in 1952 by transport workers, shop workers, Local Government officers, agricultural workers and miners must also be considered as substantial. In the outcome, however, the principle of moderation has in no way been flouted. Regardless of the increases demanded, in most cases the unions accepted uniform flat-rate increases of about 7*s*. a week (7*s*. 4*d*. in the case of engineers). Wage increases in 1952, in fact, do not seem to have compensated for the rise in the cost of living. In the twelve months to November, the index of wage rates rose by 5 per cent., whereas the cost-of-living index rose by 8 per cent. In the year to November, 1951, the index of wage rates rose by 12 per cent. and the cost-of-living index by 11 per cent. Fig. 8, herewith, shows the trends of the two indices.

The increase in earnings in 1952, unlike those in former years, has almost certainly been smaller than in the increase in wages. Returns covering about six million persons, in the middle of 1951, indicated that 10 million hours of overtime a week were being worked and that there were only half a million hours of short time. In May, 1952, overtime had fallen to 9 million hours a week, but short-time working exceeded 5 million hours. Since then the situation has deteriorated further. Statistics of earnings, which are only published annually, in April, by the Ministry of Labour, fail to show this trend, but nevertheless are interesting. These are presented diagrammatically in Fig. 9. It will be seen that earnings in metal manufacture and in the metal-using industries compare very favourably with those in other industries. They are, however, substantially lower than earnings in coal-mining. These are not given by the Ministry of Labour in this series of statistics, but information published elsewhere shows that the average weekly pay packet of all colliery workers in the second quarter of 1952 was 10*l*. 17*s*. 5*d*. and the average weekly earnings of underground miners were 11*l*. 10*s*. 3*d*. This compares with 9*l*. 3*s*. 10*d*. in metal manufacture and 8*l*. 10*s*. 7*d*. in vehicle manufacture, the highest-paid of the engineering group.

Earnings, Unions and Productivity.

There are no statistics of the earnings of particular trades in the various industries, but it is clear that the differential between skilled and unskilled grades is being steadily diminished. Claims for wage increases in the past few years have generally been for flat-rate increases. As a result, the wages of the lower-paid grades have more than kept up with the cost of living, but the wages of the higher-paid tradesmen have lagged increasingly. Deplorable as it may be, there is an inevitability about this trend. A man who has had to devote many patient years to the acquisition of skill and knowledge has some cause for complaint if he is not suitably rewarded. Moreover, in a society which values a man according to his earning capacity, he finds it difficult to maintain that self-respect which has always been the prerogative of the skilled worker. Unskilled workers in more highly paid industries, on the other hand, enjoy a quite undeserved social prestige.

The fault lies more in social values than in the industrial system. In a dynamic economy, changes in demand and technology can reduce the earning capacity of machines as well as men—without reflection on the quality of either. Bulk-production methods are steadily eliminating the need for skill, but are steadily increasing earnings in the industries to which they are applicable. This trend, moreover, has been associated with the growth of the large national unions, whose membership covers all the workers in single industries, and the decline of the craft unions, whose membership may spread over several industries. It is the business of unions to-day to see that the share of wages in the turnover of the industries with which they are associated is kept as high as possible. In the United States, unions consider that, to increase the amount available for disbursement to the workers, it is their business to do everything possible to increase the turnover of the industry. This may even mean bringing in consultants (with the agreement of the management). Continual pressure exerted by the unions for higher wages has been one of the most important factors in the rapid rise in industrial productivity in the United States.

In the United Kingdom, while the unions have also been concerned with increasing wages, they have not thought it any part of their business to encourage managements to increase efficiency or turnover. They have been very much concerned, however, over the security of employment of their members, and have not welcomed changes which, while increasing the total wage bill, created redundancy. On the national level, the T.U.C. can be persuaded not to seek wage increases, on the ground that unemployment would result; individual unions which, contrary to T.U.C. policy, press for substantial wage increases, do so not in the expectation that their industry can become more efficient and raise profits, but on the ground that increased wages should be paid at the expense of current profits. Although there is this difference in emphasis between the policies of British and American unions, it must not be supposed, of course, that the American unions have no regard for security, or that the British unions care nothing for productivity. The American attitude, however, is the more "realistic," in that there is an uninhibited acceptance of the forces of demand and supply. In the United Kingdom, considerable confusion arises from the simultaneous pursuit of two conflicting ideals: maximum productivity, which requires a flexible employment policy, and security of employment. It is not proposed to argue here which of these ideals is the worthier—though, in present circumstances, there are few who will not admit the necessity of placing greater emphasis on productivity in the United Kingdom if the country is to remain solvent. It is, however, of the utmost importance that British industry should recognise clearly which aim it is pursuing at any given time. The Productivity Teams which visited the United States have acquired a fairly detailed knowledge of the methods adopted for increasing productivity there. Not all of these methods are applicable, however, in an economy which gives a high priority to social security, and a great deal of mischief can be caused by urging their unqualified adoption.

THE VALUE OF STUDYING AMERICAN METHODS.

This is not, of course, an adverse criticism of the work of the Anglo-American Council on Productivity. In the four years of their existence, the Council sent to the United States 66 study teams, consisting of over 900 industrialists, technicians and craftsmen, to visit some 2,000 factories. About 500,000 copies of Team reports have been distributed, and some have still to be published. In their final report, the Council (which ceased officially to exist on June 30) pointed out that many man-hours and much money had been devoted to achieving the results, and asked: "Have they been worth while?" This will obviously depend on the use made of the findings. Even if workers and managements in the United Kingdom were willing and anxious to apply lessons learned from American practice, there are still, as the Council point out, many difficulties to be overcome "in days when taxation reduces incentives, when the steady supply of raw materials is uncertain, when limitations on capital expenditure restrict development, or when recessions in trade threaten employment." In short, no magic wand has been brought back from the United States which will cure the ills of British industry. Expenditure on the activities of the Council must be regarded as a long-term investment which will eventually pay for itself, but from which the annual returns are likely to be small.

As originally conceived, the arranging of team visits to America was to be only one of the responsibilities of the Council. Committees were set up to make comparative studies of the following subjects in Britain and the United States: maintenance of productive plant and power; productivity measurement; standardisation and simplification; and the dissemination of economic information. The first two of these committees, however, encountered difficulties, and achieved comparatively little. The committee on the maintenance of productive plant and power was asked to examine the very important question whether British industry was being urged to export so large a portion of its production of machine tools and generating equipment that the efficiency of British plants was suffering. The Council's resources however, proved to be inadequate to the task of assembling and analysing the required data. It could do no more, therefore, than to recommend further research and to urge the necessity of the highest possible level of investment in the United Kingdom. The committee on productivity measurement found the development of objective bases for the comparison of productivity in Britain and the United States to be beyond their resources—despite the fact that the results of extensive work undertaken by trade and research associations in the United Kingdom on this subject was available to them. Some useful work was done, however, on the measurement of productivity in the United Kingdom and a booklet on *Productivity Measurement in British Industry* was produced. The work of the committee on standardisation, specialisation and simplification in industry is very well known through the report on "Simplification in Industry" (the Lemon Report) and its sequel "Simplification in British Industry," which gave some concrete examples of progress made, some of which were directly attributable to the recommendations of the first report.

The committee on economic information found surprisingly little difference in the methods of disseminating economic information in the two countries, and found the British technical Press inferior to the American only in the quantity of paper at its disposal. The total expenditure by the Anglo-American Council has not been very considerable, judged by the scale on which public money is commonly disbursed to-day. The total outlay of the British section has been about 320,000*l*., of which only 172,000*l*. was supplied by the Treasury. The British Employers' Confederation, the Federation of British Industries and the Trades Union Congress each supplied 10,000*l*., and the remainder came directly from industry. Reports from some industries indicate that returns from this investment are already coming in. To take only a few examples, steel-founding, iron-founding, Diesel-engine and Diesel-locomotive manufacture have already obtained substantial benefits from the adoption of American techniques. The work of applying the findings of the Team, however, is only just beginning, and the new British Council of Productivity has a long and arduous career before it, both in pursuing further research and in keeping managements and workpeople abreast of developments.

THE GROWTH OF ENGINEERING FIRMS.

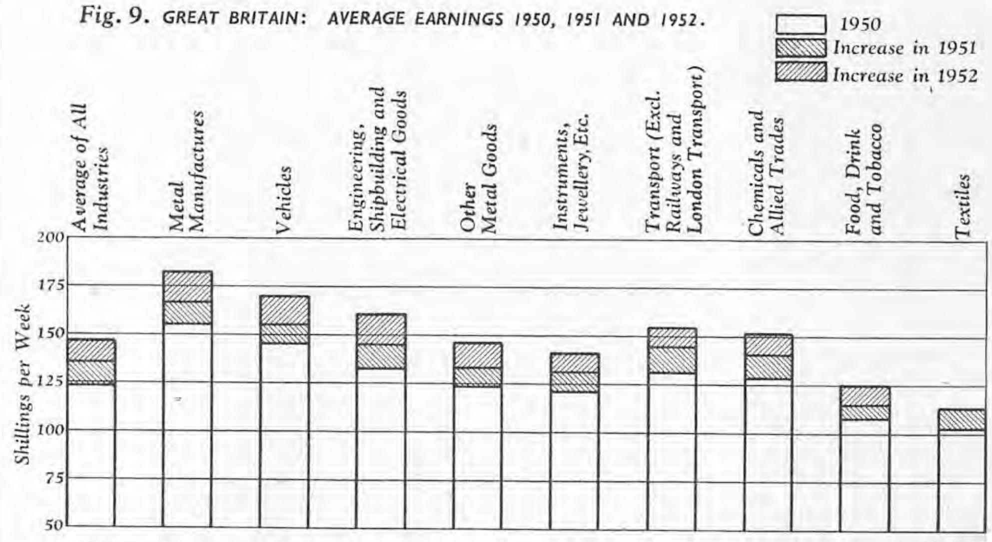
The Ministry of Labour publishes, every two or three years, an analysis of the size of industrial establishments. These statistics are based on returns submitted by all industrial establishments with more than ten employees. A comparison of the returns made in December, 1949, and in May, 1952, is given in Table IV*, taken from the *Ministry of Labour Gazette*. The number of establishments in the engineering industry is not only greater, but the average size of the individual establishment has increased appreciably. The average number of persons employed per establishment in the engineering, shipbuilding and electrical-goods industries rose over the period from 189 to 198, and in the vehicle industry from 150 to 156; the average for all industries increased only from 125 to 126. In a day and age when bulk-production methods are extolled for their superior efficiency, there are still 26 per cent. of the establishments producing engineering, shipbuilding and electrical goods which have fewer than 25 employees, and 69 per cent. which have fewer than 100. The trend is, however, clearly away from the smaller establishment. The number of establishments in the engineering and vehicle industries declined over the period only in the case of those with fewer than 25 employees; at the same time, 19 new establishments with more than 2,000 employees emerged—which represents

TABLE IV.—UNITED KINGDOM: SIZE OF ESTABLISHMENTS IN THE ENGINEERING INDUSTRY.

Number of Employees.	11 to 499.				500 to 999.				1,000 to 1,999.				Over 2,000.				Total.			
	1949.*		1952.†		1949.*		1952.†		1949*.		1952.†		1949.*		1952.†		1949.*		1952.†	
	a.	b.	a.	b.	a.	b.	a.	b.	a.	b.	a.	b.	a.	b.	a.	b.	a.	b.	a.	b.
Metal manufacture	1,561	166	1,680	178	129	89	144	100	64	88	66	91	47	148	49	159	1,801	49	1,939	528
Engineering, shipbuilding and electrical goods ..	7,650	608	7,824	640	367	255	391	271	214	297	228	318	107	414	120	463	8,338	1,574	8,563	1,692
Vehicles	4,917	244	5,273	283	102	75	118	83	76	108	81	117	81	351	87	387	5,176	778	5,559	870
Metal goods not elsewhere specified	4,586	306 }	5,714	394	100	74 }	135	92	33	46 }	37	51	3	9 }	7	19	4,731	435 }	5,893	546
Precision instruments, jewellery, etc.	1,206	77 }			20	13 }			.8	10 }			2	8 }			1.236	108 }		
Total, All industries ..	52,747	3,865	54,187	3,945	1,439	984	1,471	1,011	601	822	619	857	342	1,277	361	1,367	55,129	6,948	56,638	7,180

a = Number of establishments. b = Number of employees (thousands). * December. † May.

Fig. 9. GREAT BRITAIN: AVERAGE EARNINGS 1950, 1951 AND 1952.



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* To save space, this Table, as reproduced above, has been condensed, the figures relating to establishments having 11 to 24, 25 to 99 and 100 to 499 employees being combined to cover "11 to 499."—ED., E.

an increase of about 10 per cent. in the number of undertakings of this size. The trend is to be welcomed so far as it advances productivity, and so far as advancing productivity best meets the needs of the community. A good case can be made out, however, for the view that the small manufacturing unit, like the small farm, has advantages which, despite lower efficiency, make it a better servant of the community than the larger unit.

In every respect, the man-power situation in 1953 is very different from that in 1952. Apart from certain skilled grades, labour, like most other commodities, is no longer scarce. Further deterioration in marketing conditions may increase unemployment still more, but there is no cause for grave alarm. The advent of the buyers' market is no more than a return to more normal conditions of competitive trading. Management and workpeople in the United Kingdom are ready to meet it and capable of doing so. There is much that can be done to increase productivity, and lessons drawn from American experience will prove of great value. The drive for higher productivity is not, however, an end in itself—a point that, apparently, is forgotten in many management studies—and must be pursued most circumspectly. Under present conditions, goodwill between employees and managements is more essential than ever and can be achieved only if human relationships are considered to be as important as units of output.

ENGINEERING TRAINING IN THE R.E.M.E.

THE two-year period of National Service which young men are required to serve is not wholly a loss to the engineering industry. Those who join the Corps of Royal Electrical and Mechanical Engineers are given intensive training in theoretical and practical engineering subjects, and in the case of young engineers who study electronic applications, such as radar and gun-control equipment, they have a unique opportunity of familiarising themselves with equipment which is far in advance of anything they are likely to encounter in civil life. Nor is training of this kind devoted solely to the detailed study of a particular military instrument, since the policy of the teaching staff is to inculcate a knowledge of basic principles. Thus, when the student is posted to a field workshop, he should have no difficulty in dealing with the maintenance and repair of any equipment, new or old in design. Moreover, the Corps' instruction manuals are designed to smooth the path of the officer or other rank who is faced with an equipment which is new to him.

This ability of the Corps to adhere faithfully to a policy of teaching fundamentals—a policy which was inherited from the Royal Army Ordnance Corps when R.E.M.E. was formed in 1942—was, perhaps, the most reassuring feature revealed in the course of a Press visit last week to the R.E.M.E. Training Centre at Arborfield and Bordon. It was surprising, in view of the complexity and variety of present-day Army equipment, particularly the electronic equipment; and when it is realised that about 6,000 officers and men a year are being trained at the Centre, it is clear that the country is benefiting in two ways: a large pool is being created of engineers who, in the event of an "emergency," would be responsible for the technical function, so vital in modern war; and these same engineers, if they are National Service men, are being returned to industry with valuable experience and, in some cases, qualifications. Success in some of the courses, for example, exempts a student from part of the corporate membership examinations of the Institution of Electrical Engineers. On returning to civil life, many take up posts in research, where their training and experience in R.E.M.E. are valuable assets. Over 50 per cent. of the National Service officers who are given a radar course lasting 26 weeks are degree men, but it does not follow that a young engineer from a university is automatically granted a commission; he is given every opportunity, but however brilliant he is technically, he must show potential officer qualities before he can be commissioned.

The R.E.M.E. Training Brigade consists of the 3rd (Telecommunications) and the 5th (Radar) training battalions at Arborfield, and the 4th (Armament) and 6th (Vehicle) training battalions at Bordon. There is also the Officers' School, at Arborfield, where non-technical training is given on Army organisation and on workshop management; for the latter, the most up-to-date management methods are taught, and the Corps receives considerable assistance from industry in the provision of opportunities for students to study and gain experience. Here, as in other branches of the Training Centre, courses are also provided for senior regular officers.

The technical skill and the ability of the Corps as a whole depend largely on the armament artificers (staff-sergeants and warrant officers) who, in technical education, are trained to about Higher National certificate standard. They are the foremen-technicians who supervise the work of the various craftsmen in their group—armament, vehicle, radar, or telecommunications. In addition, there are now "leading artisans," who are of a similar technical standard but who, from a military point of view, are not given the same rank as armament artificers. The tradesmen are classified as I, II or III, according to their technical ability, but whether they are craftsmen (i.e., privates) or N.C.O.s depends on their powers of leadership. A recruit at the Training Centre can be passed out as a Class III or Class II tradesman, but he must obtain practical experience with a unit before he can be up-graded to Class I.

The Commandant, Brigadier G. E. Butler, explained, in an introductory address to the Press representatives, that the Training Brigade took all R.E.M.E. men on joining. It was thus possible to sort them out according to their previous experience. Some are university graduates with, perhaps, little practical experience; others are engineering apprentices who have had the benefit of a first-class training at one of the industrial firms who are well known for the thoroughness of their training methods; others, again, are youths who have had a rather patchy training in an engineering works. As far as possible, little time is wasted in repeating instruction which a man has received in civil life.

The 4th (Armament) Training Battalion deals with equipments which are, historically, the oldest in the Army: guns, gun carriages, small arms, and instruments, including fire-control instruments, such as directors, dial sights, range-finders, telescopes, binoculars, and coast-artillery transmission systems. In this battalion, as in the others, there are courses for a wide range of trades, as well as for officers and armament artificers. The 6th (Vehicle) Training Battalion deals with armoured fighting vehicles and load-carrying vehicles; in addition, it is now responsible for instruction in the repair and maintenance of Royal Engineer equipment, which includes crawler tractors, graders, rollers, trenchers, fork-lift trucks, pile-drivers, and stone-crushers—a group which is now designated "C" vehicles, following the established practice of calling armoured fighting vehicles "A" vehicles and load-carrying vehicles "B" vehicles. The 6th Battalion also provides training on refrigerators, on waterproofing of equipments, and on recovery. For the latter type of work they are equipped with a Centurion armoured recovery vehicle—a Centurion tank fitted with a powerful winch and a hinged spade at the rear for obtaining an anchorage.

The 3rd (Telecommunications) Training Battalion deals with wireless and line equipment. Broadly, the courses range from a general training in telecommunications for officers to a more detailed study of a limited number of equipments for Class III tradesmen. In the 5th (Radar) Battalion, the instruction covers, in addition to radar apparatus, electronic control and computing equipments, anti-aircraft gun control, gun-stabilising gear for tanks, searchlight equipment, and infra-red equipment. On all courses, theoretical instruction goes hand in hand with practical instruction. The Training Centre is undoubtedly the largest establishment for theoretical and practical engineering training in the country, and it is evident that the Army will benefit from this concentration in one Corps of the inspection, maintenance and repair of the whole of its mechanical and electrical equipment.

THE INSTITUTION OF NAVAL ARCHITECTS.

THE programme has been provisionally announced of the 1953 Spring Meetings of the Institution of Naval Architects, which are to be held on Wednesday, March 25, and on the two following days on board the Wellington, the headquarters ship of the Honourable Company of Master Mariners, moored off the Temple Stairs, Victoria Embankment, London. The proceedings will open with the annual general meeting of the Institution at 10.15 a.m. on the morning of March 25, when it is expected that the President, Viscount Runciman of Doxford, will deliver an address. This will be followed by the first of nine papers, which will deal with "The B.S.R.A. Resistance Tests on the Lucy Ashton: Part II—The Ship Model Correlation for the Naked Hull Conditions"; the authors are Dr. J. F. C. Conn, Mr. H. Lackenby and Mr. W. P. Walker. There will be no meeting in the afternoon of March 25, but in the evening the annual dinner of the Institution will be held at the Connaught Rooms, Great Queen-street, London, W.C.2, at 7 for 7.30 p.m.

On Thursday morning, March 26, two papers will be presented, namely, "Large Dry Docks," by Mr. E. L. Champness, M.B.E., M.Sc., and "The Motion of an Aircraft Carrier at Sea in Relation to the Operation of Naval Aircraft," by Mr. J. L. Bartlett, C.B.E., R.C.N.C. In the afternoon also two papers will be read, these being on "The Effect of Radial Pitch Variation on the Performance of a Marine Propeller," by Professor L. C. Burrill, M.Sc., Ph.D., and Mr. C. S. Yang, M.Sc., and on "Fatigue in Ship Structures," by Dr. R. Weck. On the morning of Friday, March 27, Mr. W. C. S. Wigley, M.A., will present a paper on "Water Forces on Submerged Bodies in Motion," which will be followed by one on "A Skin Friction Determination, using Wall-Sided Models of Great Draught," by Mr. R. T. Shiells, B.Sc. In the afternoon, there will be a joint meeting with the Institute of Marine Engineers, at which Mr. J. D. Farmer, O.B.E., and Mr. K. C. Hales will deliver a paper on "Refrigeration" and Professor G. Aertssen will present one on "Sea Trials of a Victory Ship A.P.3 in normal Merchant Service."

The Council also announce that they will offer for competition in 1953 the Institution of Naval Architects, Trewent, and Denny Scholarships in naval architecture and the Parsons and Denny Scholarships in marine engineering, for all of which the entries close on May 31; and the Sir William White and Froude Post-graduate Research Scholarships. Particulars of all of these scholarships may be obtained on application to the secretary of the Institution at 10, Upper Belgrave-street, London, S.W.1, who will also supply, on request, a copy of the revised regulations for the award of the Watts Prize, for proposals designed to improve the accommodation for crews or passengers on board ship. Entries for the Watts Prize, to be eligible for the 1953 competition, must be received at the Institution not later than July 31.

In conjunction with the Institution of Mechanical Engineers, a Conference on Marine Steam Turbines will be held in the hall of that Institution, Storey's-gate, St. James's Park, London, S.W.1, on Friday, March 6. At this conference, a series of papers will be presented, dealing with the work of the Parsons and Marine Engineering Research and Development Association. Admission will be by ticket only. A list of the papers to be read, and other particulars of the Conference, may be obtained from the secretaries of the two Institutions.

The Autumn Meeting of the Institution of Naval Architects is to be held in Holland from September 13 to 20, on the invitation of the Koninklijk Instituut van Ingenieurs.

FOOT-OPERATED SWITCH.—A foot switch now being produced by H. G. Poxon Engineering Co., Northolt-road, Harrow, Middlesex, has been designed for heavy workshop duty and has a current carrying capacity of 20 amperes at voltages up to 250. The switch has a toggle action with quick make-and-break wiping contacts, and is contained in a light-alloy case. There is no external pedal, the switch being actuated by depressing the cover.

APPARATUS FOR ANALYSIS OF GASEOUS MIXTURES.

GRIFFIN AND TATLOCK, LIMITED, LONDON.

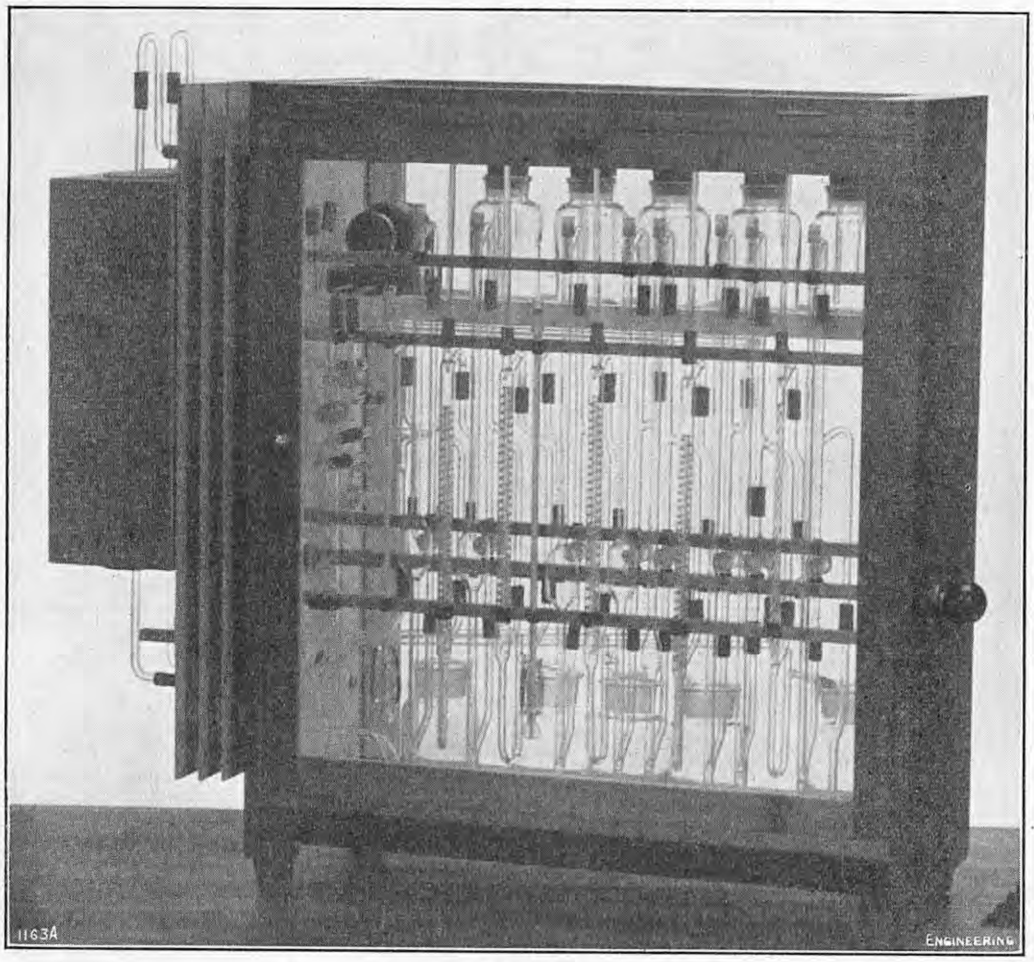
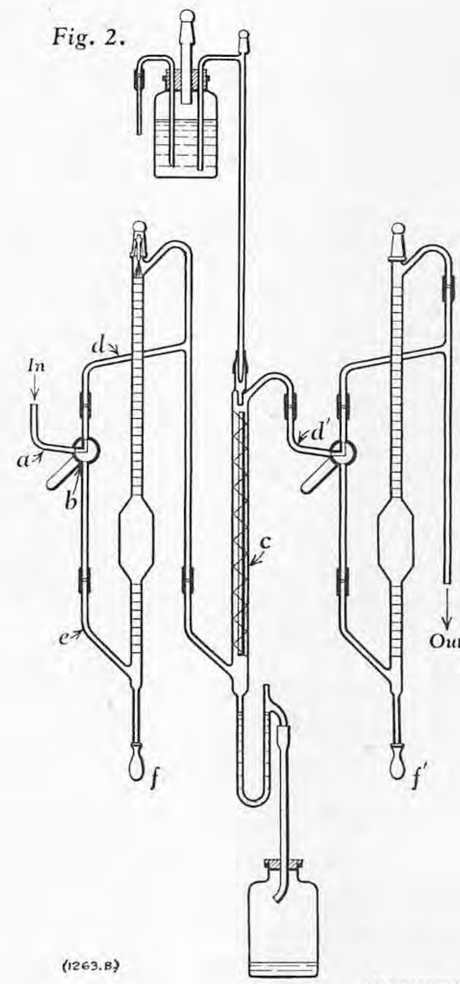


FIG. 1.



APPARATUS FOR QUANTITATIVE ANALYSIS OF GASES.

THE gas analyser illustrated on this page is based on a dynamic method for the quantitative analysis of gaseous mixtures and has been developed for the North Thames Gas Board in what was formerly the Fulham research laboratory of the Gas Light and Coke Company. It has now been put on the market by Messrs. Griffin and Tatlock, Limited, Kemble-street, London, W.C.2. The design is based on the work of Gooderham* and Barr.† The apparatus commonly in use for gas analysis is of the static variety; an example is the Gas Light and Coke Company's constant-volume analyser of the Bone and Wheeler type. The disadvantage of the static method is the time required to make a complete analysis—usually, for town gas, 1 to 1½ hours, because the gas constituents have to be removed consecutively from one representative sample and the residual gas volumes measured. Moreover, its use requires the services of a skilled analyst. With the dynamic method, an analysis of town gas or other gaseous mixture of similar composition can be made after flushing in a period of three minutes, by unskilled persons who have been briefly instructed. An accuracy of $\pm 0 \cdot 1$ per cent. is claimed for this apparatus, and, though designed primarily for a town gas with a low nitrogen content, it may be adapted, by the use of appropriate soap-film gas meters, for other gaseous mixtures of widely differing composition, typical of which are blast-furnace gas, eucalypt wood gas, and gases obtained from brown coal.

The gas flows continuously through a system of alternating measuring burettes and reagents, the number used depending on the number of constituents present in the gas mixture. Each measuring burette passes a volume of gas which is one constituent less than that in the previous burette, the lost constituent having been absorbed by the intermediate reagent. The introduction of a soap film or bubble into the gas in each burette makes the flow through each tube visible; by simultaneously noting the position of the film surfaces against calibrated scales and by taking a second series of readings when the films in the acceptance tube containing the whole gas have moved up 100 units of volume, the percentages of each constituent present in the gas mixture will be the difference between the reading from each adjacent tube. By-pass tubes can be introduced to the measuring burettes instantly and can again be diverted from them when the desired volume for the test has passed through the apparatus. By this method, another test may be made immediately after the first one is complete.

The gas meters utilise a soap film; a typical meter-scrubber-meter unit is shown diagrammatically in Fig. 1. The gas sample enters under constant pressure at *a*. Via stopcock *b*, it may travel to the scrubber *c* by the tube *d*, or, by turning the cock *b* through 90 deg., it may travel via the tube *e* to the calibrated tube or meter. Compression of the rubber teat *f* at the base of the meter causes a soap film to be formed across the tube, and this film pushed up the whole length of the meter by the gas advancing down *e*. A measured volume of gas thus passes up the scrubber *c* against a counter current of liquid reagent, which removes one constituent. The residual gas flows via the tube *d'* to the second gas meter, where its volume is measured. By extending the units, a complete analytical system is built up of meters and scrubbers in series, each scrubber being charged with an absorbent appropriate to a given constituent of the gas. All the reactive constituents are thus removed, leaving only the inerts. From the change in volume, shown by the relative movements of the soap films in successive meters, the percentage of each constituent can be read off or easily calculated.

* Gooderham, *J.S.C.I.*, vol. 57, page 388 (1938), and several British Standards; Gooderham and the Gas Light and Coke Co., British Patent 489,117; Gooderham, *J.S.C.I.*, vol. 59, page 1 (1940); *Chem. and Ind.*, vol. 18, page 368 (1940); Gooderham and the Gas Light and Coke Co., British Patent 550,323; Gooderham, *Analyst*, vol. 72, page 520 (1947); Gooderham, *Anal. Chim. Acta*, vol. 2, page 452 (1948).

† Barr, *J. Sci. Instr.*, vol. 11, page 324 (1934).

"BANKSIDE 'B' ELECTRIC POWER STATION": ERRATUM.—We regret that, in the account of Bankside "B" electric power station, which appeared on page 107, *ante*, the contractors for the fuel tanks were stated to be the Westinghouse Company. This should have been Whessoe, Limited, Darlington.

PRE-WAR GERMAN TRADE MARKS REGISTERED IN THE UNITED KINGDOM.—At the outbreak of war in 1939, German trade marks then on the United Kingdom Register of trade marks remained on the Register during the war in the names of the German proprietors, and have since been vested in the Custodian of Enemy Property for England. The Board of Trade are now to return such trade marks to their former German proprietors or their successors in title. Full particulars of the action to be taken by the former German proprietors, or by those who wish to object to the return of a trade mark to its former proprietor, are given in a notice published in the ***Trade Marks Journal*** and the ***Official Journal*** (***Patents***) of January 28, 1953.

EMULSION PAINTS.—The Building Research Station, Garston, Hertfordshire, have issued No. 50 in their series of building digests, entitled *Emulsion Paints*. Among the better-known emulsion paints are oil-bound distempers and bituminous-emulsion paints, but the digest is concerned primarily with those introduced during recent years and called latex paints. In stating the advantages of such paint, note is made of its easy-working properties and its freedom from smell during the drying period, but among the disadvantages must be considered the uncertainty of obtaining long durability. Details of the different types of emulsion paints available are followed in the digest by recommendations on where to use such paints and on how to prepare the surfaces. Copies of the digest, [price 3*d*. each], can be obtained from H.M. Stationery Office, York House, Kingsway, London, W.C.2.

150-B.H.P. INDUSTRIAL DIESEL ENGINE.

LEYLAND MOTORS, LIMITED, LEYLAND, LANCASHIRE.

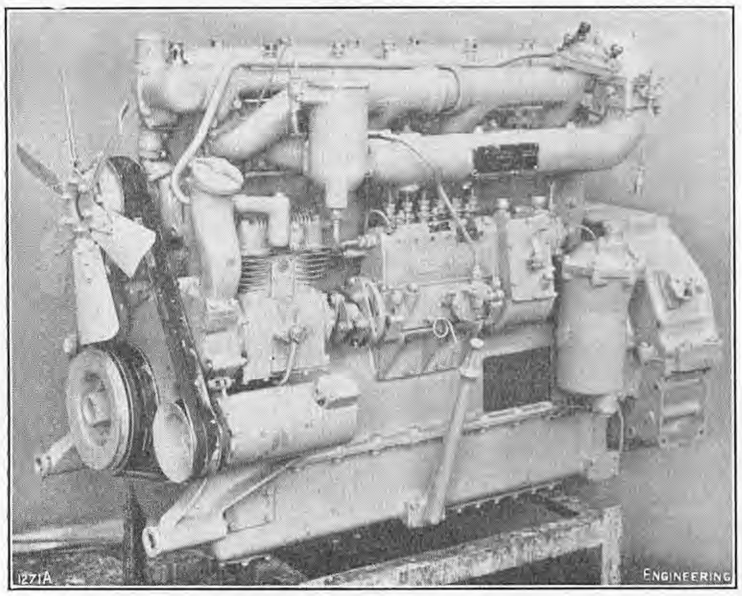


FIG. 1.

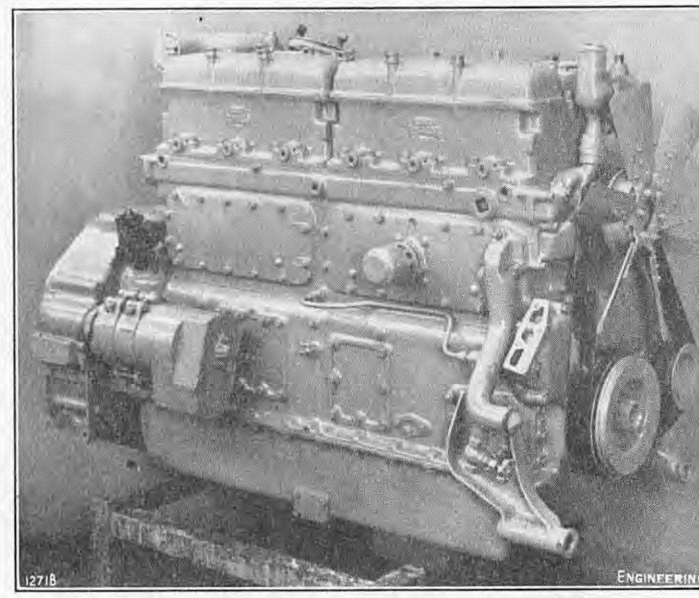


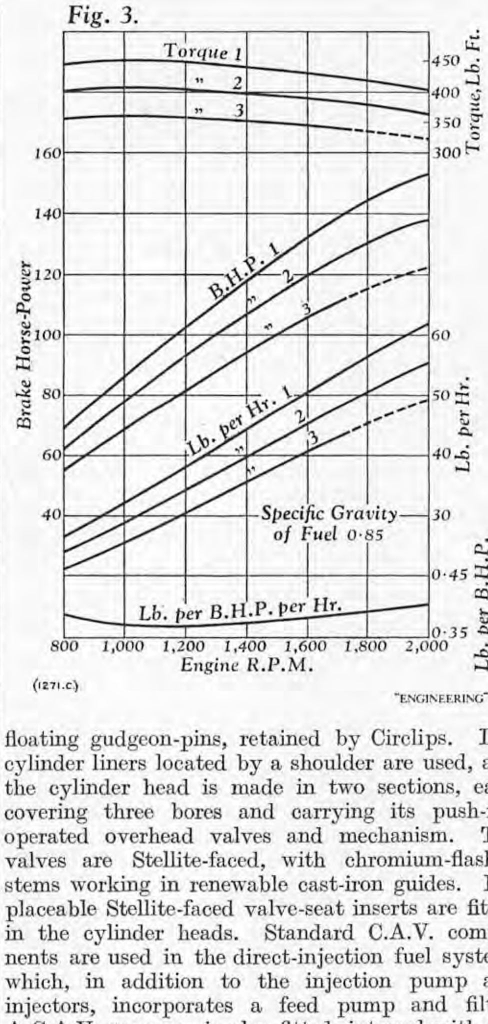
FIG. 2.

150-B.H.P. INDUSTRIAL DIESEL ENGINE.

A DIESEL engine of larger power output has been added to the range of engines produced by Leyland Motors, Limited, Leyland, Lancashire. It has an output of 150 brake horse-power and a capacity of 11·1 litres, and is known as the "680" engine. The engine is shown from both sides in Figs. 1 and 2. It is similar in design to the Leyland "600" engine, which was introduced in 1946. The "680" has been designed mainly for earth-moving machinery, and Euclid (Gt. Britain), Limited, Newhouse, Lanarkshire, are proposing to use 500 of them for this purpose. The engine is also to be used for Diesel-electric ground units for starting the engines of large aircraft. Where possible, the external dimensions have been limited to those of the "600" unit so that it is, in fact, interchangeable with this unit, although its use in Leyland trucks and 'buses is not yet proposed. Another advantage of this dimensional similarity is that much of the existing special-purpose plant and machine tools used for the "600" engine can also be used for the new engine.

The engine is a four-stroke six-cylinder water-cooled Diesel with overhead valves and a direct-injection fuel system. It has a bore of 5 in. (127 mm.) and a stroke of 5·75 in. (146 mm.), giving a cubic capacity of 677 cub. in. (11·1 litres), and the compression ratio is 15·75 to 1. Rotation is in a clockwise direction when viewed at the timing-case end. The full-load speed range is from 600 r.p.m. to 2,000 r.p.m., and the engine idles at 300 r.p.m. to 350 r.p.m. The engine is water-cooled by means of a centrifugal water-pump with a self-adjusting carbon-gland. The pump impeller, which rotates at 1·46 times the engine speed, delivers the water directly to the block for circulation through the cylinder water jackets; after the water leaves the block, it enters a large cored passage and is then directed through drilled holes into the cylinder heads and on to the nozzle and exhaust-valve housings. A thermostat is incorporated in the water pump to give main and by-pass flow. A monobloc cylinder and crankcase, of cast iron, is used, and in it a nitrided alloy-steel crankshaft and gear-driven camshaft are fitted. The camshaft and crankshaft run in seven bearings each, and in the latter case the bearings are $3\frac{1}{2}$ in. in diameter, of steel-shell copper-lead indium-coated construction; 3-in. crankpin bearings of the same kind are fitted to the forged connecting rods, and at the small end the bearing is a phosphor-bronze bush. The aluminium-alloy pistons have three compression rings and two scraper rings, and are held to the connecting rods by $1\frac{5}{8}$-in. fully-

Fig. 3.



floating gudgeon-pins, retained by Circlips. Dry cylinder liners located by a shoulder are used, and the cylinder head is made in two sections, each covering three bores and carrying its push-rod operated overhead valves and mechanism. The valves are Stellite-faced, with chromium-flashed stems working in renewable cast-iron guides. Replaceable Stellite-faced valve-seat inserts are fitted in the cylinder heads. Standard C.A.V. components are used in the direct-injection fuel system, which, in addition to the injection pump and injectors, incorporates a feed pump and filter. A C.A.V. governor is also fitted, integral with the injection pump. The main and crankpin bearings, timing gear, camshaft and valve gear are lubricated from a gear pump which works at a pressure of 60 lb. to 70 lb. per square inch at 1,750 r.p.m. A wet sump is used and the oil is filtered by a full-flow cloth-element filter. There is a 24-volt electrical system for starting and lighting, supplied by a 5-in. diameter swing-mounted dynamo which is on the left-hand side of the engine and driven by a belt. The starter motor is of the axial type and is cradle-mounted on the opposite side of the engine. The timing gear is at the front of the engine and is driven from the crankshaft by hardened helical gears. At the rear, an S.A.E. standard No. 1 flywheel housing is provided and the flywheel is machined to accommodate a Leyland-type clutch. The fan, with six blades, is mounted on the water pump shaft and its outside diameter is $21\frac{1}{2}$ in. The inlet manifold has a rear intake coupled to the air cleaner by a hose, and above it is the exhaust manifold with an outlet at 30 deg. from the vertical for connecting to the exhaust pipe and silencer. The front end of the crankshaft is fitted with a rubber-bonded torsional vibration damper. The engine has a weight, complete with fittings, of 1,925 lb. (873 kg.) dry, and its overall dimensions are 54·35 in. to the clutch face, 29·35 in. wide and 40 in. high.

Three sets of performance curves for this engine are shown in Fig. 3. They are based on an ambient temperature of 15 deg. C. and pressure of 29·92 in. of mercury. The fuel consumptions shown were obtained with pool gas-oil of 0·85 specific gravity, 19,600 B.Th.U. per lb., and a cetane value of 45. The first set of curves (1) gives the automotive rating of the engine, which allows no surplus horse-power for change of altitude, temperature and humidity; this rating is normally used in commercial vehicles where moderate horse-power is required and full horse-power is used only for short periods. The second set of curves (2) give the intermittent rating, where the engine may be used for infrequent periods of from one to three hours at moderately high horse-power, and it provides a surplus to correct for changes in atmospheric conditions. The third rating (3) is for continuous running at a high power output for long periods where long engine life is important; a large surplus is available for changes in altitude, etc.

STEAM ECONOMY IN INDUSTRY.—The Combustion Engineering Association are arranging a conference on "Heat Conservation in the Generation, Distribution and Utilisation of Steam in Industry," to be held at the Grand Hotel, Harrogate, on Wednesday and Thursday, February 11 and 12. Addresses, to be followed by discussions, are to be given by Mr. A. J. Small, A.M.I.C.E. (British Oil and Cake Mills, Ltd.) on steam generation; Mr. D. P. Golch (Spirax Manufacturing Co., Ltd.) on steam distribution; Dr. E. G. Ritchie, A.M.I.C.E., on steam utilisation; Mr. J. S. Brough (Monsanto Chemicals, Ltd.) on the factors influencing heat transfer; and Mr. A. E. Nixon (Darlington Insulation Co., Ltd.) on heat insulation. Dr. A. C. Dunningham, F.Inst.F., will sum up the proceedings. The fee for the conference is 2l. 2s. Further particulars can be obtained from the association, at 6, Duke-street, St. James's, London, S.W.1; but after February 9 inquiries should be addressed to the secretary, C.E.A. Conference, Grand Hotel, Harrogate.

NOTES FROM THE INDUSTRIAL CENTRES.

SCOTLAND.

MOBILE RESCUE UNIT FOR COLLIERIES.—A mobile rescue unit for use at Scottish collieries during an emergency, when men of the rescue brigade might be required to remain for a long period at the pithead, has been assigned to the Mines Rescue Station, Coatbridge. The unit, said to be the first of its kind in Britain, has sleeping facilities for 14 men together with accommodation for all the apparatus necessary for rescue operations. Mr. W. F. Richardson, chief safety engineer to the National Coal Board, states that, after the inquiry into the disaster at Knockshinnoch Colliery, the Commissioner made a recommendation that such services should be provided where existing accommodation was not suitable, and that every division had been asked to make a survey.

ELECTRICITY SUPPLY IN GLASGOW.—Plans for a new grid substation at Killermont, Glasgow, and associated transformer stations in adjoining districts to reinforce the electricity supply in the north-west of the city, at a cost of 836,000*l*., have been announced by the South-West Scotland Electricity Board. Approval was recently given for a similar project, costing 154,300*l*., in the south-west of the city. The Killermont substation will receive from the grid at 132,000 volts and redistribute it at 33,000 volts. Supplies had been substantially increased by the new generating station at Braehead.

JUTE MACHINERY FOR PAKISTAN.—Deliveries of jute-milling machinery to the value of 1,750,000*l*., part of the 3,500,000*l*. contracts placed last year by Pakistan with British textile machinery manufacturers, are now being made from Dundee works.

INDUSTRIAL EXPANSION AT RENFREW.—The Scottish Department of Health have informed Renfrew Town Council that it is desired to allocate to industry that part of the Blythswood estate between the new road and the land leased to the former Clyde Valley Electrical Power Co. for the erection of a power station.

SAFETY PRECAUTIONS IN MINES.—Returning a verdict of accidental death at an inquiry in Kirkcaldy on January 23 into an accident at Frances Mine, Fife, two months ago, when two men lost their lives in a gassing mishap, the jury added a rider recommending that more than two men should be employed when "blowman" breathing apparatus was being used. A colliery training officer wearing this type of apparatus had died from carbon-monoxide poisoning when he entered a sealed-off section. A colliery deputy entering the section to rescue him was also overcome.

CLEVELAND AND THE NORTHERN COUNTIES.

PROPOSED QUARRY EXTENSIONS IN NORTHUMBERLAND.—The Northumberland Quarry Owners' Association have asked the Ministry of Transport to inquire into a 63,000*l*. scheme proposed by Northumberland County Council for extensions to Harecrag stone quarry, Alnwick. The members of the Association have supplied over 1,750,000 tons of stone to the County Councils of Northumberland and Durham in the past five years. Now the County Council have decided to extend their own quarry at Harecrag, because, they contend, they have been overcharged by private firms. So far, the Ministry of Transport has turned down the Quarry Owners' Association's request for a public inquiry on the grounds that healthy competition in the industry was not undesirable. Mr. R. Speir, M.P. for Hexham, has been asked to make another approach to the Ministry to state the quarry owners' case.

PHOSPHATE PLANT FOR WHITEHAVEN.—Marchon Products, Ltd., Whitehaven, Cumberland, have received licences for further developments covering 36,000 sq. ft. The new extensions include a phosphate plant. The company, in association with a subsidiary, Solway Chemicals, Ltd., are already carrying out an important extension scheme for the manufacture of sulphuric acid from anhydrite.

POTASH IN EAST YORKSHIRE.—Mr. A. Spearman, M.P. for Scarborough and Whitby, addressing the Whitby Chamber of Trade, expressed the view that it would be seven years or longer before the production stage was reached in the development of potash in the Whitby area. He said that the difficulties encountered had proved greater than was expected. Referring to the possibility of Government aid towards the project, Mr. Spearman said the development of local potash resources would absorb a large quantity of raw materials and vital machinery for a number of years, and that, on the face of it, was not an attractive policy from the Government's point of view.

EMPLOYMENT ON TEES-SIDE.—The annual report of the Tees-side Industrial Development Board states that, at the beginning of 1952, a serious rise in the number unemployed seemed a possibility, but happily this fear proved to be groundless. At the end of 1952, there were nearly 3,000 unemployed on Tees-side, an increase of 700 on the previous year, but a lower figure than in the intervening months. Mr. J. C. H. Booth, the president of the Board, said that, between 1945, and 1949, when restrictions on capital expenditure were imposed, extensions had been carried out to 33 existing industries on Tees-side and 20 new industries had been established.

IRON-ORE IMPORTS AT MIDDLESBROUGH.—The S.S. Dorington Court, which arrived at the South Bank Wharf, Middlesbrough, of Messrs. Dorman, Long & Co. with a cargo of 9,905 tons of iron ore, commenced to discharge the ore at 5.55 a.m. on Tuesday, January 6, and completed discharging on Thursday, January 8. No overtime was worked and the whole cargo was unloaded in $33\frac{1}{2}$ working hours.

BOAT YARD CLOSED AT BERWICK.—William Weatherhead & Sons, Berwick, have closed their boat-building yard at Spittal, where Fleming lifeboats have been constructed. This step has been taken because more space is now available at the firm's main yard at Cockenzie. The Spittal yard, which was opened only last year, employed between 20 and 30 men.

DRY-DOCK EXTENSIONS AT SOUTH SHIELDS.—The Middle Docks & Engineering Co., Ltd., South Shields, who have recently completed an extension to their No. 1 and No. 2 dry docks, are to begin work on a 40-ft. extension to their No. 3 dock, which will then have a length of 500 ft. The No. 3 dock will be able to take vessels of 12,000 tons deadweight, which, at present, can be accommodated only in the No. 4 dock, which is 640 ft. long.

THE MIDLANDS.

EXHIBITION OF OLD MACHINE TOOLS.—An exhibition of old machine tools was opened at the Birmingham Museum of Science and Industry on January 23. The exhibits, which are partly from the Museum's permanent collection, and partly on loan from firms and individuals in the Midlands, are of various dates ranging over the late Eighteenth Century, and the major part of the Nineteenth. Two fine examples of rose-turning engines are included and other machines used in Birmingham's jewellery and silver-ware trades are well represented. Among these may be mentioned a goldsmith's pole lathe, and watchmaker's lathe. General engineering exhibits include a treadle lathe, principally of wooden construction, said to have belonged to Matthew Boulton; a hand-operated planing machine; and a screw-thread rolling machine of 1879. There is also a collection of small tools from the old engine-erecting shop at Soho Foundry. The exhibition is to remain open in its present form until April 26. Several new exhibits will then be introduced.

ACCESS TO THE CLAERWEN DAM.—Now that the Birmingham Corporation Water Department's Claerwen dam is officially in use, the Radnorshire Highways Committee, which is responsible for the roads in the area, is to improve the access to the dam for members of the public. The road leading to Claerwen dam from the older Elan Valley waterworks is winding and narrow, and widening is to be carried out to enable motor coaches to use it in safety.

INDUSTRY AND TOWN PLANNING.—The Dudley area committee of the National Union of Manufacturers are in contact with local authorities at Tipton, Halesowen Brierley Hill, Stourbridge, Oldbury, Wednesbury, Old Hill and Dudley, with the object of obtaining full information about the planning schemes for these areas as soon as possible. Several local manufacturers have complained about uncertainty regarding the future of their premises, and the Union are asking for definite dates by which objections to planning schemes must be lodged.

SITES FOR INDUSTRY.—The Urban District Council of Bromyard, Herefordshire, have appealed to the Midlands Industrial Development Association for assistance in persuading industry to settle in the town. The Council say that they have suitable sites, that labour is available, and that they would give priority in housing to key workers. At present, Bromyard has only one small factory, and many residents travel daily to work in Worcester and Hereford.

BOOKINGS FOR THE BRITISH INDUSTRIES FAIR.—It is expected that all the indoor space at the Birmingham section of the British Industries Fair will be fully booked well before the opening date, April 27. About 96 per cent. has already been taken.

LANCASHIRE AND SOUTH YORKSHIRE.

STRUCTURAL GIRDERS IN ALUMINIUM ALLOY.—The Birmingham City Transport Department, three years ago, required $7\frac{1}{2}$ tons of steel for converting a tram shed into a 'bus garage, but permission was refused. A Leeds engineering firm, Samuel Butler & Co., Ltd., offered to make girders from aluminium alloy and the offer was accepted. Two girders were then supplied and now a repeat order for six aluminium plate girders has been executed by the firm for Birmingham City Transport. The girders are nearly 67 ft. long, but only weigh between $1\frac{1}{2}$ and $1\frac{3}{4}$ tons.

DIESEL LOCOMOTIVES FOR DONCASTER.—A dozen Diesel-electric locomotives have been allocated to Doncaster for shunting work in the marshalling yards as an experiment, with a view to their more extensive use. They will not be used for passenger or goods traffic. Eventually, the railway works at Doncaster will be responsible for the repair and maintenance of Diesel locomotives from a wide area.

MINING DEVELOPMENTS.—Plans are being prepared by the National Coal Board for a new colliery at Cotgrave, near Nottingham, to exploit the 200,000,000 tons of workable coal which has been proved south of the Trent. The colliery will be situated about a mile from the Nottingham-Newark railway line and the estimated annual output is 2,000,000 tons.

STEELWORKS MODERNISATION.—A further stage in the modernisation and re-equipment scheme at the works of Hadfields, Ltd., Sheffield, estimated to cost about 4*l*. millions, was reached on January 21, when a 20-ton electric-arc steel-melting furnace was tapped for the first time at the East Hecla Works. The estimated weekly production is about 300 tons. The cost of the new furnace is 45,000*l*.

GAS COKE STOCKS.—There is no shortage of gas coke in the Sheffield area. Stocks have risen to 14,650 tons, compared with 5,424 tons a year ago. This is in sharp contrast to conditions in earlier years when users were unable to obtain all the coke required. In the whole area of the East Midlands Gas Board, stocks are as high as 63,000 tons, compared with 28,000 tons a year ago.

SOUTH-WEST ENGLAND AND SOUTH WALES.

THE SOUTH-WALES TIN-PLATE INDUSTRY.—The new tin-plate works to be erected at Velindre, near Swansea, by the Steel Company of Wales, is planned to be operating in five years time. Sir David Maxwell Fyfe, Home Secretary and Minister for Welsh Affairs, speaking in the recent House of Commons debate on Welsh affairs, said that, so far, the project had only reached the planning stage, with Government permission to proceed. Preparation of the site, it was estimated, would take two years. The coming into operation of this new works would mean that, if there were no new developments or changes in the area, some 10,000 to 12,000 workers in the tin-plate industry would be redundant. Seven of the old hand-operated tin-plate works have been completely closed and three partly closed this month. Of 2,400 employees affected, many will be transferred to other works.

STEEL PRODUCTION IN SOUTH WALES.—The South Wales steel works and mills achieved a record production of steel in 1952. The total Welsh output of ingots and castings was 3,720,400 tons, compared with the previous best total of 3,475,200 tons, in 1951. Pig-iron production also increased, from 1,350,700 tons in 1951 to 1,545,100 tons in 1952.

CARDIFF WATER SUPPLY.—A scheme, estimated to cost 260,200*l*., is said to be urgently needed to increase the present unsatisfactory water pressure in various parts of Cardiff. It provides for two new reservoirs, at Radyr and Wenvoe, and two new mains.

THE PROPOSED USKSIDE SHIPYARD.—It was confirmed at a meeting of the Welsh Board for Industry on January 23 that the Government have agreed in principle to the project for a shipbuilding yard on a site at the mouth of the River Usk at Newport. The estimated cost is 1,500,000*l*.

NOTICES OF MEETINGS.

IT is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

INSTITUTION OF MECHANICAL ENGINEERS.—*North-Eastern Branch:* Monday, February 2, 6 p.m., Neville Hall, Westgate-road, Newcastle-upon-Tyne. Thomas Lowe Gray Lecture on "Welding in Marine Engineering," by Mr. H. N. Pemberton. *North-Western Branch:* Thursday, February 5, 6.45 p.m., Engineers' Club, Manchester. "The Measurement and Interpretation of Noise, with Special Reference to Oil Engines," by Mr. C. H. Bradbury.

INSTITUTION OF ELECTRICAL ENGINEERS.—*South Midland Centre:* Monday, February 2, 6 p.m., James Watt Memorial Institute, Birmingham. (i) "Arc-Quenching Circuits," by Mr. B. H. Stonehouse; and (ii) "Machines, Animals and Information," by Mr. B. de Ferranti. *North-Western and Mersey and North Wales Centres:* Monday, February 2, 6.30 p.m., Town Hall, Chester. "275-kV Developments on the British Grid System," by Mr. D. P. Sayers, Dr. J. S. Forrest and Mr. F. J. Lane. *London Students' Section:* Monday, February 2, 7 p.m., Victoria-embankment, W.C.2. Students' Lecture on "Electrical Safety Precautions," by Mr. H. W. Swann. *District Meeting:* Monday, February 2, 7.30 p.m., Wig and Gown Hotel, Maidstone. "Electrical Installations in Large Chemical Factories," by Mr. D. B. Hogg. *Measurements and Supply Sections:* Tuesday, February 3, 5.30 p.m., Victoria-embankment, W.C.2. "A Moving-Coil Relay Applied to Modern High-Speed Protective Systems," by Mr. C. Ryder, Mr. J. Rushton and Mr. F. M. Pearce. *North-Western Centre:* Tuesday, February 3, 6.15 p.m., Engineers' Club, Manchester. "Control of a Thermal Neutron Reactor," by Mr. R. V. Moore. *East Midland Centre:* Tuesday, February 3, 6.30 p.m., East Midland Electricity Board's Service Centre, Derby. "Electricity in Newspaper Printing," by Mr. A. T. Robertson. Tuesday, February 3, 7 p.m., University Arms Hotel, Cambridge. "Electrical Engineering in the Steel-Tube Industry," by Mr. H. E. Knight. *North Midland Centre:* Tuesday, February 3, 6.30 p.m., 1, Whitehall-road, Leeds. Discussion on "Electric Winders and the Supply Authority," opened by Mr. D. R. Love and Mr. L. Abram. *Southern Centre:* Wednesday, February 4, 6.30 p.m., Municipal College Extension, Portsmouth. "Principles of Colour Television," by Dr. J. H. Mole and Mr. J. W. R. Griffiths. *Institution:* Thursday, February 5, 5.30 p.m., Victoria-embankment, W.C.2. "The First Stage of the Electrification of the Estrada de Ferro Santos a Jundiai (late São Paulo Railway)," by Mr. R. J. B. Chatterton and Mr. D. H. Rooney.

INSTITUTION OF THE RUBBER INDUSTRY.—*North-Eastern Section:* Monday, February 2, 7 p.m., Neville Hall, Newcastle-upon-Tyne. "The Neoprene Latices: Their General Characteristics, Compounding and Processing," by Mr. W. G. Vennells.

ROYAL INSTITUTION.—Tuesday, February 3, 5.15 p.m., 21, Albemarle-street, W.1. "Experimenting at High Pressures." II.—"Design of High-Pressure Plant and Equipment," by Professor D. M. Newitt, F.R.S.

INSTITUTION OF CIVIL ENGINEERS.—*Road Engineering Division:* Tuesday, February 3, 5.30 p.m., Great George-street, S.W.1. "Some Aids to Traffic Flow," by Mr. R. A. B. Smith.

INSTITUTION OF STRUCTURAL ENGINEERS.—*Northern Counties Branch:* Tuesday, February 3, 6.30 p.m., Cleveland Scientific and Technical Institution, Middlesborough. "Electricity Generating Stations," by Mr. B. A. E. Hiley. Also on Wednesday, February 4, 6.30 p.m., Neville Hall, Newcastle-upon-Tyne. *Western Counties Branch:* Friday, February 6, 6 p.m., The University, Bristol. "Some Local Contracts and Welded Steelwork for a 'Bus Garage," by Mr. F. G. Clarke. *South Western Counties Branch:* Friday, February 6, 7 p.m., Duke of Cornwall Hotel, Millbay, Plymouth. "Unusual Design for a Large Constructional Shop," by Mr. F. R. Bullen.

INSTITUTE OF METALS.—*Oxford Section:* Tuesday, February 3, 7 p.m., Black Hall, St. Giles, Oxford. Symposium on "Metal Pressing." *Birmingham Section:* Thursday, February 5, 6.30 p.m., James Watt Memorial Institute, Birmingham. "Substitution," by Professor A. J. Murphy. *London Section:* Thursday, February 5, 7 p.m., 4, Grosvenor-gardens, S.W.1. "Titanium," by Dr. N. P. Allen.

INCORPORATED PLANT ENGINEERS.—*London Branch:* Tuesday, February 3, 7 p.m., Royal Society of Arts, John Adam-street, Adelphi, W.C.2. "Selection, Installation and Maintenance of Small Diesel Engines," by Mr. D. C. Edwards. *Edinburgh Branch:* Tuesday, February 3, 7 p.m., 25, Charlotte-square, Edinburgh. "Preventive Maintenance: British and American Approaches," by Mr. T. C. Robinson. *South Wales Branch:* Tuesday, February 3, 7.15 p.m., South Wales Institute of Engineers, Park-place, Cardiff. Discussion on "Water Treatment." *Southampton Branch:* Wednesday, February 4, 7.30 p.m., Polygon Hotel, Southampton. Film Display on "Electronics in Industry." *Peterborough Branch:* Thursday, February 5, 7.30 p.m., Offices of the Eastern Gas Board, Church-street, Peterborough. "Processed Steam," by Mr. E. S. Chandler.

INSTITUTION OF WORKS MANAGERS.—*Sheffield Branch:* Tuesday, February 3, 7.30 p.m., Grand Hotel, Sheffield. "The Human Factor and Its Relationship to Industry," by Mr. J. Leask.

INSTITUTION OF ENGINEERING INSPECTION.—*Coventry Branch:* Tuesday, February 3, 7.30 p.m., Technical College, Coventry. "Precision Measurements," by Mr. W. Foster. *South-Western Branch:* Tuesday, February 3, 7.30 p.m., Grand Hotel, Broad-street, Bristol. "Manufacture and Properties of Natural and Synthetic Rubber Compounds," by Mr. L. G. Shelton. *Birmingham Branch:* Wednesday, February 4, 7.30 p.m., 95, New-street, Birmingham. Discussion on "The Evolution of the Watch and the Modern Methods Now Employed During Manufacture." *London Branch:* Thursday, February 5, 6 p.m., Royal Society of Arts, John Adam-street, W.C.2. "Education and Training for the Inspection Branch of Engineering," by Mr. G. V. Stabler.

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS.—*West London Branch:* Tuesday, February 3, 7.30 p.m., Windsor Castle Hotel, King-street, Hammersmith, W.6. "Jointing and Compounds," by Mr. B. A. Masted. *Nottingham Branch:* Tuesday, February 3, 7.30 p.m., Offices of the East Midland Electricity Board, Smithy-row, Nottingham. "Developments of Electronic Equipment for Industry," by Mr. R. J. F. Howard. *South London Branch:* Thursday, February 5, 8 p.m., Café Royal, North End, Croydon. "Flame Proof Motors," by Mr. A. N. D. Kerr.

ROYAL SOCIETY OF ARTS.—Wednesday, February 4, 2.30 p.m., John Adam-street, Adelphi, W.C.2. Peter Le Neve Foster Lecture on "A Century of Photography," by Mr. I. D. Wratten.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—Wednesday, February 4, 6 p.m., Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W.1. "Conservation of Fuel, Heat and Energy: Report of Productivity Team's Visit to United States," by Mr. W. L. Boon, Dr. E. G. Ritchie and Mr. L. Copeland Watts. *East Midlands Branch:* Wednesday, February 4, 6.30 p.m., College of Technology, Leicester. "Heating and Ventilating Problems in Atomic Energy Establishments," by Mr. W. L. Wilson.

ILLUMINATING ENGINEERING SOCIETY.—*Newcastle Centre:* Wednesday, February 4, 6.15 p.m., Minor Durrant Hall, Oxford-street, Newcastle-upon-Tyne, 1. "Lighting and Vision as Age Advances," by Mr. H. C. Weston. *Edinburgh Centre:* Wednesday, February 4, 7 p.m., 357, High-street, Edinburgh. "Luminescence as Applied to Lighting," by Mr. H. G. Jenkins and Mr. A. H. McKeag.

MANCHESTER METALLURGICAL SOCIETY.—Wednesday, February 4, 6.30 p.m., Engineers' Club, Manchester. "Some New Laboratory Techniques," by Dr. F. Ashworth and others.

INSTITUTION OF PRODUCTION ENGINEERS.—*Nottingham Section:* Wednesday, February 4, 7 p.m., Victoria Station Hotel, Nottingham. "Developments in Centreless Grinding Technique," by Mr. A. Scrivener. *Liverpool Section:* Wednesday, February 4, 7.30 p.m., Radiant House, Bold-street, Liverpool. "The Function of Rate Fixing in Workshop Practice," by Mr. V. Eaves. *Leicester Section:* Thursday, February 5, 7 p.m., Bell Hotel, Leicester. "Joint Consultative Machinery at Factory Level," by Mr. F. Hayday. *Reading Section:* Thursday, February 5, 7.15 p.m., Canteen, Transport Equipment (Thornycroft) Ltd., Basingstoke. "Manufacture and Applications of Ball and Roller Bearings," by Mr. R. K. Allan.

CHEMICAL SOCIETY.—Thursday, February 5, 2.30 p.m. and 7.30 p.m., Burlington House, Piccadilly, W.1. Symposium on "Acetylene Chemistry."

BRITISH INSTITUTION OF RADIO ENGINEERS.—*Scottish Section:* Thursday, February 5, 7 p.m., The University, Edinburgh. "The Principle of Electronic Computing Machines," by Dr. B. V. Bowden.

INSTITUTE OF FUEL.—*South Wales Section:* Friday, February 6, 6 p.m., South Wales Institute of Engineers, Park-place, Cardiff. (i) "Ash and Clinker in Practice: Handling and Disposal," by Mr. W. G. Marskell and Mr. C. W. Pratt; and (ii) "Ash and Boiler Efficiency," by Dr. A. C. Dunningham. *Scottish Section:* Friday, February 6, 7 p.m., North British Hotel, Edinburgh. "Collection of Dust from Flue Gases," by Mr. J. C. Cleeves.

JUNIOR INSTITUTION OF ENGINEERS.—Friday, February 6, 7 p.m., Townsend House, Greycoat-place, S.W.1. Film Evening: "Depositing Stellite with the Oxy-Acetylene Flame."

PERSONAL.

The gold Albert Medal of the Royal Society of Arts for 1952, which, as stated in our issue of July 4, 1952, page 15, has been awarded to AIR COMMODORE SIR FRANK WHITTLE, K.B.E., C.B., M.A., F.R.S., will be presented to him by H.R.H. the Duke of Edinburgh, K.G., the President of the Society, at Buckingham Palace, on Wednesday, March 4.

PROFESSOR WILLIS JACKSON, D.Sc., M.I.E.E., has accepted the full-time appointment of director of research and education to the Metropolitan-Vickers Electrical Co. Ltd., Trafford Park, Manchester, 17, as from July 1, 1953. He will succeed DR. C. DANNATT, who will thus be released for an extension of his present duties as assistant managing director.

DR. T. E. ALLIBONE, F.R.S., has been appointed to the board of the Edison Swan Electric Co. Ltd., 155, Charing Cross-road, London, W.C.2, as director of research. He will, however, retain his position as director of the research laboratory of Associated Electrical Industries Ltd., Aldermaston, Berkshire.

DR. WALTER CAWOOD, C.B.E., is to be the Ministry of Supply's principal director of scientific research (defence) in succession to DR. O. H. WANSBROUGH-JONES, C.B., O.B.E., who, as foreshadowed on page 599 of our issue of November 7, 1952, is succeeding SIR HARRY GARNER, K.B.E., C.B., as chief scientist at the Ministry of Supply. The appointments take effect from February 23.

DR. R. BAULK, recently seconded to the Department of Fuel Technology of Sheffield University under Professor R. J. Sarjant, has been appointed fuel research officer to the Samuel Fox Branch of the United Steel Companies Ltd., Sheffield.

MR. P. BRIGGS, M.Inst.F., chief generation engineer (operation), South Eastern Division, British Electricity Authority, has been appointed controller, Merseyside and North Wales Division, in succession to MR. W. A. GALLON, B.Sc., M.I.E.E., who has been appointed deputy chairman, South Wales Electricity Board.

MR. G. M. BAKER, general works manager, C. A. Parsons & Co. Ltd., Heaton Works, Newcastle-upon-Tyne, 6, has been elected a director. MR. J. L. PACKARD is the new London office manager in succession to MR. E. P. PRESTON, who retired on December 31.

MR. W. S. KNIGHT, managing director of Lightalloys Ltd., has been granted six months' leave of absence by the board and MR. K. C. T. MARSHALL, works director, has been appointed acting managing director. THE RT. HON. LORD ROCKLEY has resigned from the board owing to the pressure of other commitments.

MR. JAMES HODGE, M.A., A.M.I.Mech.E., A.F.R.Ae.S., senior consultant of Power Jets (Research and Development) Ltd., has gone to Columbia University, New York, for four months as visiting lecturer in gas turbines.

MR. R. E. HARVEY, general manager, and MR. D. KEITH-LUCAS, B.A., M.I.Mech.E., F.R.Ae.S., chief designer, have been elected to the board of Short Bros. and Harland Ltd., Belfast, with effect from January 16.

MR. C. H. DE NORDWALL, M.I.E.E., has been appointed manager, Metropolitan-Vickers Electrical Export Co. Ltd., for South America. MR. G. D. HARRADINE, Assoc.I.E.E., has been made sales manager, industrial control department, Metropolitan-Vickers Electrical Co. Ltd., in succession to MR. DE NORDWALL.

MR. H. SOMERVILLE SMITH, C.M.G., D.S.O., O.B.E., M.C., late comptroller general, Export Credit Guarantee Department, has been elected a director of British Overseas Engineering and Construction Corporation Ltd.

MR. A. D. LIDDERDALE, A.M.I.Mech.E., M.I.Prod.E., has left the A.P.V. Co., Ltd., to take up the position of chief mechanical engineer to the Telegraph Construction and Maintenance Co. Ltd., Telcon Works, Greenwich, London, S.E.10.

WICKMAN LTD., Coventry, announce that, as from January 5, their subsidiary company, APPLIED HIGH FREQUENCY LTD., functions directly as a division of the company under the title of WICKMAN LTD., APPLIED HIGH FREQUENCY DIVISION. The address of the division is still Actarc Works, Goldhawk-road, London, W.12.

MR. W. A. BIGGS, A.M.I.E.E., has been appointed London manager of the Electrical Power Engineering Co. (B'ham) Ltd., Bromford-lane, Birmingham, 8, as from February 1, in succession to MR. A. N. D. KERR, who has relinquished the post.

C. MACKECHNIE JARVIS & PARTNERS have removed from No. 26 to No. 53, Victoria-street, London, S.W.1. (Telephone: ABBey 4751.)

MR. M. C. BLYTHE having been appointed sales manager to Brush Electrical (Australia) Pty. Ltd., MR. C. J. STEWART, B.Sc., has been appointed acting manager of the Newcastle office of the Brush Electrical Engineering Co. Ltd.

GAS-FIRED ANNEALING OF LOCOMOTIVE BOILER TUBES.

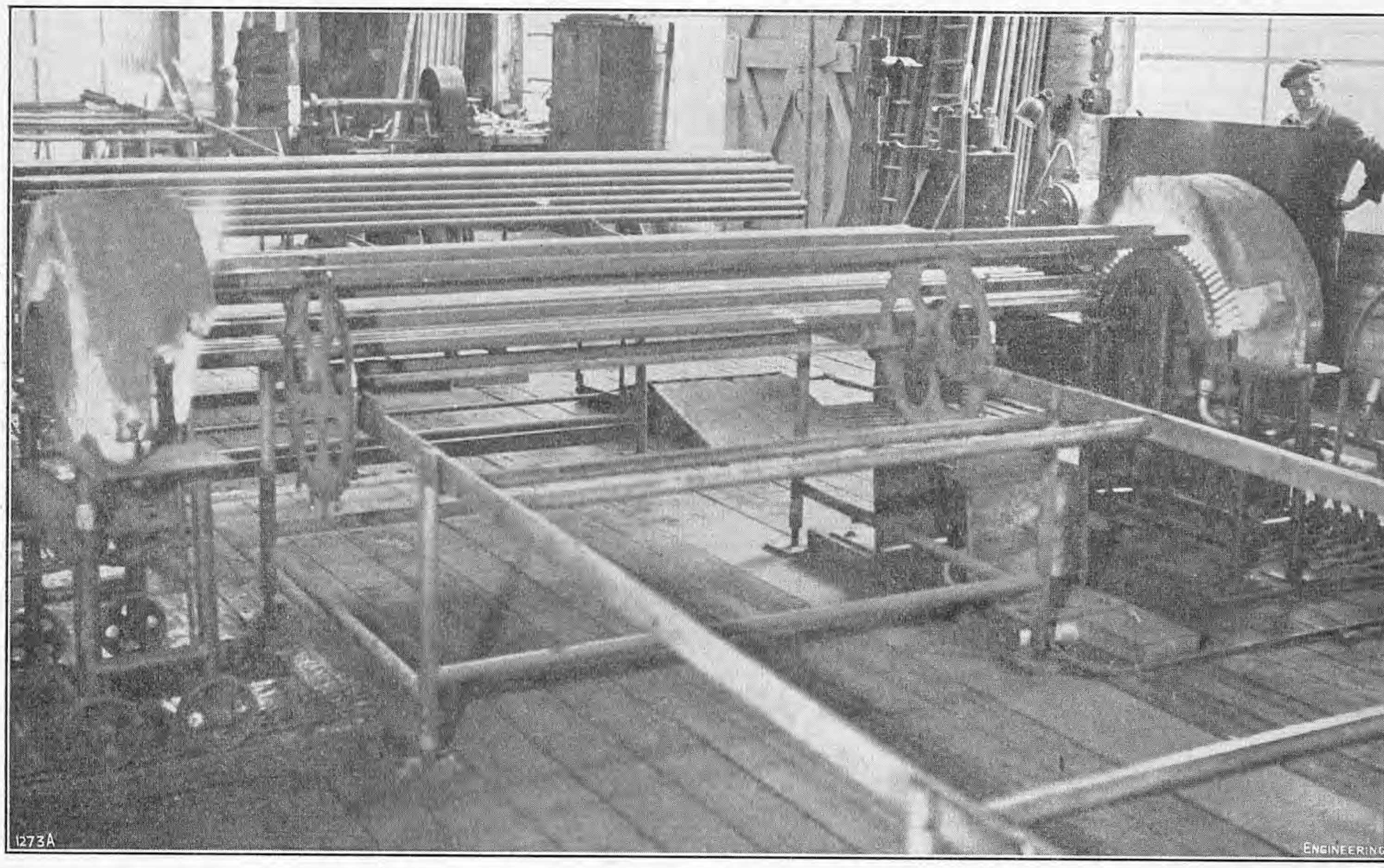


FIG. 1. PLANT AT ASHFORD LOCOMOTIVE WORKS.

GAS-FIRED ANNEALING OF LOCOMOTIVE TUBES.

A PLANT at the Ashford Locomotive Works of the Southern Region, British Railways, employs an improved design of gas burner and a simple method of conveying locomotive boiler tubes past the burner to anneal their ends. The tubes are allowed to roll down a ramp towards the two burners—one for each end of the tube—as shown in the background of Fig. 1. They are then picked up by a pair of sprocket-shaped wheels which are driven at a constant rate. As Fig. 2 shows, each burner consists of a number of gas jets arranged in a semi-circle. The jets are directed upwards, thus providing a concentrated heating zone between them and a refractory arch above them. The sprocket wheels carry the tubes over, through a semi-circular path, so that about 3 or 4 in. of both ends pass through the heating zones. They are raised to an annealing temperature of 700 deg. C., and, on leaving the sprockets, roll down the ramp shown in the foreground of Fig. 1. Each tube is in the heating zone for about three minutes.

Originally, the burners consisted of a number of vertical tubes arranged like a group of organ pipes. The improved design shown in Fig. 2 consumes about 24 per cent. less gas. Each jet is a separate screwed-in brass piece drilled 0·182 in. in diameter (No. 14 Morse). There are four rows, with about 24 jets in each row, and they are staggered. The main body of the burner is fabricated from $\frac{1}{4}$-in. mild-steel plate; that into which the jets are screwed is bent into a semi-circle of $9\frac{1}{2}$-in. radius. An inner semi-circular plate is bent to a radius of 7 in., and the space between the two is closed by end and side plates. Air is admitted through a short vertical length of 1-in. pipe which is fitted inside a 2-in. by $1\frac{1}{4}$-in. T-piece; it joins the gas, which enters at the side through the $1\frac{1}{4}$-in. connection of the T-piece, and the mixture passes up, through a connection to the curved inside wall of the burner, to the jets. During a test period of five hours, the gas consumption was 2,850 cub. ft. (13·5 therms), for 734 tubes annealed. The weekly output of all sizes of tubes, from $1\frac{3}{8}$-in. to $2\frac{1}{4}$-in. diameter, is 1,200, the hourly rate being 240. To improve the economy of the plant, it is proposed to arrange for the tubes to be rotated as they pass through the burners, and for the refractory arch to be lowered on to the tubes. One of the burners can be moved to allow for different lengths of boiler tubes. The particulars given here are based on Report No. 504/52 of the Industrial Gas Development Committee of the Gas Council, from information supplied by the South Eastern Gas Board.

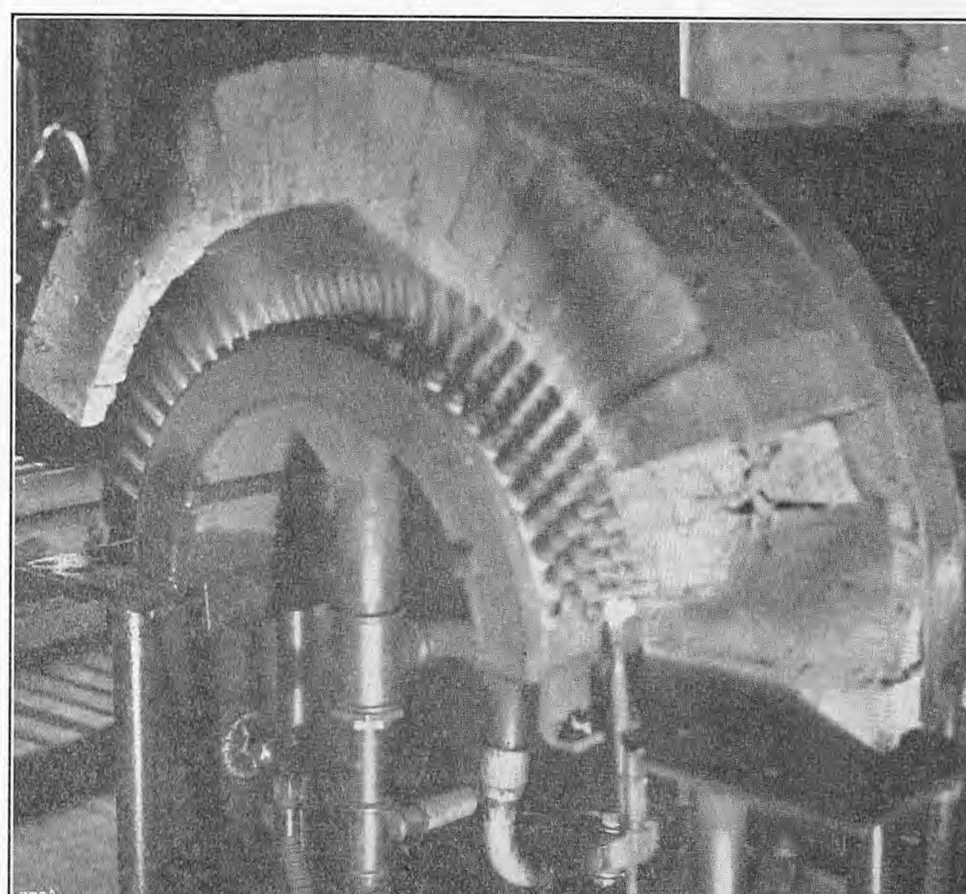


FIG. 2. GAS BURNER.

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CONTENTS.

ENGINEERING

FRIDAY, JANUARY 30, 1953.

VOL. 175. No. 4540.

THE MACHINE TOOL INDUSTRY.

MACHINE tools are a basic element in the manufacturing plant of practically all metal-using industries, so that their design, price, quality and other features are of importance far beyond the confines of the industry which makes them. It was natural, and indeed inevitable, that one of the productivity teams visiting the United States under the auspices of the Anglo-American Council on Productivity should be concerned with metal-working machine tools, and their report,* now published by the British Productivity Council, which has succeeded the Anglo-American Council, should be of wide general interest. This is particularly the case because the team—the terms of reference of which were, broadly, to study American methods and judge whether they could with advantage be adopted in Great Britain—have made recommendations which involve criticism of the American machine-tool industry equally with the British and which, if acted upon, would have reactions affecting the majority of machine-tool users.

The main criticism is that both American and British machine tools are too expensive and that "in neither country is the productivity of the industry as high as it reasonably should be." Both countries, it is asserted, are in danger of losing a large proportion of their markets unless they can rapidly increase their productivity. These remarks are very different from those which have appeared in most of the Anglo-American Productivity reports. In most cases, the high productivity of American industry has been emphasised, and British manufacturers have been urged to adopt American shop methods, so far as the different conditions make it practicable to do so. The lavish provision of lifting and handling appliances is enlarged upon in many of the reports, but, in the present case, it is observed that "the economics of lifting equipment in some of the plants appeared to be of doubtful validity." British manufacturers are recommended, however, to use localised lifting appliances wherever these are justified. It is a little difficult to see why the conditions in machine-tool manufacture should be any different, in this respect, from those obtaining in other engineering shops. No such assertion is made in so many words, but the recommendations appear to support the inference.

The broad conclusion reached is that there are no outstanding differences between the American industry and the British. The best factories in America are considered to be no better than the best in Great Britain, and the range between best and worst is much the same in both countries; and both suffer from what are neatly described as "'feast and famine' oscillations." On the average, American productivity is higher, mainly because of a wider application of "the science of design for production," a more realistic approach to questions of accuracy and finish, better machinability of the steels and cast-irons used, and better servicing of the machine operatives. The American operative is said to work no harder than the British operative, but he gets a better standard of living for his efforts. This better standard is only partly justified by the slightly higher productivity of the industry; "in the main it is subsidised by those industries which have given America her prosperity."

This latter statement summarises the gravest charge brought against the American machine-tool industry, namely that it is a "must" industry and has been living on the rest of the country. The extent to which it has failed to increase its productivity and take full advantage of modern methods is illustrated by the statement that the price of household refrigerators, which was 500 dols. per unit in 1920, was 275 dols. in 1930, and only 100 dols. in 1940, whereas in 1920, the machine-tool price per unit was 2,000 dols., in 1930 it was 4,000 dols., and it stood at the same figure in 1940. The remarkable fall in the price of household refrigerators was undoubtedly due to an enormous increase in output, but the inference is that, if the machine-tool industry had improved its productivity methods and lowered its prices, it also might have achieved a greatly-increased output.

The proportion of the report that is devoted to export business is relatively small, but its importance is not to be measured only on a space basis. It is observed that the export trade of the American machine-tool industry is modest compared with the total output; and that "the industry is now exporting, almost exclusively, machines developed for certain operation's either highly productive or highly specialised, for which there is a fair demand at present in the U.S.," and for which, "elsewhere, the demand for them is such that no other country can afford to develop or manufacture them." This has a familiar ring; for several years, since the war, British industry has been urged to concentrate on producing articles for export (not only machine tools) so distinctive that other countries will admit them on favourable terms rather than go to the trouble of manufacturing equally good articles themselves. After all, the Swiss engineering industry has been built up largely on that basis,

* *Metalworking Machine Tools. Report of a Productivity Team representing the British Machine Tool Industry which visited the United States of America in* 1951. *British Productivity Council,* 21, *Tothill-street, London, S.W.*1. [Price 3*s.* 6*d.* post free.]

so why not the British? The report adds that "America has practically ceased to export general-purpose machines, particularly of the lighter types, because of the high U.S. prices compared with the prices of competitors of other countries"; though, surely, this is a question of international exchange at least as much as it is a question of the quality of the goods. The report points out that the American industry normally exports only about 15 to 20 per cent. of its output, whereas the British machine-tool manufacturers have been exporting as much as 40 to 45 per cent. of theirs. If, therefore, any substantial proportion of British or American export trade in machine tools is lost to Continental makers, the effect is bound to be more serious to the British manufacturers than to the American.

On this point, it may be remarked that, to judge by the numbers of American machine tools to be seen in British workshops at the present time, the American export trade must be of very considerable dimensions, even though it represents a much smaller proportion of the total output; against which may be marshalled the undeniable contention that every good product—whether machine tool or not—which goes overseas is a standing advertisement of unknown potentialities. This view, however, may require qualification, for, in any country that has trouble with its foreign exchange—which seems to be true of most countries at the present time—the factors which ultimately sway the direction and amount of the individual purchaser's capital disbursement are first cost and date of delivery. A machine that is, say, 10 or 20 per cent. more efficient than another will not be ordered if delivery takes three or four times as long as would be needed to obtain one of more ordinary type. It may be recalled that a certain make of American typewriter achieved remarkable sales in Britain during the 1914-18 war, not because it was so much better than any other, but because it was not so highly regarded as others in the years preceding the war; therefore, the agents had stocks in hand from which they could give immediate delivery when almost every competitor had a long waiting list. There seems to be rather more than a possibility that the sales of some machine tools have been affected by similar factors from time to time. In short, production cost and efficiency are not the only considerations which influence sales.

The comments in the report which are likely to excite the most vigorous controversy are those suggesting that too much attention is devoted to unnecessary accuracy and to "spit and polish," that drawing-office practice is too elaborate, that makers make too many different types, and that the future of the British machine-tool industry can only be assured if a large proportion of the firms engaged in it can be persuaded to sink their individualities and combine in a general assault upon the available markets. There appears to be almost unanimity among the component firms in the British industry in opposing these opinions. Admittedly, the course suggested has been followed in at least one other branch of British engineering, with marked benefit from the point of view of productivity; but the Miltonic principle that it is "better to reign in Hell than serve in Heaven" appears to be so deeply ingrained in the British character that we cannot visualise the machine-tool industry voluntarily reorganising itself along such lines. A certain amount of rationalisation—the avoidance, in other words, of completely irrational competition—may be accepted; but to suggest that the industry as a whole should sacrifice its multiple individuality merely as a means of cutting costs is a proposal that could only emanate from those who do not appreciate fully the solid worth of an honoured name in the markets of the world, as an indication of just that avoidance of "sameness" which such a scheme must inevitably tend to suppress.

THE STATUTORY DUTY OF AN EMPLOYER.

Although actions for damages for injuries sustained by workmen have become rarer since the passing of the Industrial Injuries Act some years ago, they have by no means come to an end; the kind of case in which a workman makes a claim based upon an alleged breach of a statutory regulation, made pursuant to the Factory Acts, is of frequent occurrence. It is a general rule that, when a contract of service is entered into, the common law infers that the servant takes upon himself the ordinary risks incident to such business as is lawfully carried on upon his master's premises. This, however, does not apply with regard to an absolute statutory duty imposed on the master, for in such cases the master remains personally responsible. Thus, where there is a statutory duty to fence certain machinery, the master is personally responsible not only if the foreman employed by him for the purpose fails, in the first instance, to put in the necessary fencing, but also if he neglects to maintain it. As a corollary to this rule, it may be mentioned that, if there has been a breach of, say, the duty to fence, and as a result there is an accident, negligence on the part of the employer is presumed.

An example is the case of *Lay* v. *D. & L. Studios, Ltd.* (1944) 1 All E.R. 322, which related to a chain mortising machine. The machine was provided with a guard which was inaccurately adjusted so that $\frac{3}{8}$ in. of the cutter protruded beyond it. It transpired that the guard was in that position during the entire time that the plaintiff was working for the defendants, and that he was not instructed how to make an adjustment and did not, in fact, make any. While operating the machine he injured a finger, for which injury the employers were held liable. In the course of his judgment, Mr. Justice Singleton said: "I think it was the duty of the employees to see from time to time that the guard was properly adjusted, and if it was seen that there was an exposed place, it was then their duty to stop that system of work." It is not, however, the duty of the employer to stand by and see that every adjustment of a movable fence is made in the proper way and at the proper time. It will be assumed that the workman is endowed with a reasonable amount of intelligence and that (in effect) the employer "delegates" to his workman the duty to observe the statutory regulation.

Of this principle, an illustration is afforded by the case of *Smith* v. *Baveystock & Co. Ltd.* (1945) 1 All E.R. 278. There, too, a workman was injured by a circular saw. The guard was admitted to be one of a type which complied with the regulations, and was in good order; the accident was due to the improper adjustment of the guard by the plaintiff himself. It was contended on his behalf that the duty to fence the saw by proper adjustment of the guard was placed by the regulations on the defendants, the employers, and that, if they did leave the adjustment to the plaintiff, it remained their adjustment, for which they should take responsibility if, in consequence, the plaintiff suffered injury. But the Court of Appeal would not accept this. Being satisfied on the evidence that the employers had delegated their duty to the plaintiff, the Court held that the improper adjustment of the guard was his own act, for the consequences of which he could not recover damages.

The use of the word "delegated" should be noted. That there must be definite "delegation" by the employer appears from the case of *Vyner* v. *Waldenberg Bros. Ltd.* (1945) 2 All E.R. 547. In that case, a guard on a circular saw had been habitually kept at a height of $3\frac{1}{2}$ in., which was a breach of the safety regulations. The plaintiff, who was injured while using the machine, had been in the defendant's employment for many years as a wood carver, but was not a skilled circular-saw operator. He had never been taught how to set and adjust the guard. It was held by the Court of Appeal that, if there is a definite breach of the safety provision imposed on the occupier of a factory and a workman is injured, the onus of proof is on the employer to show that the breach was not the cause. Further, it was held that nothing short of definite delegation of authority and duty in regard to maintenance, to a person qualified and instructed, can absolve the occupier of the factory from his duties under the regulations.

This does not mean, however, that the employer must tell his workman in so many words that he is delegating the statutory duty to him. It is obvious that, in the first case mentioned above, *Lay* v. *D. & L. Studios, Ltd.*, there was an implied delegation. The question of what constitutes delegation again came before the Courts in a recent case *Manwarring* v. *Billington* (1952) 2 All E.R. 747, the plaintiff in which was employed by the defendant in building operations. He was instructed by the defendant not to ascend any ladder without putting sacking under it to prevent it slipping, and to lash the ladder at the top. The plaintiff erected a ladder with the assistance of another workman, who had been similarly instructed, and ascended it without placing sacking or lashing it. The ladder slipped and he sustained injuries. It was admitted that there was a breach of a regulation to the effect that every ladder should have a level and firm footing and be securely fixed, but the defendant contended, *inter alia*, that he had delegated that duty to the plaintiff, who was at fault in not carrying it out. The Court found that there was no delegation. It was held that a mere instruction to a workman as to the method of carrying out his duties did not constitute the delegation of a statutory duty relating to that matter: for there to be a "delegation," it must be made clear that such a duty is being delegated, and that it is not a mere instruction which is being given. This case is important as indicating the view of the Court of Appeal on the subject of delegation; but it is interesting for another reason. Though the Court came to the conclusion that there was a breach of the statutory duty, their Lordships held that there was evidence on which the judge who tried the case was entitled to find (as he did) that the sole cause of the accident was the negligence of the plaintiff himself, and that the employers were not liable.

NOTES.

THE INDUSTRIAL USE OF ATOMIC ENERGY

In a lecture which he delivered recently before the Institution of Electrical Engineers (see page 84, *ante*), Sir John Cockcroft touched briefly on the possible use of atomic reactors for power production. In reply to a question by Mr. H. Hughes in the House of Commons on Monday, January 26, the Minister of Supply (Mr. Duncan Sandys) amplified this information by stating that the problem had been studied in the light of the experience gained with the graphite piles at Harwell and Windscale, and the results obtained with the heavy-water reactor at Chalk River, Ontario, had been discussed with the Canadian experts. The most certain method of generating power from atomic energy would be to build an improved type of uranium reactor, enclosed in a pressure cylinder. The heat produced in this reactor would then be transferred by gas under pressure through a heat exchanger to a conventional electric-power generator. Plutonium would be obtained as a by-product and could be used as fuel for further reactors. The potentialities of such a reactor were being actively studied and, if the prospects were favourable, the construction of an experimental atomic power station would be considered. At the same time, the development of breeder-reactors would be undertaken and would include the construction of a small experimental model at Harwell and the design of a full-scale unit at Harwell and Risley. The latter would be capable of producing substantial amounts of electricity and a suitable site for its construction was being sought. It was, however, too early to say how soon electricity generated from atomic energy would be available on a significant scale for industrial purposes; and it should not be imagined that, in the near future, nuclear reactors would supersede existing methods of producing electric power. The Minister added that it was not proposed to undertake work on the application of nuclear energy to ship propulsion until more experience had been gained with stationary plants.

THE INSTITUTION OF MECHANICAL ENGINEERS.

At the meeting of the Institution of Mechanical Engineers held on Friday, January 23, the 1953 James Watt International Medal was presented to Sir Harry Ricardo, F.R.S., by Mr. A Roebuck, a vice-president of the Institution, who took the chair at the meeting. Mr. Roebuck said that the Council had awarded the Medal to Sir Harry Ricardo in recognition of his contributions to knowledge of the fundamental principles of internal-combustion engines and the application of those principles to design and development. The citation was read by Dr. R. W. Bailey, F.R.S., chairman of the Watt Medal Committee. Sir Harry Ricardo said, in reply, that the award of the Watt Medal marked the summit of any mechanical engineer's ambition. He had really done no more than follow the path pointed out to him, nearly 50 years ago, by Professor Hopkinson, who had impressed upon him that the future of road transport, then in its infancy, and of aviation, as yet unborn, would lie with the light high-speed internal-combustion engine. It was Professor Hopkinson, in those early days, who had suggested that the cure for knock should be sought in the form of the combustion chamber and in the composition of the fuel. At the opening of the meeting, members stood in silence for a moment as a token of respect to the late Brigadier-General Magnus Mowat who, as recorded on page 148, died on January 20. The paper presented at the meeting is reprinted, in abridged form, on page 149.

THE SHIPBUILDING RETURNS.

The quarterly shipbuilding returns published by Lloyd's Register of Shipping, for the three months ended December 31, 1952, show that 336 steamers and motorships were under construction in Great Britain and Northern Ireland at the end of the year. Their aggregate gross tonnage was 2,146,402, an increase of 83,920 as compared with the previous quarter. Of the total, ships under construction for registration or sale abroad numbered 96, amounting to 671,843 tons and representing 31·3 per cent. of the total tonnage building in the country. Thirty-three of the 96 ships are for Norwegian owners. During the quarter, work began on 63 new ships, 66 were launched, 66 were completed, and work was suspended on four—the tonnage of which, however, was almost negligibly small, as the four ships together represented only 1,019 tons. Oil tankers building in Great Britain and Northern Ireland numbered 103, of 1,214,864 tons, or 56 per cent. of the total under construction in the country. Vessels building abroad at the end of 1952 numbered 843 and had a total gross tonnage of 3,972,183, which was 169,792 tons more than at the end of September, 1952; these totals, of course, are exclusive of whatever ships may be in hand in the yards of Russia, Poland and China, from which countries no figures have been available for a number of years. New ships on which work was begun in overseas yards during the quarter numbered 225, of 1,059,716 tons; 239 ships, of 1,016,002 tons, were launched; and 237, of 859,456 tons, were completed. Work was suspended on 39 ships, of 61,111 tons. Summarising these totals, it is seen that vessels building throughout the world numbered 1,179 steamers and motorships, of 6,118,585 tons, of which total 35·1 per cent. was being built in Great Britain and Northern Ireland. Oil tankers of 1,000 tons gross or more amounted to 274 ships, of 3,277,115 tons; 117, totalling 1,646,213 tons, were steamers and 157, of 1,630,902 tons, were motorships. The increase in tanker tonnage under construction, compared with the figure at the end of September, was 350,141 tons; and, between the same dates, the total of tanker tonnage building, in relation to the total of all tonnage, rose from 49·9 to 53·6 per cent. The ships being built in the world at the end of 1952 included 28 steamships and 72 motorships of between 6,000 and 8,000 tons each; 34 steamers and 33 motorships of between 8,000 and 10,000 tons; 69 steamers and 118 motorships of between 10,000 and 15,000 tons; 36 steamers and 14 motorships of between 15,000 and 20,000 tons; and 22 steamers and three motorships of between 20,000 and 30,000 tons. Of the total under construction in Great Britain and Northern Ireland, 974,621 tons were steam-driven and 1,171,781 tons were motorships; the corresponding totals abroad were 1,829,458 tons and 2,142,725 tons, respectively. Of the world total, 3,846,907 tons (or 62·9 per cent.) were being constructed under the inspection of Lloyd's Register (including those to be classed according to the rules of the British Corporation Register, now amalgamated with Lloyd's Register). In Great Britain and Northern Ireland, 2,048,994 tons (or 95·5 per cent.) is intended for Lloyd's classification; and, of the tonnage building abroad, 1,797,913 tons, or 45·3 per cent.

INSTITUTE OF WELDING.

The annual dinner of the Institute of Welding was held at the Holborn Restaurant, London, on Wednesday, January 28, the President (Mr. A. R. Jenkins) being in the chair. Proposing the toast of "The Institute of Welding," Sir Christopher Hinton, Deputy Controller of Atomic Energy (Production), Ministry of Supply, said that his department owed a great debt to the welding industry. The chemical plant associated with the production of fissile material became highly radioactive and, once the plant was started, maintenance and repairs were difficult. One leaky joint might put out of service plant worth 500,000*l*., so that, absolute reliability was essential; that the welding industry had provided. As recently as ten years ago the demand that had been made on the industry would have been considered unreasonable, and 25 years ago they would have been thought impossible. Perhaps the greatest achievement of the Institute had been that they had trained mechanical and structural engineers to use welding intelligently and to modify their designs to comply with non-traditional techniques. Welding engineers had, however, now reached a position when they could afford to be self-critical and they should ask themselves whether too many new ideas were not coming from abroad. The President, in reply, said that the Institute had devised a scheme for giving better service to members by improving the publication of information. They were also taking preliminary steps towards obtaining a Royal Charter. He agreed that the Institute should play an increasing part in teaching the proper use of welding and in this matter they could learn a great deal from the three leading engineering institutions. The toast of "British Welding and the British Welding Research Association" was proposed by the Master Cutler, Sir Harold West, and was acknowledged by Sir Charles Lillicrap.

INSTITUTION OF ELECTRICAL ENGINEERS BENEVOLENT FUND.

It has been the practice for some years for the President of the Institution of Electrical Engineers to issue an appeal to members for their support of the Institution's benevolent fund. The level of prosperity of its electrical industry remained high in 1952, and therefore it is not satisfactory, as Colonel B. H. Leeson, the President, points out in his appeal, that the total subscriptions and donations to the fund should have decreased. For the year ended June 30, 1951, the total was 13,057*l*.; for the corresponding period ended June 30, 1952, it was 11,245*l*. This decline is attributed, in the President's appeal, to increases in death duties and to high taxation. Its effect is accentuated by the fact that rising prices have depreciated the value of the sums received. The overall effect has been that expenditure in the years exceeded income by 2,511*l*., though the average sum distributed per beneficiary was only 75*l*.; in present-day conditions, such a sum will not go very far in relieving some of the cases of serious distress which are brought to the notice of the Court of Governors of the fund. The membership of the Institution is large and is continually increasing. Two-thirds of the members do not subscribe to the fund. It is pointed out that, if the individuals making up this majority would contribute 5*s*. each per annum, the income would be increased by over 6,000*l*.

THE INSTITUTE OF REFRIGERATION.

Speaking at the dinner of the Institute of Refrigeration, held at the Savoy Hotel, London, on January 28, Sir Ben Lockspeiser, F.R.S., secretary of the Department of Scientific and Industrial Research, said that scientific knowledge and practice did not descend on firms like manna from heaven; it could only be generated from within. There was no substitute for the employment by industry of scientists, engineers and technicians who knew what industry should be aiming at to keep abreast of the latest developments. In the board rooms of firms, he suggested, there should be an occasional move round, leaving one or two chairs for those who knew what was going on in the scientific world. He had been told recently by an industrialist that 40 per cent. of the net profits of his firm in 1951 had come from products which were unknown in 1938. The success of the aircraft industry was not a matter of chance and there was no reason why other industries should not achieve a similar supremacy. Referring to the D.S.I.R.'s biological refrigeration research unit, Sir Ben suggested that the Institute might co-operate in this work, both financially and by providing men from the industry. It would be a great step forward, by which the industry would benefit in the same way that the fire insurance companies benefited from the help they gave to the work of the Fire Research Station. Young men from the industry could spend part of their time at the biological refrigeration research unit. Lord Dudley Gordon, D.S.O., proposing the toast of "Science and Industry" to which Sir Ben replied, said that the practice of refrigeration was not confined to food applications, since there was the problem of removing heat due to the friction of aircraft flying at very high speeds in rarefied atmosphere. He suggested, in another connection, that there was a regrettable tendency in engineering specifications to stipulate materials of construction when it would be better to state what the materials, were required to do, leaving the designer to find those most suitable. The chair at the dinner was taken by Sir Charles G. Darwin, F.R.S., President, who referred to the work of the National College of Heating, Ventilating, Refrigeration and Fan Engineering. He suggested that the College was in rather cramped quarters. It would be better if it were allowed to expand; not only physically, but also in the scope of its studies. Work on liquid helium was not, perhaps, of immediate significance to industry, but the time was not far distant when the work should be continued outside the universities. The principal guest at the dinner was to have been Major the Rt. Hon. Gwilym Lloyd George, Minister of Food, but he was prevented from attending by Parliamentary business. His speech was read by Mr. I. Graul, of the Ministry.

MR. RHYS JENKINS.

It is with deep regret that we learned, as this issue was being closed for press, of the death on January 27 of Mr. Rhys Jenkins, M.I.Mech.E., a former senior examiner at the Patent Office and one of the original members of the Newcomen Society for the Study of the History of Engineering and Technology, of which he was President in 1924-25. Mr. Jenkins, who was in his 93rd year, was an outstanding historian of engineering and allied subjects, and collaborated with the late Dr. H. W. Dickinson in writing the James Watt memorial volume, *James Watt and the Steam Engine*. We hope to publish a more extended notice of his life and work in our next issue.

LETTERS TO THE EDITOR.

FIRES IN PASSENGER LINERS.

TO THE EDITOR OF ENGINEERING.

SIR,—The loss of the Empress of Canada by fire in the Gladstone Dock, Liverpool, once more raises the questions: What causes these fires, and what can be done about them? One of the likely causes of a fire in such circumstances arises from the practice of using acetylene welding for repairs and alterations within the ship's structure. Firing of the acetylene cylinder is easily caused if a back-fire occurs at the torch or burner. If the acetylene hose is accidentally perforated through rough usage, the escaping gas is readily ignited and the flame will then travel back to the cylinder. Experienced welders know how to deal with this, provided that the cylinder is in the open; but, if the accident should occur inside the accommodation, the natural tendency is to run from the danger of imminent explosion due to spontaneous combustion of the acetylene in the cylinder. For this reason, a regulation might well be made that no oxy-acetylene plant should be used in a confined space on board passenger vessels. Fires have occurred on ships where welding and burning are employed externally, due to inside woodwork, etc., becoming ignited by the molten metal thrown off. If the target is 100 per cent. safety, acetylene welding should be prohibited in any passenger liner and the necessary repairs and alterations should be made with electric welding, or the aid of pneumatic tools, etc.

Why do fires in passenger liners spread so quickly through the accommodation? Experience has shown that even a small fire in an enclosed space without free ventilation quickly raises the temperature in adjoining cabins and alleyways, where the woodwork becomes hot and dry before the fire reaches it. This, in my opinion, accounts for fires spreading so rapidly that the position becomes hopeless before the fire-fighters have time to tackle the outbreak

Yours faithfully,
CHARLES L. STOKOE.

Monitor Works,
King's-road,
Wallsend-on-Tyne.
January 27, 1953.

COAL STOCKS.

TO THE EDITOR OF ENGINEERING.

SIR,—Is it not strange that, in spite of nationalisation, mechanisation, standardisation, statistical research, etc., etc., each winter there are complaints from customers who cannot get supplies of good household coal? Some interesting figures were given in *The Times* on January 23, in an article headed "Fuel Supplies Adequate," which had the subtitle "Customers Blamed for Failure to Stock." We are all customers, and I think everyone would agree that for a coal merchant to be without coal is as absurd, as for a grocer to be without sugar. Londoners, the article said, bought 273,000 tons less coal in the summer of 1952 than they did in 1951. That was, of course, very wrong of them; but if they bought 273,000 tons less, how does that account for some merchants' yards being empty in January? Then, again, we are told that the national stocks of house coal is now 1,172,000 tons. Does anyone think that satisfactory, seeing it works out at about half a cwt. per head of population? But the public is not told what the stock includes or where it is situated. One delightful sentence in the article said that "the coal merchants as a whole are not so lavishly manned and equipped that they can handle the spate of orders that starts when cold weather comes." There is nothing remarkable about a spate of orders in cold weather and surely it is the business of the Coal Board, the Ministry of Fuel and Power, and the merchants to be prepared for it. To blame customers for coal shortages is like blaming electors for the ground-nut scheme. It is only the authorities who can prevent these recurring crises, and I would respectfully suggest that, by next winter, the national stock of house coal should be raised to 2,000,000 tons, and that it should be stored at strategic points where it could easily be drawn upon. All relevant figures of customers, rations, supply and demand are known.

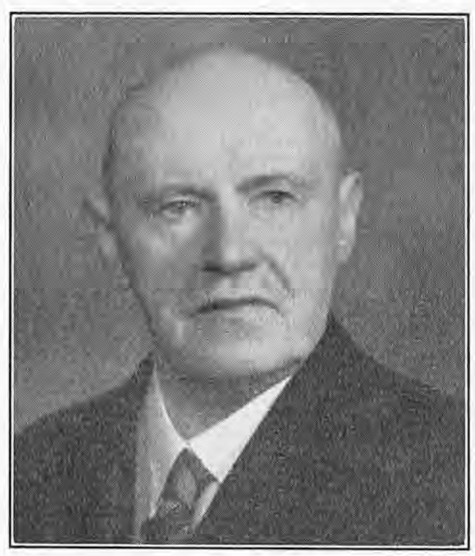
Yours faithfully,
EDGAR C. SMITH,
Eng.-Capt., R.N. (Retd.).

Keepers Corner,
Horley, Surrey.
January 24, 1953.

OBITUARY.

BRIGADIER-GENERAL MAGNUS MOWAT, C.B.E.

WHEN we received the news of the death, on January 19, of Brigadier-General Magnus Mowat, secretary *emeritus* of the Institution of Mechanical Engineers, our issue of January 23 was already being prepared for press and there was no opportunity to insert more than the short paragraph which appeared on page 116, *ante*. We append below an outline of his career, which, as will be seen, embraced a wide variety of engineering experience before, in 1920, he was appointed to the secretaryship of the Institution, which he held for 18 years.



THE LATE BRIGADIER-GENERAL MAGNUS MOWAT, C.B.E.

Magnus Mowat was born on November 10, 1875, and received his general education at Aberdeen grammar school, Blackheath School, and at King's College, London, where he obtained the diploma of Associate. In 1896, he commenced a pupilage in the locomotive shops of the North British Railway at Cowlairs, Edinburgh, under Mr. W. H. Holmes, the then locomotive superintendent. Early in 1898, however, he turned to civil engineering and was engaged on the construction of the Great Central Railway line between London and Leicester as resident engineer and assistant to Mr. Edward Parry, M.I.C.E. Towards the end of the following year, he joined the Indian Midland Railway as assistant engineer and, on January 1, 1900, took up his duties at Jhansi, in the North West Province, where he was in charge of the section of the main line, 118 miles in length, between Bina and Sonagir. The amalgamation of the Indian Midland system with that of the Great Indian Peninsular Railway led to his transfer to Gwalior as resident engineer at Agra, in charge of a section of some 120 miles; but in the same year, 1901, he returned home to take up an appointment with Messrs. Robert McAlpine and Sons, Limited, who had received the contract to construct the Partick section of the Glasgow main drainage scheme. He had been with them for only about a year when he obtained the post of chief assistant to Mr. F. E. Duckham, M.I.C.E., the engineer and general manager of the Millwall Dock Company, London, whom eventually he succeeded as engineer. After the formation of the Port of London Authority in 1909, and the consequent absorption of the Millwall company's property, he remained in charge of the Millwall docks, and the East and West India docks.

During the 1914-18 war, Mowat, who was a Territorial officer, served in the Royal Engineers; for two years in command of the Royal Engineers of a division, and afterwards in a number of staff appointments, as Commandant of the School of Heavy Bridging and Pontooning, and as Command Roads Officer at the War Office, where, at the close of the war, he was deputy chairman and administrative officer of the Joint Roads Committee. For these services he received the C.B.E. in 1919, and the honorary rank of Brigadier-General. In the following year, as mentioned above, he was appointed to succeed the late Mr. Edgar T. Worthington as secretary of the Institution of Mechanical Engineers, holding that position until, in 1938, ill-health obliged him to relinquish it. He had been a member of the Institution since 1905, and was previously an associate-member. He was also a member of the Institution of Civil Engineers and of the Institution of Engineers and Shipbuilders in Scotland, a Fellow of the Royal Society of Edinburgh, of King's College, London, of the American Society of Mechanical Engineers, and of the Chartered Institute of Secretaries. In the City of London, he was a liveryman of the Worshipful Company of Clockmakers.

As secretary, General Mowat accomplished with notable success the somewhat difficult feat of impressing his distinctive personality upon the organisation of the Institution while never losing sight of the fact that he was there in the service of each and every member, of whatever grade. Many there were who learned to seek his shrewd advice on matters which, as often as not, were personal rather than institutional. We recall one casual observation which well revealed his kindly nature: "I would rather," he declared, "trust ten men and be wrong once than distrust them and be wrong nine times." The remark may or may not have been original, but it was certainly typical of a character which inspired more than ordinary regret among his many friends that his recent years, under the shadow of continual ill-health, were in such contrast with his former vigour.

MR. H. PELHAM LEE.

WE regret to record, also, the death on January 22 of Mr. Horace Pelham Lee, M.I.Mech.E., one of the pioneers of the motor-car industry in this country and managing director of Coventry Climax Engines, Limited. Mr. Lee, who was born on April 19, 1877, was educated at private schools in Folkestone and Reading, and received his early training in engineering in the Electrical and General Engineering College at Earl's Court, London. He served his apprenticeship with Messrs. W. H. Allen, Sons and Company, Limited, at Bedford; though, of his four years as an apprentice, 18 months were spent with the Forces in the South African War. He returned to spend a further year with the firm as a draughtsman, and then went to the Daimler Company, at Coventry, in whose shops he worked for some 15 months. He then founded the firm of Lee, Stroyer and Company, at Coventry, to build petrol engines. One of his exceptional contracts was to engine the tractors built for Sir Ernest Shackleton's expedition to the South Pole, in 1914. He also supplied the engines for, among others, the Clyno, Horstmann and Waverley motor-cars. During the 1914-18 war, he constructed generating sets for searchlights, as well as shells and other munitions. The supply of small portable electric generating sets was also one of his principal activities during the second World War. Later, he established a new company, Coventry Simplex Engines, Limited, to which he afterwards added the business of Messrs. Johnson and Smith, Limited, also of Coventry. The firm was subsequently reconstituted as Coventry Climax Engines, Limited, whose affairs he continued to direct until his death.

DESIGN OF PRECISION GRINDING MACHINES.

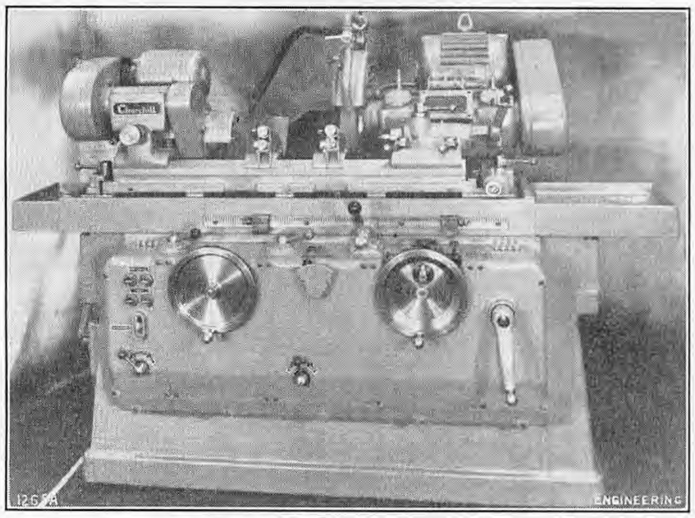


FIG. 1.

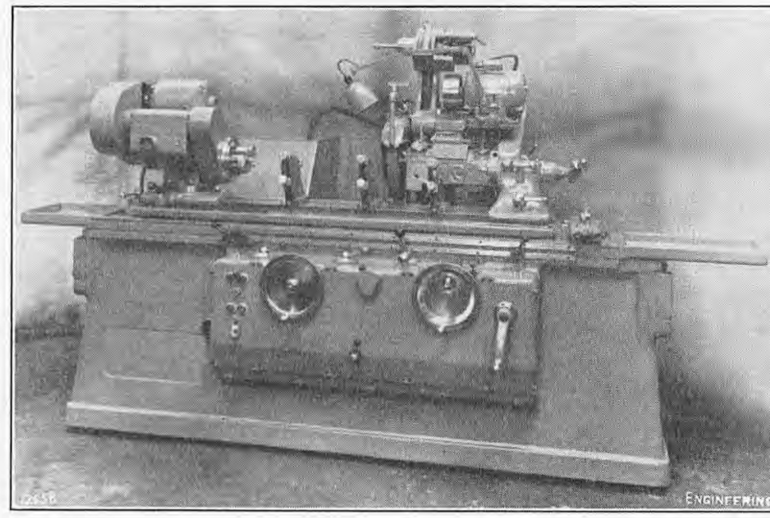


FIG. 2.

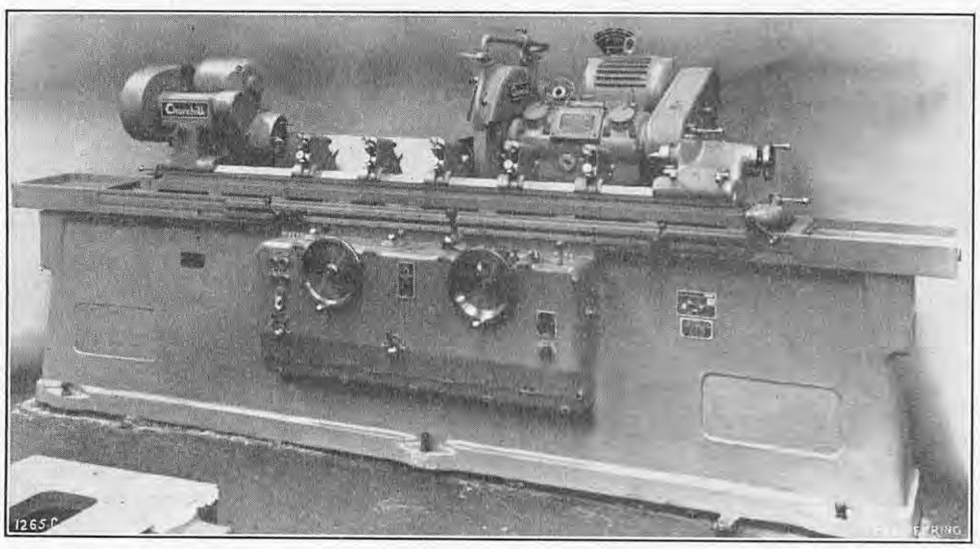


FIG. 3.

FIGS. 1 TO 3. THREE GRINDING MACHINES USING SAME MECHANISM.

DESIGN OF PRECISION GRINDING MACHINES.*

By G. H. ASBRIDGE.

As a preliminary introduction to any discussion on the design of grinding machines, account must be taken of certain factors which, while not actually a part of any design, have a bearing on design in general. The first and most important of these is cost. At every stage in design the ultimate cost must be constantly borne in mind, so that the new or redesigned machine will offer advantages to the customer in the form of greater productivity or work of better quality at an economic price. The direct effect of cost on the design of any machine or group of machines is to force the designer to standardisation of components, i.e., the use of a single mechanism for several different models, which permits interchangeability and allows the manufacturer to make greater numbers of any single part. An example of this is shown in Figs. 1 to 3.

A second factor is accessibility or ease of maintenance. This point must be taken into consideration early in the design because of the demand, over the last few years, that machines be improved in appearance, which has often been at the expense of accessibility. A third factor which cannot be disregarded is what I call "user-influence." It must be borne in mind that from the operating standpoint the user often knows much more than the machine designer and builder, and he is in a position to offer suggestions and make constructive criticisms which it would be foolish to ignore.

* Paper presented at a meeting of the Institution of Mechanical Engineers, in London, on Friday, January 23, 1953. Abridged.

ESSENTIAL ELEMENTS OF A GRINDING MACHINE.

There are many different types and sizes of precision grinding machines, but whatever the type there are certain elements which must be built into it, irrespective of type or size. These in order of importance are: rigidity, accuracy, and constancy.

Rigidity.—Rigidity is probably the most obvious, and most important, because without it, it is practically impossible to achieve the other two. For instance, a heavy roll-grinding machine, which has all its alignments in correct relations when standing unloaded upon its foundation, must be capable of carrying a roll of up to 50 tons or more in weight without its alignments being affected. Similarly, a large surface-grinding machine must be capable of carrying loads of up to 10 or 12 tons on the table without deformation. As the machine can produce work only as good as its own slides, any deformation of the body is reflected in the finished work.

These two examples may serve to emphasise the high degree of rigidity required. This rigidity is attained by ribbing, well laid out so that the load can be spread evenly over as large as possible an area of the machine and its foundation. This is particularly important where the load is moving from one end of a bed to another, as in a surface grinder.

Accuracy and Constancy.—Accuracy will be fairly obvious, but there may be doubt as to what is meant by constancy. It might be said that the obtaining of specified limits of accuracy with a grinding machine is a question for the shop floor. Though this is true, the retention of the limits over a period of years is a matter for the designer, because, should he not provide adequate, or sufficiently supported, bearing surfaces, any accuracy will be short lived, necessitating constant maintenance. This is true with reference to either reciprocating motion or to journal bearings, such as wheel-head or other bearings.

Constancy is perhaps best illustrated by another example. If a roll-grinding machine be imagined grinding a parallel roll of, say, 10 ft., or more face length, the carriage carrying the roll must traverse past the grinding wheel in a constant path, free from any deviation. This calls for accuracy of the sliding surfaces, but also for a number of other conditions, for instance, the lubrication of the sliding ways must be constant since any change in oil supply would alter the path taken by the roll; this, while immeasurable, will be perfectly obvious on a polished roll. Also, any slight variation in traverse speed will affect the lubricating film and so cause deviation. Similarly, with the work rotation, any change from a constant velocity in the work drive will affect the finished work. The wheel spindle too must be free from a tendency to oscillate in any direction.

While a roll-grinding machine was used as an example of this element of constancy, the remarks apply just as well to any type of machine, be it just a simple, plain grinding machine or an automatic cylindrical or internal grinder. In fact, in automatic machines it is important that cycle times be kept as constant as possible, since any variation leads to incorrect sizing. These three elements must be catered for in the design stage of any machine, and all three are dependent on one another, since without rigidity accuracy cannot be obtained, and the value of both is nullified if frequent variations of the motions are present.

Traverse Mechanisms.—Over the past 25 years or so, mechanical traverse has given way to hydraulic systems; now each system has its own fairly well-defined range of machines, mechanical traverse being confined only to the larger and heavier machines where the length between centres exceeds 12 or 14 ft. As these two systems are practically universal, the advantages the hydraulic system has over the gear traverse will now be considered.

Flexibility must be first; it has the ability to give a stepless variation in speed over a very wide range, and can be made to give a very "kind" traverse, being virtually shockless on the point of reversal. This latter point in itself is a great asset, as shock on reversal tends to upset the machine and so destroy the constancy, referred to earlier. Possibly, however, its greatest advantage is the ability to use the hydraulic system for other purposes, such as automatic wheel-head feeds and other auxiliary movements. There are, however, dis-

DESIGN OF PRECISION GRINDING MACHINES.

Fig. 4. GRINDING MACHINE HYDRAULIC SYSTEM.

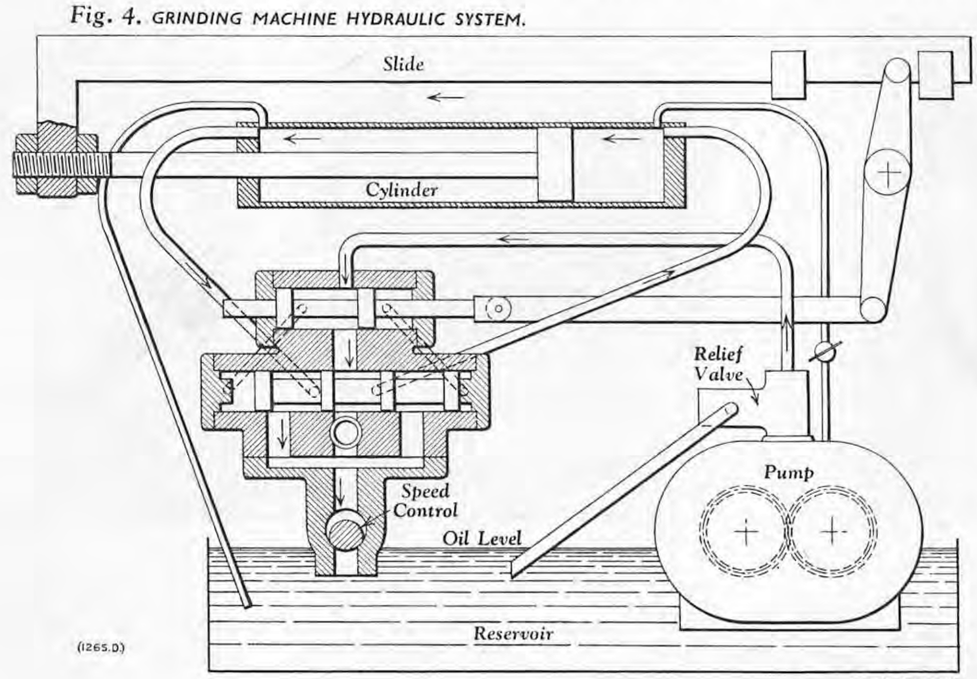


Fig. 5. "FILMATIC" WHEEL-SPINDLE BEARING.

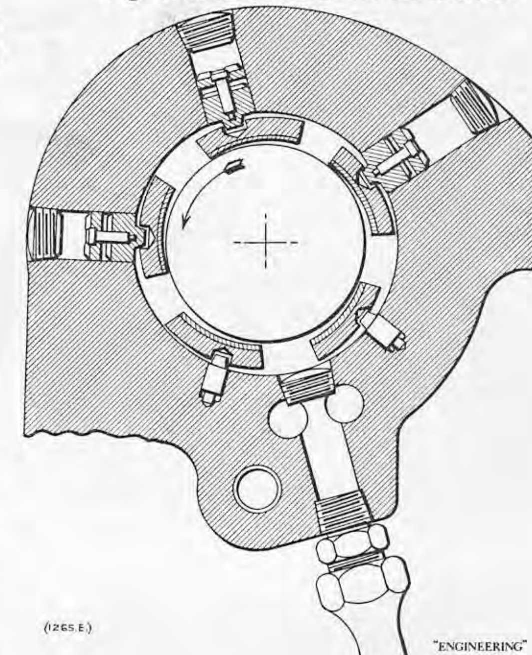
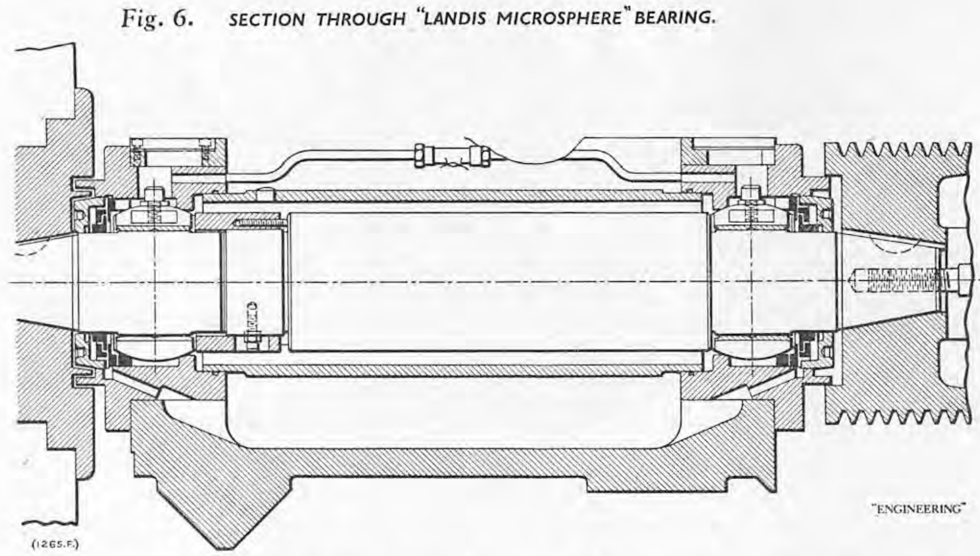


Fig. 6. SECTION THROUGH "LANDIS MICROSPHERE" BEARING.



advantages, the greatest of which is due to the fact that, although oil is supposed to be virtually incompressible, there is always present a certain amount of air, and, however fine the dispersion, it turns the oil into a very elastic means of transmission, which, unless a great deal of consideration has been given to the table lubrication, results in a "stick-slip" action which is very noticeable at slow speeds.

A further drawback is the heat generated; depending on the system in use, this could result in an oil temperature of anything from 70 to 140 deg. F., and there are machines, even modern ones, which incorporate fan-cooled oil-radiators to keep down the temperature. The chief disadvantage of this heat, apart from the fact that it is wasteful, is that the body of the machine, which usually incorporates the oil tank, is at a varying temperature, which destroys the initial accuracy and makes impossible the production of accurate work. Fortunately, the machines most affected are large surface grinders and, as these machines usually require considerable floor space, a separate tank can be arranged without materially increasing the space required. A hydraulic circuit can be made to do almost anything the designer has in mind, and a glance at the range of proprietary equipment available will show how complex the hydraulic system is becoming.

A typical hydraulic system, used solely for a table traverse with no auxiliary uses, is shown in Fig. 4. The circuit is a simple open one, and the exhaust oil is returned to the reservoir after use. Movement is by a conventional double-acting cylinder, which can be used direct, or through a doubling-up motion, to give double the stroke and at the same time keep the cylinder short and stiff. The reversing valve, which is of a piston type, is moved from one position to another by oil under pressure, admitted to each end of the valve by a pilot valve mechanically connected to the reverse lever. A common chamber collects the exhaust oil from both sides of the piston, in turn, and passes it through the speed-control valve, through a check valve—which is used solely to prevent the system from draining when the machines are at rest—and back to the reservoir. The pump is a simple gear pump, which, for systems such as this, cannot be bettered, as its few working parts give a long and trouble-free life. Starting and stopping are accomplished by throwing the circuit open and allowing the oil from the pump to pass freely back to the reservoir; this prevents the generation of heat which would be caused if all the oil was pumped through the relief valve while the table was at rest. This is a small but important point.

A fundamental rule for any designer of hydraulic systems is to endeavour to keep them as simple as possible, whatever the demands. Complications arise when more than one operation, such as table traverse and wheel-head feed, are attempted with one pump; in such circumstances the simple gear pump is justified, as gear pumps are readily nested together, and thus two or three simple circuits are obtained instead of one complicated circuit. Each circuit can be controlled by its own relief valve and so obtain the pressure which is best suited for the work it has to do.

To-day, hydraulic operation for table reciprocation and auxiliary movements is applied to practically every machine of small and medium capacity that is built. However, the last few years have seen improvements in mechanical transmissions, and developments are in hand which might conceivably make mechanical transmission more attractive than hydraulic transmission, even on small machines. For instance, the Norton tumbler gearbox, which is still in common use to-day, is giving place to a simple four-speed or five-speed constant-mesh gearbox coupled to a variable-speed motor, which arrangement can be designed to give a stepless variation in speed throughout the full range. The development of electronic control gear now makes possible a degree of retardation before the point of reversal and gradual acceleration up to speed after it.

To sum up future trends, it is possible that during the next few years, with the improvement which has, and is, taking place in electrical control gear, there may be a reversion to mechanical traverse mechanisms in view of their simplicity and reliability.

WHEEL-HEAD SPINDLES.

A grinding machine is as good as its wheel-head spindle bearings; should these be at fault in any detail high-quality work cannot be produced. No single component of the grinding machine has exercised the designer's mind more than the design of the wheel-spindle bearings. The suggested reasons for this are: the very exacting conditions of operation, and the decline in quality and skill of machine operators.

The first of these reasons will be fully appreciated when it is considered that for satisfactory work a spindle must run so that its axis has no movement whatever, either radial or longitudinal (this must be achieved with no loss of rigidity due to a too excessive oil film and yet no danger of seizure due to shortage of lubricant); it must be capable of running over long periods with no attention except for lubrication, and under very dirty conditions; and be able to stand the action of the cutting pressure of the wheel in one direction on one end of the spindle, and the belt pull in the reverse direction at the other end. The slightest failure to fulfil any of these conditions will affect the work produced.

The second reason is a very good example of what earlier was called "user influence." For instance, there are many conditions, apart from the wheel spindle, which will cause a grinding machine to give a chattered finish, but with the decline in quality and skill of operators these other causes are overlooked, and the wheel spindle is blamed. If this is provided with any easily accessible external bearing adjustment, that bearing is tightened up so that the running clearance is reduced below that necessary for adequate lubrication, and seizure results. This is put down as the fault of the machine manufacturer, when the true cause of seizure is maltreatment by an unskilled operator.

While all designers of grinding machines are endeavouring to produce a perfect wheel-head—perfect, that is, in that it will fulfil all the conditions set out previously—the present and future trends are along two distinct and separate lines of approach. The first is the use of bearings having self-adjusting or self-compensating characteristics, of which two examples are the Hydrauto bearing* and the Cincinnati Filmatic bearing, shown in Fig. 5. The Hydrauto bearing is a conventional bearing, but has the top cap loaded by a spring pressure through a piston; oil is fed on to the top of the piston through a non-return valve, and so provides a hydraulic lock which, while allowing the piston and bearing to travel down towards the spindle to keep the oil film at a minimum, does not allow the spindle to lift. The Cincinnati Filmatic bearing is a tilting-pad type of bearing, the spindle being surrounded by five longitudinal pads supported on studs through the cast-iron housing; the whole assembly is run completely immersed in oil at a slight pressure. The action of the bearing is that, as the spindle revolves, oil is dragged round with it and forced into the leading edge of the pads, which tilt and so grip the spindle. Both these constructions have been in use for a considerable number of years and have given satisfactory results.

The second line of approach is to use a bearing of conventional design and pay careful attention to the method of adjustment and the lubrication. The object of this type of construction is to obtain very precise adjustment of the bearing in a manner which cannot easily be tampered with, and which, in conjunction with good lubrication, can be relied upon to give several years' life before adjustment becomes necessary. A good example of this type of bearing is the Landis Microsphere bearing, shown in Fig. 6, which has a white-metal-lined split steel sleeve which is spherical in shape on its outside diameter, and is locked in its housing between two spherical faces, one of which has a micrometer adjustment for precise setting. The lubricant is pumped through the bearing directly by way of the annular space between the spindle and bearing. These are the two lines of approach which it is believed the wheel-head design will follow in the next few years.

Materials used for wheel-head spindles and bearings are very few in number, considering the large number of manufacturers. Nitralloy is used practically exclusively for wheel-head spindles because of its hardness, ease of machining, and freedom from distortion after final machining. Bearing materials are either a lead bronze of, generally, 18 to 22 per cent. lead content, or white-metal-lined steel or cast-iron bearings.

There is a point in connection with the effect of wheel speeds on grinding which will probably assume more importance in the future. It is a well known and accepted fact that the more rigid the wheel spindle the softer the wheel that has to be used, but there is a limit to this because, as grinding wheels get softer, so wheel wear increases. On certain classes of work the limit has already been reached, with the result that other means have to be adopted to obtain free-cutting properties with an economic wheel life. This has been achieved by reducing the speed of the wheel from the generally accepted speed of 5,000 to 6,000 to as low as 3,000 ft. per minute; and it may be that over the next few years wheel speeds for all external operations will be lower than in the past.

(To be continued.)

THE PROPAGATION OF FRACTURES IN MILD-STEEL PLATES: ERRATA.—Equation (24) of this article, on page 102, *ante*, contained an error: the two denominators dV should have been dr. Also, the numbered reference, to Mr. T. S. Robertson's paper, given in line 14 of the third column on page 101, should be 27.

* See ENGINEERING, vol. 160, page 493 (1945).

FORTHCOMING EXHIBITIONS AND CONFERENCES.

THIS list appears in the last issue of each month. Organisers are invited to send to the Editor particulars of forthcoming events.

THIRD NATIONAL POWER FARMING CONFERENCE.—Tuesday, Wednesday and Thursday, February 10, 11 and 12, at the Town Hall, Cheltenham. Held under the auspices of the *Power Farmer*, Dorset House, Stamford-street, London, S.E.1.

CONFERENCE ON STEAM ECONOMY IN INDUSTRY.—February 11 and 12. See page 141.

CONFERENCE ON HYDRAULIC SERVO-MECHANISMS.—Friday, February 13, Institution of Mechanical Engineers, Storey's-gate, London, S.W.1. See page 69, *ante*.

FIFTH ANNUAL PAKISTAN SCIENCE CONFERENCE.—Monday, February 16, to Saturday, February 21, at Lahore. Applications to be made to Dr. Bashir Ahmad, Pakistan Association for the Advancement of Science, The Mall, Lahore, Pakistan.

MODERN INVENTIONS AND NEW IDEAS EXHIBITION.—Wednesday, February 18, to Saturday, February 28, at the Central Hall, Westminster, London, S.W.1. Apply to Moorland Exhibition Enterprises, 69, Moorland-road, Weston-super-Mare.

MIDLANDS BUILDING TRADES EXHIBITION.—Wednesday, February 18, to Saturday, February 28, at Bingley Hall, Birmingham. Organised by Herbert Daniel Exhibitions, Ltd., 15, Dover-street, London, W.1. (Telephone: MAYfair 5846.)

FRANKFURT INTERNATIONAL SPRING FAIR.—Sunday, February 22, to Thursday, February 26, at Frankfurt. *Agents*: Lep Transport Ltd., Sunlight Wharf, Upper Thames-street, London, E.C.4. (Telephone: CENtral 5050.)

INDIAN RAILWAYS CENTENARY EXHIBITION.—Saturday, February 28, to Thursday, April 16, at Purana Quila, India. Additional particulars obtainable from the joint director, Indian Railways Centenary Exhibition, Ministry of Railways, New Delhi.

NORTH OF SCOTLAND HYDRO-ELECTRIC EXHIBITION.—March, at Perth. Arranged by the North of Scotland Hydro-Electric Board, 16, Rothesay-terrace, Edinburgh, 3. (Telephone: Central 1361.)

HANOVER FAIR.—*Light Industries Fair*: Sunday, March 1, to Thursday, March 5, at Hanover. *Heavy Industries Fair*: Sunday, April 26, to Tuesday, May 5, at Hanover, Germany. *Agents*: Schenkers, Ltd., 27, Chancery-lane, London, W.C.2. (Telephone: HOLborn 5595.)

"DAILY MAIL" IDEAL HOME EXHIBITION.—Tuesday, March 3, to Saturday, March 28, at Olympia, London, W.14. Organised by Associated Newspapers, Ltd., New Carmelite House, Carmelite-street, London, E.C.4. (Telephone: CENtral 6000.)

33RD INTERNATIONAL SPRING FAIR.—Sunday, March 15, to Sunday, March 22, at Vienna. Apply to the British-Austrian Chamber of Commerce, 29, Dorset-square, London, N.W.1. (Telephone: PADdington 7646.)

CONFERENCE ON DEEP DRAWING OF METALS AND CONTINUOUS CASTING OF INGOTS.—Monday and Tuesday, March 16 and 17, at the University of Birmingham. Apply to the secretary, Department of Industrial Metallurgy, The University, Edgbaston, Birmingham, 15.

ROYAL NETHERLANDS INDUSTRIES SPRING FAIR.—Tuesday, March 17, to Thursday, March 26, at Utrecht, Holland. *Agent*: Mr. W. Friedhoff, 10, Gloucester-place, London, W.1. (Telephone: WELbeck 9971.)

FRANKFURT INTERNATIONAL MOTOR SHOW.—Thursday, March 19, to Sunday, March 29, at Frankfurt-am-Main. Organised by the Versand der Deutschen Automobilindustrie, Westendstrasse, Frankfurt-am-Main.

FACTORY EQUIPMENT EXHIBITION.—Monday, March 23, to Friday, March 27, at the New Horticultural Hall, Greycoat and Elverton Streets, Westminster, London, S.W.1. Further particulars obtainable from Mr. J. E. Holdsworth, Exhibition Offices, 117, Kingsway, London, W.C.2. (Telephone: HOLborn 1414.)

CONFERENCE ON STATIC ELECTRIFICATION.—Wednesday, Thursday and Friday, March 25, 26 and 27, at Bedford College for Women, Regent's Park, London, N.W.1. Organised by the Institute of Physics. Applications should be addressed to the conference secretary, Mr. N. Clarke, Institute of Physics, 47, Belgrave-square, London, S.W.1. (Telephone: SLOane 9806.) See also our issue of December 12, 1952, page 751.

SECOND NATIONAL ELECTRICAL ENGINEERS' EXHIBITION.—Wednesday, March 25, to Saturday, March 28, at Earl's Court, London, S.W.5. Organised by the Association of Supervising Electrical Engineers. Apply to Mr. P. A. Thorogood, 35, Gibbs-green, Edgware, Middlesex. (Telephone: MILl Hill 3528.)

PHYSICAL SOCIETY'S EXHIBITION.—Monday, April 13, to Friday, April 17, at the Royal College of Science main building, Imperial Institute-road, and the Huxley Building, Exhibition-road, South Kensington, London, S.W.7. Organised by the Physical Society, 1, Lowther-gardens, London, S.W.7. (Telephone: KENsington 0048.)

RADIO COMPONENTS SHOW.—Tuesday, April 14, to Thursday, April 16, at Grosvenor House, Park-lane, London, W.1. Organised by the Radio and Electronic Component Manufacturers' Federation, 22, Surrey-street, Strand, London, W.C.2. (Telephone: TEMple Bar 6740.)

FIFTH EMPIRE MINING AND METALLURGICAL CONGRESS.—To be opened on Tuesday, April 21, at Melbourne. Closing date in May not yet fixed. Sessions will be held at centres in Australia and New Zealand. Apply to Miss B. E. Jacka, Australian Institute of Mining and Metallurgy, 399, Little Collins-street, Melbourne, C.I.

LIÉGE INTERNATIONAL FAIR.—Saturday, April 25, to Sunday, May 10, at Liége. Apply to the manager, Foire Internationale de Liége, 17, Boulevard d'Avroy, Liége, Belgium.

BRITISH INDUSTRIES FAIR.—Monday, April 27, to Friday, May 8, at Earl's Court, London, S.W.5, and Olympia, London, W.14; and Castle Bromwich, Birmingham. Particulars obtainable from the director, British Industries Fair, Board of Trade, Lacon House, Theobald's-road, London, W.C.1. (Telephone: CHAncery 4411); or the general manager, British Industries Fair, 95, New-street, Birmingham, 2. (Telephone: Midland 5021.)

ROYAL SANITARY INSTITUTE HEALTH CONGRESS.—Tuesday, April 28, to Friday, May 1, at Hastings. Particulars obtainable from the secretary, Royal Sanitary Institute, 90, Buckingham Palace-road, London, S.W.1. (Telephone: SLOane 5134.)

GLASS INDUSTRIES EXHIBITION.—Monday, May 11, to Saturday, May 16, in the New Horticultural Hall, Greycoat-street, London, S.W.1. Apply to Mr. G. F. E. Grimaldi, B. and C.D. Exhibitions, Ltd., 194-200, Bishopsgate, London, E.C.2. (Telephone: AVEnue 1444.)

CONFERENCE ON BRITTLE FRACTURE IN STEEL.—Friday, May 15. See page 158.

ROYAL ULSTER AGRICULTURAL SHOW.—Wednesday, May 27, to Saturday, May 30, at Balmoral Showgrounds, Belfast. Organised by the Royal Ulster Agricultural Society, The King's Hall, Balmoral, Belfast.

BATH AND WEST AGRICULTURAL SHOW.—Wednesday, June 3, to Saturday, June 6, at Bath. Organised by the Bath and West and Southern Counties Society, 3, Pierrepont-street, Bath. (Telephone: Bath 3010.)

BRITISH PLASTICS EXHIBITION.—Monday, June 8, to Thursday, June 18, at Olympia, London, W.14. Organised by *British Plastics*, Dorset House, Stamford-street, London, S.E.1. (Telephone: WATerloo 3333.) See also our issue of October 10, 1952, page 462.

BRITISH ELECTRICAL POWER CONVENTION EXHIBITION.—Monday, June 8, to Friday, June 12, at Torquay. Arranged by the British Electrical Development Association, 2, Savoy-hill, London, W.C.2. (Telephone: TEMple 9434.) See also page 115, *ante*.

THREE COUNTIES AGRICULTURAL SHOW.—Tuesday, June 9, to Thursday, June 11, at The Racecourse, Hereford. For further particulars, apply to the Three Counties Agricultural Society, Berrington House, 2, St. Nicholas-street, Hereford. (Telephone: Hereford 3969.)

BUSINESS EFFICIENCY EXHIBITION.—Tuesday, June 16, to Friday, June 26, at Olympia, London, W.14 Organised by the Office Appliance and Business Equipment Trades Association, 11-13, Dowgate-hill, Cannon-street, London, E.C.4. (Telephone: CENtral 7771-2.)

SAFETY AND FACTORY EFFICIENCY EXHIBITION.—Friday, June 19, to Friday, June 26, at Bingley Hall, Birmingham. Sponsored by the Birmingham Industrial Safety Group, 15, Old Town Close, Birmingham, 30. Further particulars obtainable from the exhibition secretary, Mr. A. G. Cogswell, Dunlop Rubber Co., Ltd., Fort Dunlop, Birmingham, 24. (Telephone: Erdington 2121.)

ROYAL HIGHLAND SHOW.—Tuesday, June 23, to Friday, June 26, at Alloa. Organised by the Royal Highland and Agricultural Society of Scotland, 8, Eglington-crescent, Edinburgh, 12. (Telephone: Central 6106.)

SECOND BRITISH INSTRUMENT INDUSTRIES' EXHIBITION.—Tuesday, June 30, to Saturday, July 11, at Olympia, London, W.14. Apply to F. W. Bridges & Sons, Ltd., Grand Buildings, Trafalgar-square, London, W.C.2. (Telephone: WHItehall 0568.)

ROYAL AGRICULTURAL SHOW.—Tuesday, July 7, to Friday, July 10, at Stanley Park, Blackpool. Organised by the Royal Agricultural Society of England, 16, Bedford-square, London, W.C.1. (Telephone: MUSeum 5905.)

GREAT YORKSHIRE AGRICULTURAL SHOW.—Tuesday, July 14, to Thursday, July 16, at Harrogate. Apply to the Yorkshire Agricultural Society, Cliftonfield, Shipton-road, York. (Telephone: York 3102.)

SEVENTH INTERNATIONAL CONGRESS OF RADIOLOGY.—Sunday, July 19, to Saturday, July 25, at Copenhagen. Further particulars obtainable from the secretary-general, Professor Flemming Nørgaard, Kommunehospitalet, Copenhagen, Denmark.

THIRD INTERNATIONAL CONFERENCE ON SOIL MECHANICS AND FOUNDATION ENGINEERING.—Sunday, August 16, to Tuesday, August 25, at Zürich and Lausanne. Apply to the secretary, Société Internationale de Mécanique des Sols et des Travaux de Fondations, Gloriastrasse 37, Zürich 44.

RADIO AND TELEVISION EXHIBITION.—Saturday, August 29, to Sunday, September 6, at Düsseldorf. *Agents:* John E. Buck and Co., 47, Brewer-street, London, W.1. (Telephone: GERrard 7576.)

NATIONAL RADIO SHOW.—Tuesday, September 1, to Saturday, September 12, at Earl's Court, London, S.W.5. Applications to the organisers, Radio Industries Council, 59, Russell-square, London, W.C.1. (Telephone: MUSeum 6901.)

19TH ENGINEERING, MARINE AND WELDING EXHIBITION AND CHEMICAL PLANT EXHIBITION.—Thursday, September 3, to Thursday, September 17, at Olympia, London, W.14. Apply to F. W. Bridges & Sons, Ltd., Grand Buildings, Trafalgar-square, London, W.C.2. (Telephone: WHItehall 0568.)

AMERICAN CHEMICAL SOCIETY: 124TH NATIONAL MEETING.—Sunday, September 6, to Friday, September 11, at Los Angeles, California. Apply to the secretary, American Chemical Society, 1155, 16th-street, Washington 6, D.C., U.S.A.

FOURTH ANGLO-AMERICAN AERONAUTICAL CONFERENCE.—Monday, September 14, to Thursday, September 17, in London. Communications to the secretary, Royal Aeronautical Society, 4, Hamilton-place, London, W.1. (Telephone: GROsvenor 3515.)

PUBLIC LIGHTING CONFERENCE AND EXHIBITION.—Tuesday, September 15, to Friday, September 18, at Liverpool. Arranged by the Association of Public Lighting Engineers, 22, Surrey-street, London, W.C.2. (Telephone: TEMple Bar 9607.)

EIGHTH NATIONAL INSTRUMENT EXHIBIT.—Monday, September 21, to Friday, September 25, at the Sherman Hotel, Chicago. Organised by the Instrument Society of America, 921, Ridge-avenue, Pittsburgh 12, Pennsylvania, U.S.A.

AMERICAN SOCIETY OF AUTOMOTIVE ENGINEERS: NATIONAL AERONAUTICAL MEETING, AIRCRAFT ENGINEERING DISPLAY AND AIRCRAFT PRODUCTION FORUM.—Wednesday, October 7, to Saturday, October 10, at Los Angeles, California. Apply to the secretary of the Society, 29, West 39th-street, New York 18, U.S.A.

ENGINEERING INDUSTRIES ASSOCIATION; LONDON REGIONAL DISPLAY.—Tuesday, Wednesday and Thursday, October 13, 14 and 15, at the Horticultural Hall, Vincent-square, London, S.W.1. Apply to the secretary of the Association, 9, Seymour-street, Portman-square, London, W.1. (Telephone: WELbeck 2241.)

INTERNATIONAL TEXTILE MACHINERY AND ACCESSORIES EXHIBITION.—Wednesday, October 14, to Saturday, October 24, at Belle Vue, Manchester. Organised by the Textile Recorder Machinery and Accessories Exhibitions, Ltd., Old Colony House, South King-street, Manchester, 2. (Telephone: Blackfriars 7234-6.)

INTERNATIONAL MOTOR SHOW.—Wednesday, October 21, to Saturday, October 31, at Earl's Court, London, S.W.5. Organised by the Society of Motor Manufacturers and Trades, Ltd., 148, Piccadilly, London, W.1. (Telephone: GROsvenor 4040.)

SCOTTISH MOTOR SHOW.—Friday, November 13, to Saturday, November 21, at Kelvin Hall, Glasgow. Apply to the Scottish Motor Trades Association, Ltd., 3, Palmerston-place, Edinburgh, 12. (Telephone: Central 3643.)

FUEL EFFICIENCY EXHIBITION.—Saturday, November 14, to Saturday, November 21, at the City Hall, Manchester. Applications to Provincial Exhibitions, Ltd., City Hall, Deansgate, Manchester (Telephone: Deansgate 6363); or to the London agent at 167, Oakhill-road, Putney, London, S.W.15. (Telephone: VANdyke 5635.)

CYCLE AND MOTOR CYCLE SHOW.—Saturday, November 14, to Saturday, November 21, at Earl's Court, London, S.W.5. Organised by the British Cycle and Motor Cycle Manufacturers' and Traders' Union, The Towers, Warwick-road, Coventry. (Telephone: Coventry 62511.)

BUILDING EXHIBITION.—Wednesday, November 18, to Wednesday, December 2, at Olympia, London, W.14. Apply to the organisers: Building Trades Exhibitions, Ltd., 4, Vernon-place, London, W.C.1. (Telephone: HOLborn 8146-8.)

SMITHFIELD SHOW AND AGRICULTURAL MACHINERY EXHIBITION.—Monday, December 7, to Friday, December 11, at Earl's Court, London, S.W.5. Details obtainable from the Smithfield Show Joint Committee, 148, Piccadilly, London, W.1. (Telephone: GROsvenor 4040.)

LABOUR NOTES.

FINAL arrangements were made by the Ministry of Labour and National Service on Monday last for the opening of a national inquiry into the spending habits of some twenty thousand British households, in all walks of life and in every part of the country. Officials of the Ministry began their task of calling on households, to invite the co-operation of the members in compiling up-to-date information, on the way in which the family incomes are spent on rent, fuel, food, clothes, fares, entertainment and insurance. Each member of the family will be asked to record, on a form provided by the Ministry, every penny which he or she spends and to state in detail on what it is spent. The Ministry hopes in this way to obtain particulars from a thoroughly representative cross-section of the British community, and will use the statistics thus secured as the basis for a new index for the recording of cost-of-living changes. The inquiry will continue throughout the year.

Educational trends and the prestige accorded to craftsmanship in recent years are discussed at some length in the January issue of *Federation News*, the official journal of the General Federation of Trade Unions. After stating that one of the most urgent requirements of the country is for the maintenance of good relations between all those who employ and those who are employed, the editor affirms that the present economic situation is not healthy. The treatment needed to ensure a quick return to healthy conditions depends upon a correct psychological approach to the nation's wants. Too often the economic problem is considered only from the point of self-interest. Modern education and its resulting psychological tendencies appear to have been used contrary to the real requirements of a densely-populated country like Britain. In Victorian times, education was in the direction of training for industrial craftsmanship. Those possessing technical skill were then regarded socially as being the salt of the earth, but, to speak of craftsmanship and skill, has been for some decades to introduce an unpopular topic.

There are encouraging signs of a change, however. Craftsmen and those possessing operative skill have been called upon to supplement their industrial standards by acquiring greater technical knowledge. As illustrations of this, the editor quotes from the speech of the Duke of Edinburgh at the annual meeting of the City and Guilds of London Institute, on November 3, and from the presidential address of Colonel B. H. Leeson to the Institution of Electrical Engineers on October 9. He states that the management committee of the Federation have repeatedly stressed the importance to the nation of combining technical education with practical training in craftsmanship, and have urged, moreover, that technical study should be continued when the period of apprenticeship is passed.

The *Federation News* recognises that many difficulties must be faced, but considers that, by the exercise of good sense, they can be overcome. The British public should become as interested and proud of urging the acquisition of skill and practical training as parents were in the Victorian era. There were many then, who, by dint of tremendous personal sacrifice over a period of seven years gained for their boys the advantage of being taught a trade. It was all the better in their eyes if the trade was one that would win for their sons a ready welcome in any part of the world to which they chose to go and where they could earn a good living. That was the pioneer approach and it was worthy of emulation to-day, when there was such a rapid extension of industrialism, even in backward areas. Industrial workpeople should take a wider view of life than the mere production of something useful.

Action to stabilise the value of the pound, both at home and overseas, is advocated by Lord Aldenham, chairman of the Westminster Bank, Limited, in his annual statement to shareholders, issued on Tuesday last. The remedy, he suggests, to overcome the dangers of rising wages and prices, is to make the whole nation appreciate that continuous advances in paper-money wages can give only an illusion of prosperity. Such advances are, in fact, worse than ineffective unless they are accompanied by a more than corresponding increase in production. In this connection, he recalls that the General Council of the Trades Union Congress has shown that it is well aware of the dangers of an inflationary spiral in wages and prices.

If the whole community, as consumers, stood fast against any sectional gains at their expense, Lord Aldenham considers, wages would quickly reach a stable level, measured in terms of production, and everyone knew how much that was needed. Stability of wages would go far to provide stability in the cost of living. For all too long, the public, as consumers, have been the "odd man out"; employers and employed have been able to postpone industrial strife by the simple expedient of agreeing to new wage levels and, thereby, adding to selling prices at the expense of the consumers. In the nationalised industries, he concludes, the two sides certainly do not seem to have been any better able to resist the temptation to get together, at the expense of consumers, than has private industry.

Hints to the National Coal Board that the working of voluntary shifts on Saturdays will come to an end when the present agreement expires on April 30, unless the miners' wage claim is conceded, were given last Tuesday at a special delegate conference in London of the National Union of Mineworkers. After much discussion, the men's representatives instructed the union's national executive committee to approach the Board for further discussions on the union's revised claims for an extra shilling a shift (equal to 6*s*. a week) for all day-wage men employed in the pits, "in the light of an undertaking by the committee to recommend the continuation of the extended hours' agreement for a further twelve months." This resolution was carried on a card vote by 478,000 to 219,000. Representatives from the Derbyshire coalfield abstained from voting.

The same resolution, it may be noted, instructed the union's national executive committee to discuss with the National Coal Board methods which have been under consideration by the union for improving co-operation and efficiency in the mines. These proposals, it was explained after the conference, had been brought to the notice of the Board during the recent wage negotiations. The union realised that there was room for improvement, but considered that the faults were not all on the men's side and suggested that inquiries into these matters, and the search for remedies, should be conducted at colliery or coalfield level.

An interesting proposal put forward last week by the executive committee that the Government should be approached to bring pressure to bear on the Board, to improve their wage-increase offers to the union, was generally condemned by the delegates. As Sir William Lawther, the union's President, put it subsequently, the delegates were of the opinion that the Board was running "our industry" and that they should deal with the miners' problems. Last week the Board varied their earlier offer of an extra 1*s*. a shift for the 150,000 day-wage miners on the minimum rate, which had been rejected by the union. Instead, they offered an extra 8*d*. a shift for all men in the industry employed on day rates. On the recommendation of the executive committee, the special delegate conference rejected this offer also.

Average wage rates during 1952 kept pace with the rising level of retail prices. According to statistics published yesterday by the Ministry of Labour and National Service, both rose by about 6 per cent. Approximately four-fifths of the increase in retail prices last year was due to rises in the price of food, which, in turn, were mainly the result of reductions in food subsidies. Nearly 11,500,000 persons received wage increases during the year, and these amounted to about 4,500,000*l*. a week, or an average of 8*s*. a week each.

WHISKY-BLENDING AND BOTTLING WAREHOUSE.

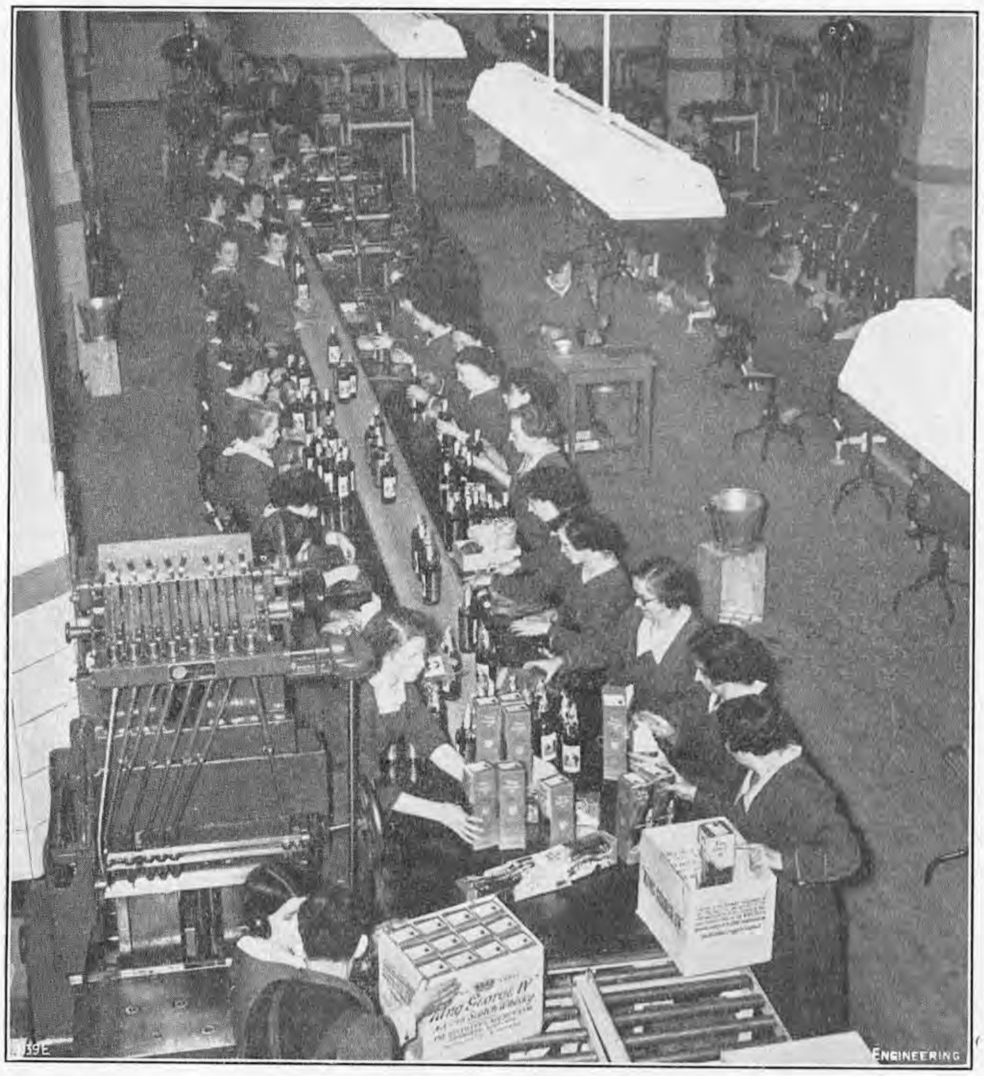


FIG. 1. GENERAL VIEW OF BOTTLING HALL.

BLENDING AND BOTTLING PLANT FOR WHISKY.

THE large whisky-blending and bottling warehouse of the Distillers Agency, Limited, 4, Torphichen-street, Edinburgh, 3, which was officially opened at South Queensferry by the Earl of Rosebery last October, contains a number of interesting machines and equipment. The buildings replace others destroyed by fire at the same site on April 29, 1949, but have three times their capacity. Constructed of reinforced concrete and brick, and built on a commanding site, they dominate the old town and afford fine views of the Firth of Forth and the Forth Bridge. The design of the buildings, including the layout of the interior, was undertaken by the engineering department of the Distillers Company, Limited, 64, Waterloo-street, Glasgow, and their erection was carried out by Messrs. Melville, Dundas and Whitson, Limited, 21, Blythswood-square, Glasgow, in conjunction with Messrs. Considère Constructions, Limited, 72, Victoria-street, London, S.W.1, who were employed as consultants on the reinforced-concrete work. Work on the premises began on March 1, 1950, and the main building was practically complete two years later, 1,100 tons of steel, 4,500 tons of cement and 2,500,000 bricks being used in its construction. It is in two sections, that to the east comprising a ground floor and three upper floors, chiefly used for the storage of empty bottles and bottling materials; the western section is a five-storey building, the ground floor containing the bottling hall shown in Fig. 1.

BOTTLE-WASHING PLANT.

On the ground floor of the eastern section there is a bottle store and a bottle-washing plant, the latter consisting of six washing machines, each having a washing capacity of 200 dozen returned bottles per hour. The machines were supplied by the British Miller Hydro Company, Limited, Buckingham-avenue, Trading Estate, Slough, and are of some interest. A typical example is illustrated in Fig. 3, on page 154. The washing involves not only the cleansing and sterilising of the bottles, but also the detachment of the labels and their removal from the detergent solution.

The sequence of operations is as follows. The bottles are first given a preliminary rinse, lasting 30 seconds, in water at 85 deg. F., and this is followed by a first washing in detergent solution at 130 deg. F. This lasts for two minutes, and is followed by a second washing of the same duration in a similar solution at 155 deg. F. Rinsing in water at 145 deg. F. for 40 seconds is the next operation, and is succeeded by drying for one minute by jets of filtered air heated to a temperature of 240 deg. F. by means of steam coils. Afterwards, the bottles are cooled before they pass out of the machine.

In loading the machine, the bottles are placed neck downwards in holders fixed in a double row on an endless conveyor-chain, and have sufficient time to drain before they receive their preliminary rinse. They are also allowed to drain after the washing is completed and before they are finally dried by the hot-air jets. In the rinsing process, the interior of each bottle is sprayed with $1\frac{1}{4}$ gallons of water, and, in the subsequent washing, by 15 gallons of detergent solution, the jets being so directed that every portion of the interior is cleansed. At the same time, approximately 14 gallons of detergent solution are sprayed on to the exterior of the bottle to cleanse it and remove the labels. In the subsequent hot rinse, the quantities of water discharged into and on to each bottle are $3\frac{1}{2}$ gallons and 3 gallons, respectively. The whole process last 6 minutes 10 seconds, and 350 bottles are under treatment simultaneously. Each machine uses approximately 540 gallons of water per hour and requires 340 lb. of steam at 50 lb. per square inch gauge pressure to heat the various liquid baths and the air needed for drying purposes In the same period the machine consumes 10 units of electricity.

The main frame of the machine is $\frac{1}{4}$ in. boiler-plate, welded electrically and suitably braced. The various tanks are divided horizontally into upper and lower sections by a central plate of steel. The lower section in each case is a reservoir containing the steam coils which heat the liquid, and other coils of steel through which the rinsing water passes and is warmed. The upper part is the washing section, and this is fitted with fountain wheels, illustrated diagrammatically in Fig. 2, which are self-cleaning. The wheels are connected to the reservoirs by headers and are fed by centrifugal pumps. To conserve the water, the wheels in the rinsing compartments are designed so that only those jets over which there are bottles are spraying water.

In the washing compartment where the labels and dirt are removed from the bottles, the detergent solution is filtered by means of a rotating perforated metal drum which is cleansed continuously by sprays. The latter wash the labels from the drum into perforated baskets, the holes in which have the same diameter as the washing jets. So as to ensure, however, that no foreign matter finds its way into the jets, the liquid has to pass through a second filter, having very fine perforations, before it returns to the reservoir.

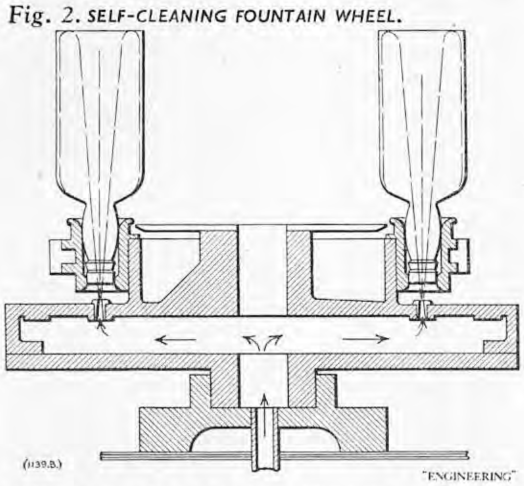
The detergent solution is mainly caustic soda in water at a concentration of 2 per cent. by weight. Besides cleansing the bottles, this also preserves the steelwork and lubricates the endless chain on which the bottle-holders are mounted. The chain and holders are made of high-grade malleable iron and are linked by hardened and ground steel pins and hardened bushes. The holders are rubber-lined to ensure that the bottles will not be scratched or otherwise damaged. The chain follows a sinuous path round a series of sprocket wheels which form the upper parts of the fountain wheels, the holders on the two sides of the chain being located alternately in successive sprockets. This location serves to fix each bottle relatively to the jet below, which travels round in step with the bottle. It also serves to drive those fountain wheels which are idlers, and to drive the chain from those which are power driven. The only adjustment required is to the tension of the chain and this is accomplished outside the machine by means of spring-loaded arms. The washing compartments are illuminated and fitted with glass windows so that the washing process may be viewed from outside. The various temperatures are controlled thermostatically and spent steam is returned to the boiler condensate tank. Each machine is 22 ft. long, 7 ft. 3 in. wide, and 6 ft. 2 in. high, and weighs 11 tons 6 cwt. when empty and, when loaded, 13 tons 3 cwt.

WATER-DEMINERALISING PLANT.

Also on the ground floor of the building is a water-demineralising plant supplied by the Permutit Company, Limited, Permutit House, Gunnersbury-avenue, London, W.4. This plant is illustrated in Fig. 4, and makes possible the use of natural water instead of distilled water when reducing the whisky. Water equivalent to distilled water is essential as a diluent, since the mineral salts present in mormal water are precipitated after admixture of the latter with whisky. The plant supplied produces the equivalent of distilled water by an ion-exchange process in the cold. The principal components are two cylinders which operate in series, the first controlling a bed of cation-exchange material and the second a similar bed of anion-exchange material. When the water passes through the former an exchange of cations takes place, resulting in the metallic cations being replaced by hydrogen and the salts being converted into their corresponding acids, chiefly carbonic, sulphuric and hydrochloric. In the second cylinder, the acid constituents are absorbed by the anion-exchange material, except for the silica and free carbon-dioxide. The water leaving the second

WHISKY-BLENDING AND BOTTLING WAREHOUSE.

Fig. 2. SELF-CLEANING FOUNTAIN WHEEL.



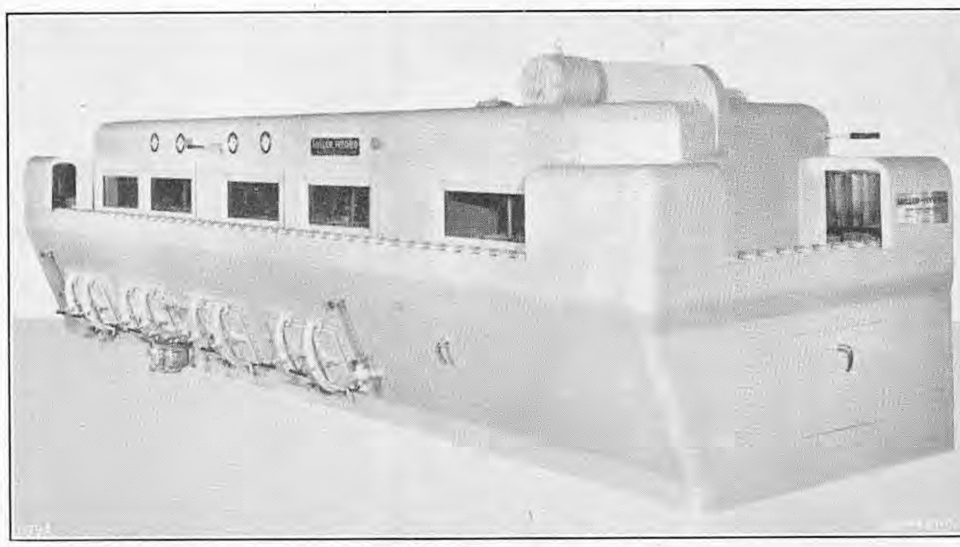


FIG. 3. BOTTLE-WASHING MACHINE.

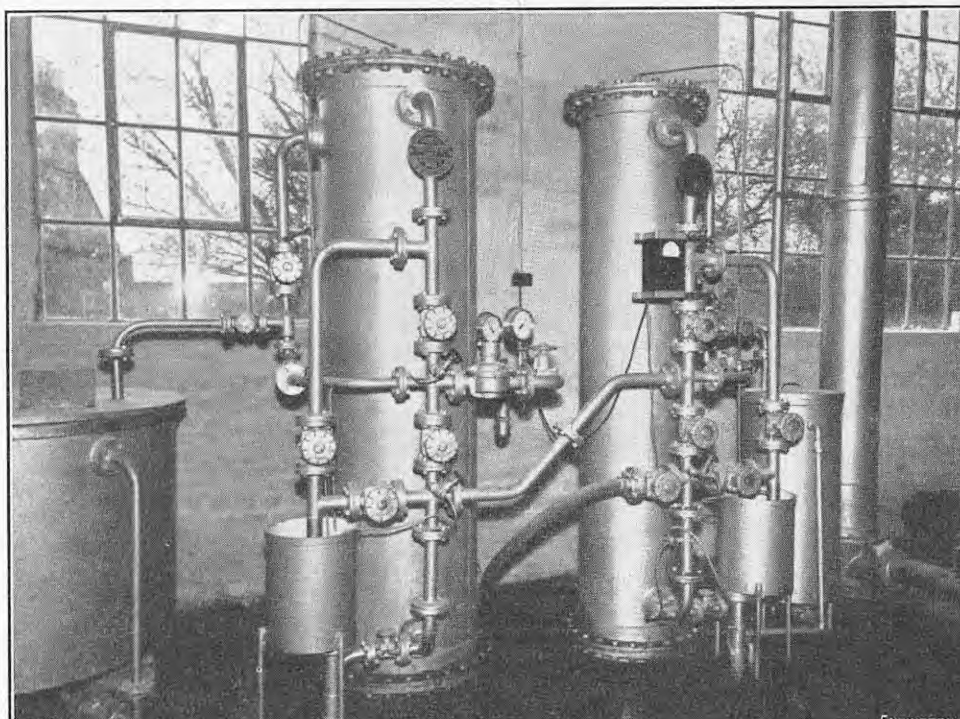


FIG. 4. WATER-DEMINERALISING PLANT.

cylinder contains a small residue of sodium salts, all the silica originally present, and carbon-dioxide equivalent to that contained initially in the bi-carbonates present. The carbon dioxide, except for a very small residue, is removed by passing the water through a scrubber in which the scrubbing agent is air, and the remaining trace is neutralised by the addition of a small quantity of caustic soda. The materials in the cylinders are regenerated periodically *in situ* by passing a weak solution of sulphuric acid through the first cylinder and another, containing sodium carbonate, through the second, residual traces of the solutions being removed by washing with water. The demineralised water is stored in two glass-enamelled tanks supplied by the Enamelled Metal Products Corporation (1933), Limited, Durie Foundry, Leven, Fife. These tanks, which are arranged horizontally, have each a capacity of 3,000 gallons and are 7 ft. 6 in. in diameter and 12 ft. 4 in. long.

CONVEYORS.

The first floor of the same section of the building houses the case-assembly plant, where timber from Sweden and other Scandinavian countries, purchased in shook form, ready for nailing, is printed and nailed by machines supplied by Messrs. Matthew Wylie and Company, Limited, 71, Milnpark-street, Glasgow, S.1. The equipment includes a two-colour wood-printing machine with automatic feed, which can accommodate boards up to 24 in. wide and 42 in. long, and from $\frac{3}{16}$ in. to $1\frac{1}{4}$ in. thick, and several nailing machines, an example of which, installed in the bottling hall, is visible in the left foreground of Fig. 1. The finished boxes are delivered to the bottling hall by travelling belt and gravity conveyors manufactured by the Paterson Hughes Engineering Company, Limited, Wyndford Works, Lochburn-road, Maryhill, Glasgow, N.W., who have designed and installed a number of conveyors in the warehouse, one being illustrated in Fig. 5. In the present instance, there are two belt conveyors, each 18 in. wide, one being 39 ft. long and the other 88 ft. long. These run side by side and convey the newly-made boxes, and other containers from the stores, through the customs door into the bonded section of the warehouse and thence on two belt conveyors each 92 ft. long to a further series of roller conveyors and chutes. The conveyors are driven by electric motors, through gear-boxes and chain drives. The belts, which are of canvas and rubber, travel at 60 ft. per minute. Cased timber is stored on the second floor of the building, and the third floor provides office accommodation and space for the storage of bottling materials.

At the loading bank in the warehouse a short gravity-operated roller-conveyor is installed to receive crates, cases and shooks of timber, and to deliver them to an inclined slatted conveyor which passes from the ground floor, through the first and second floors, to the third floor. This conveyor is illustrated in Fig. 5. Materials can be delivered to any one of the three upper floors or from these to a lower floor, since the conveyor is reversible. The floor openings through which the conveyor passes are enclosed and fitted with hinged doors. The framework of the slatted conveyor is mild steel and is horizontal at the delivery and receiving ends. It incorporates the tracks for the conveyor which is constructed from two roller chains fitted with steel slats. The conveyor is 86 ft. long and is driven by a 5-h.p. squirrel-cage motor acting through an enclosed worm-gear. A solenoid-operated brake is fitted which prevents run-back. The chain speed is 50 ft. per minute and the conveyor has a capacity of 600 cases or crates per hour in either direction.

The western part of the building, a five-storey block, is the "In Bond" or "Duty Free" portion of the warehouse and is under the control of H.M. Customs and Excise. It has storage capacity for 800,000 gallons and 30,000 cases of whisky, and its blending capacity is approximately 30,000 gallons per week. Bottling can be done at the rate of 15,000 dozen bottles a week. The ground floor accommodates the bottling hall, illustrated in Fig. 1, in which there are six complete bottling units for all sizes of bottles. There are seven bottling vats, all of mild steel and glass-lined, which were supplied by the Enamelled Metal Products Corporation. Six of these vats, which are of the vertical type and enamelled with British Pfaudler glass, have each a capacity of 4,500 gallons and are 9 ft. 6 in. in diameter. The seventh vat, with a capacity of 2,200 gallons, has a smaller diameter. All have the same overall height, namely, 11 ft. 10 in., and are fitted with perforated copper coils for air-rousing of the contents.

BOTTLING MACHINES.

The washed bottles are brought on conveyors to the bottling machines, three of which may be seen in the background of Fig. 1. One of the machines is shown in Fig. 6. They were supplied by the Albro Fillers and Engineering Company, Limited, Wharf-road, Ponders End, Middlesex. Three of the machines are fully automatic and accommodate ten bottles simultaneously. The remaining three accommodate nine bottles, and are semi-automatic. Before entering the reservoir of a bottling machine, the whisky passes through a filter. There are six of these, supplied by John C. Carlson, Limited, Newman-street, Ashton-under-Lyne. The filtering material is asbestos in the form of sheets 40 cm. square, and the filter plates are lacquered aluminium-alloy. Five of the filters have 30 plates and are used for normal bottling; the sixth is a six-plate filter employed in the filling of miniature bottles. Each filter is fitted with a self-priming pump, driven by an electric motor mounted beneath the filter in its supporting frame, and is equipped with the necessary valves and pressure gauge.

WHISKY BLENDING AND BOTTLING WAREHOUSE.

FIG. 5. CONVEYOR FOR BOTTLE CASES.

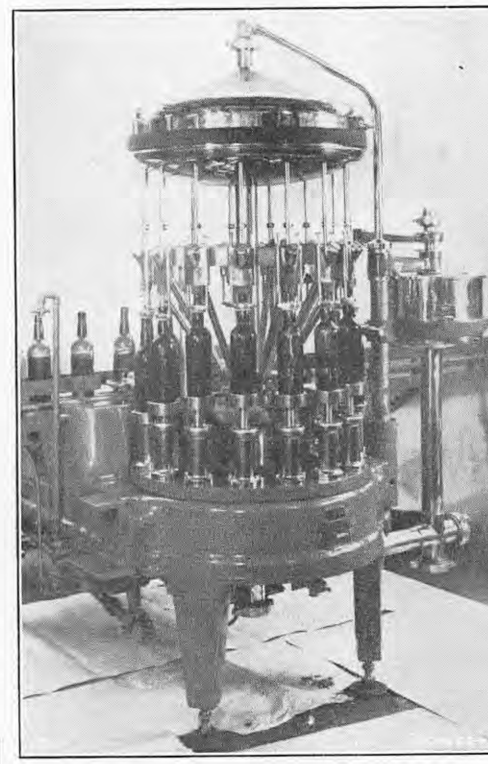


FIG. 6. BOTTLING MACHINE.

The bottle-filling process involves the raising of each bottle against a seal, the evacuation of the air from it and a simultaneous filling of the bottle with whisky. These operations proceed automatically, the bottles being held in a rotating circular carriage. Evacuation of the air into a large reservoir at the top of the machine results in the whisky being drawn up from a lower reservoir which is maintained at a constant level. It then passes into the bottle through a tube concentric with the air-extraction tube. The bottles are raised by air pressure from below and are lowered by gravity following release of this pressure after they have completed the circuit of the machine. They are then fully charged. After leaving a bottling machine each bottle is conveyed along a bottling table to be closed and packed. The tables in use were designed and manufactured by Messrs. Nealis Harrison, Limited, John-street, Hull, and were supplied by Messrs. J. and J. Dunn, Limited, 50, Wellington-street, Glasgow, C.2. They are equipped with a motor-driven conveyor belt which carries the bottles along a central strip of the table, as shown in Fig. 1. The belt is supported on a solid base and is driven by the motor through a reduction gear and a multiple V-belt drive so that the speed can be set at any desired value. On its return, the belt is supported on rollers fitted with ball bearings.

The first operation is the closure of each bottle by means of a lever-type cap applied by a capping machine. Caps and machines were supplied by Kork-N-Seal, Limited, 8, Leicester-street, London, W.C.2. The cap is fitted with a composition-cork gasket around which is a tinfoil wrapping backed with waxed paper, the tinfoil being in contact with the contents of the bottle. The tinfoil is coated to obviate corrosion, and is 99·5 per cent. pure tin, a small percentage of silver being added to improve the ductility. The machines apply pressure to the top of the cap sufficient to compress the gasket and to permit the lever's being thrown over mechanically into the locked position without strain. The bottle is thereby hermetically sealed. The contents of each bottle are later examined by holding the bottle in front of an illuminated ground-glass screen, following which a metal-foil capsule is applied over the closure. Two types of capsule machines are employed for this purpose. Four semi-automatic bench-type machines were supplied by Ideal Capsules, Limited, Edinburgh-avenue, Slough, the capacity of each being approximately 300 dozen bottles per hour. The capsule is applied automatically by the action of a rubber cup which is pressed round the neck of the bottle when the latter is pushed into the machine. The pressure is applied "hydraulically," the working fluid being castor oil and the pressure being generated by a pump driven by a $\frac{1}{2}$-h.p. motor. The other capsuling machines in use were supplied by Messrs. Betts and Company, Limited, Holloway Mills, Elthorne-road, London, N.19. These work on a similar principle to those described above. The hydraulic pressure may be set at any value up to 750 lb. per square inch, and the speed of action is 120 working strokes per minute. Each machine is driven by a $\frac{1}{3}$-h.p. motor.

BOTTLE-LABELLING MACHINES.

After being fitted with capsules, the bottles are labelled by machines supplied by the Purdy Machinery Company, Limited, Euston Buildings, Gower-street, London, N.W.1. These machines are of the type illustrated in Fig. 7. The bottle to be labelled is placed by hand in a cradle and the label to be applied, which is that at the bottom of a wad of labels in a hopper at the top of the machine, is brought down upon the bottle by the action of two metal plates known as "pickers," which have just previously been gummed by contact with a roller supplied with gum from a gum-box. A grip-finger, shown in a raised position in the illustration, then descends on the centre of the label and holds it fast to the bottle while the pickers withdraw laterally and downwards. This action causes the gummed label to spring round the bottle and its attachment is completed by the action of two rubber wipers which "iron" the edges of the label outwards. Each machine is motor-driven and controlled by means of a pedal switch. Thirty or more bottles a minute can be labelled by a single operator working one machine.

Subsequent operations include the affixing by hand of a label over the cap of each bottle when the whisky is destined for overseas, which, indeed, is the case with most of the whisky bottled at the warehouse. The bottles are then placed in cartons and packed in cases, the lids of which are nailed by the machine seen in the foreground of Fig. 1. The cases are strapped subsequently by wiring-machines of two types, namely, hand-operated machines supplied by Gerrard Industries, Limited, Harlequin-avenue, Brentford, and power-operated automatic machines supplied by Messrs. F. A. Power and Sons, Limited, Birmingham; one of the latter type is shown in Fig. 8. The machine is capable of operating at a speed of up to 24 wire ties per minute. The wire may be placed in any position, and its tension may be set at any desired value. No adjustment of the machine is necessary when the boxes or cartons are not of uniform size; the operator has merely to pass the package through the tying ring of the machine and press a pedal switch. Wire of any gauge between 14 and 18 may be used, and the binding and sealing processes are automatic. The machine is motor-driven and automatically lubricated.

At the western end of the bottling hall is the cased-goods storage-compartment, which is separated from the bottling-hall by a wire mesh screen. On the first floor of the same section of the warehouse is the assembly compartment where casks are set up and gauged by the excise officer before their contents are run into bottling vats below. The opened casks are rolled over a trough in the floor which communicates with the vats. Apart from this, the floor is used for the storage of blended whisky in casks and bottled whisky. The vatting compartment is on the second floor. There are five vats, four of which are of pine wood and were built by Messrs. W. P. Lowrie and Company, Limited, 44, Washington-street, Glasgow, C.3. Three of these have a capacity of 12,000 gallons each, but the fourth is only half this size. The fifth vessel, supplied by the Enamelled Metal Products Corporation, is glass-enamelled and similar to those installed by this firm in the bottling hall, which have already received mention. Its capacity is 1,690 gallons and it is used in racking operations on whisky destined for export. "Racking" implies transferring blended whisky from storage casks into special casks for export, and the object in using the vat is to obtain a consignment of uniform strength. Each vat is fitted with two automatic fillers which shut off the flow to a cask as soon as the latter is full. The remainder of the second floor is used solely for the storage of blended whisky, and the third floor is used for the same purpose.

The top floor, which is all in bond, runs the entire length of the building. A central compartment is used to assemble individual whiskies arriving from the distilleries prior to their vatting and blending. It is the practice at the warehouse to consign malt whiskies and grain whiskies, intended for blending, to separate vats, and the vattings are then left for three to six months to allow the component whiskies to "marry" properly. After the completion of the process, the vatted malt-whisky is blended with the vatted grain-whisky, and the blend is left for a further six weeks before being bottled. While the whiskies are in the vats they are mixed or roused by air for a period of approximately two hours. The remainder of the top floor is used for the storage of whisky in casks. The whiskies are transferred from the casks to the blending vats in the same manner

WHISKY-BLENDING AND BOTTLING WAREHOUSE.

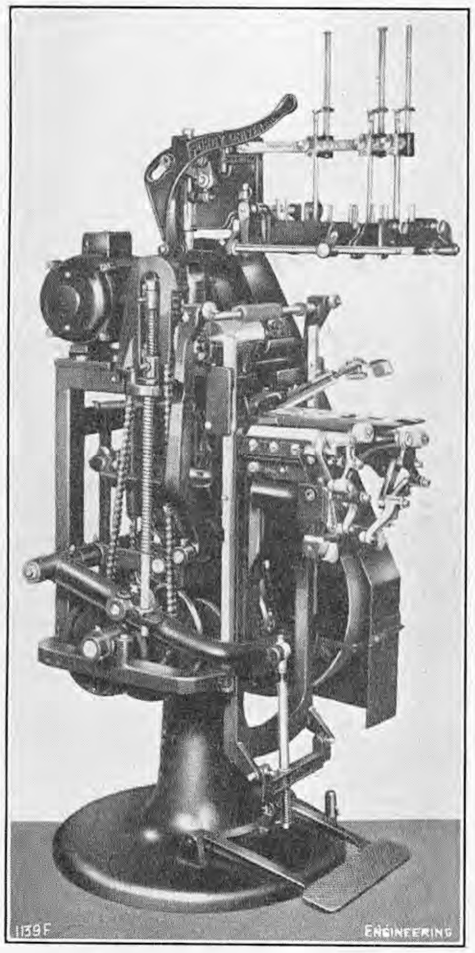


FIG. 7. BOTTLE-LABELLING MACHINE.

FIG. 8. CASE-WIRING MACHINE.

as already described in the case of the bottling vats. Copper pipes convey the whisky and air to the vats.

Provision has also been made for pumping whisky up to the vats from a receiving tank in a separate single-storey receipts warehouse. Use of this facility will in future save time and labour at present expended in lifting incoming casks to the top floor of the main building and returning empty casks. Casks of whiskies from the distilleries, unloaded at the receipts warehouse, will be set up for gauging by the excise officer and will be disgorged into a trough communicating with a glass-enamelled tank. The latter, which was also supplied by the Enamelled Metal Products Corporation, is disposed horizontally and has a capacity of 4,000 gallons. It is 8 ft. in diameter and has an overall length of 14 ft. 6 in. The pump has a capacity of 12,000 gallons per hour and the head is 60 ft. When the pumping has been completed, any whisky remaining in the pipes will be blown out by compressed air, the process involving cleaning the 4-in. diameter main pipe by blowing the residue into a pipe of small diameter running parallel to the other. All the pipes are of copper.

The empty casks are rolled from the receipts warehouse to a cask store, situated immediately behind the latter, where they are examined by coopers who determine whether or not repairs are necessary. The cask store is a two-storey building and contains a hoist in the form of a vertical endless conveyor fitted with cradles which carry empty casks down for coopering or bring coopered casks up for loading and despatch to the distilleries. Joiner's and engineer's shops adjoin the upper floor of the cask store, with a garage beneath them, and, nearby, is the workers' canteen. The total staff, when the warehouse comes into full operation, is expected to number about 250, but most of the labour will be obtained locally, the plant being almost the sole industrial undertaking in South Queensferry. To the west of the canteen is a duty-paid store.

On the west boundary of the property is a case factory and saw mill. These escaped the fire and have never ceased operation; but since the new building has its own case-making facilities, the older premises will be superfluous. They will, however, continue to supply cases to associate companies, a duty for which they are well fitted since they are equipped with machinery for manufacturing almost any type of case. The cooperage is on a separate site near the main gate. It contains machinery for repairing and re-making casks, but is not intended as a factory for supplying new casks.

BOILER-HOUSE.

The boiler-house, which adjoins the case factory, will eventually contain two vertical boilers to be supplied by Messrs. Cochran and Company, Annan. Each will be capable of delivering over 6,000 lb. of steam per hour. At present, one of the boilers has been installed. It is of multi-tubular design, being 9 ft. in diameter and 19 ft. high. The grate area is 48 sq. ft. and the heating surface 1,250 sq. ft. The working pressure is 100 lb. per square inch. The boiler has an easy steaming rate of 6,030 lb. per hour from feed water at 50 deg. F., and a heavy steaming rate of 8,000 lb. per hour when burning good quality steam coal having a calorific value of 12,500 B.Th.U. per lb. Two hopper-type stokers are fitted. They were supplied by Prior Stokers, Limited, 1-3, Brandon-road, York-way, London, N.7. Each has a maximum fuel throughput of 1,500 lb. per hour and is driven by a 4-h.p. motor through a five-speed and neutral gearbox. There are, besides, a thermally-operated feed-pump regulator and various control and safety devices. The present boiler is capable of meeting all the heating requirements of the warehouse.

The main building is steam-heated by Torridair heaters supplied by the British Trane Company, Limited, Vectair House, Clerkenwell-close, London, E.C.1. These use steam at a pressure of 40 lb. per square inch and each heater has a fresh-air intake. Extractor fans supplied by Messrs. Woods of Colchester, Braiswick Works, Colchester, provide a continuous change of air in the bottling hall to clear away vapour from the machines. The cooperage, cask stores and offices are heated by Univectair and Vectair heaters, also supplied by the British Trane Company. In the canteen, steam calorifiers supply hot water, and hot-water radiators provide the space-heating. Owing to the unevenness of the site, the mains carrying condensate do not provide a gravity return to the boiler. Hence, at several places, receivers and pumps are fitted which are controlled automatically. The contractors for the heating system were Messrs. Cormack, Limited, 34, York-street, Glasgow, C.2.

CONTRACTS.

HEENAN AND FROUDE LTD., Worcester, are to supply two fully sound-proofed Heenan jet-engine tests plants for installation at the Nantgarw depot of the British Overseas Airways Corporation, in South Wales. The contract covers main fuel-storage tanks, fire protection equipment and ventilating and other plant. The sound-proofing, by CULLUM & CO., LTD., and DETUNERS LTD., will be of the most modern type.

CHEMICAL ENGINEERING WILTONS, LTD., a member company of the SIMON ENGINEERING GROUP, Cheadle Heath, Stockport, have received an order from the South-Western Division of the National Coal Board for a continuous distillation plant in connection with a tar works at Caerphilly. The plant will treat daily 150 tons of tar, derived from new coke-oven installations in South Wales.

JAMES MILLER AND PARTNERS, LTD., Edinburgh, have received contracts valued at 107,402*l*. from the Glasgow Corporation Water Department for the laying of 4 miles of 36-in. diameter concrete-lined cast-iron water main and the erection of a bridge to carry it over the main railway line at Scotstounhill, Glasgow. The pipes are being supplied by the STAVELEY IRON AND CHEMICAL CO., LTD. Short lengths of special steel pipes are being provided by STEWARTS AND LLOYDS LTD., and the valves are being made by GLENFIELD AND KENNEDY LTD. Kilmarnock.

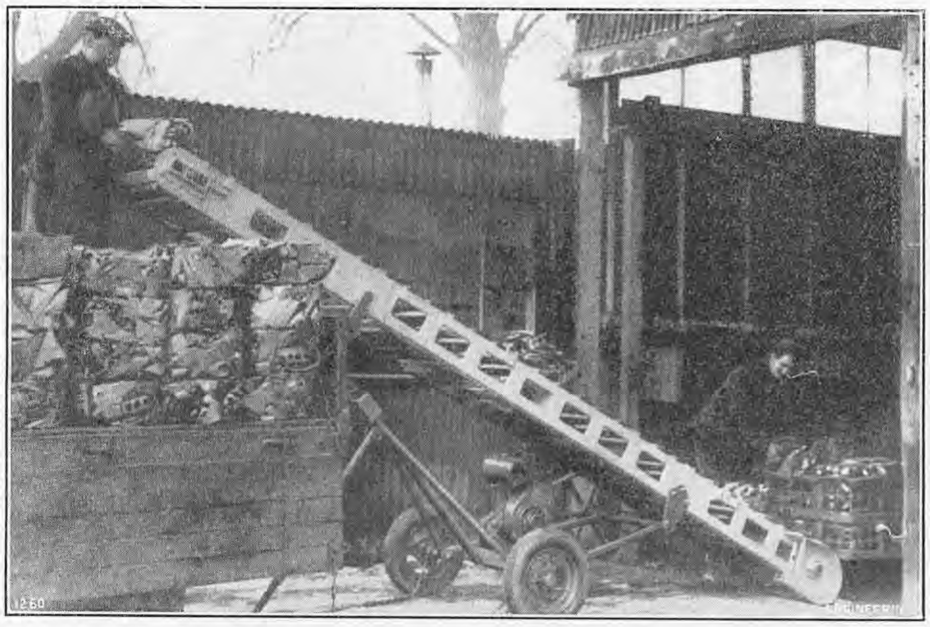
THE HUMBER GRAVING DOCK AND ENGINEERING CO., LTD., Immingham, have been commissioned by the Railway Executive, Eastern Region, to carry out repairs to a floating pontoon and to the bearings of hinged bridges at New Holland.

KINNEAR, MOODIE & CO., LTD., West Regent-street, Glasgow, C.2, have been awarded by Glasgow Corporation the contract for the construction of a tunnel under the River Clyde at a point half a mile west of the Whiteinch ferry. The tunnel will be 345 yards long, have an internal diameter of 12 ft., and be placed at a level of about 40 ft. below the deepest part of the present river bed.

Orders placed recently by British Railways, Western Region, include the supply of three electrically-driven hydraulic pumps for the central hydraulic power station, Swindon, with the HYDRAULIC ENGINEERING CO., LTD., Chester; the supply of a further three electrically-driven hydraulic pumps for the same station with HENRY BERRY & CO., LTD., Croydon Works, Hunslet, Leeds, 10; the treatment of the corrugated iron roofs of the central boiler station and various shops at the Swindon locomotive works with INDUSTRIAL ENGINEERING, LTD., Mellier House, Albemarle-street, London, W.1; the conversion of a Lucas forced-draught plate furnace at Swindon with LUCAS FURNACES, LTD., Wharton-street, Nechells, Birmingham, 7; the supply and installation of extension line equipment at the Temple Meads Exchange, Bristol, with the AUTOMATIC TELEPHONE AND ELECTRIC CO., LTD., Strowger House, Arundel-street, London, W.C.2; and the repair of Cherry Orchard-road bridge, Llanishen, Glamorganshire, with the CEMENT-GUN CO., LTD., Gunite House, Great West-road, Brentford, Middlesex.

MOBILE LOADER.

R. A. LISTER AND COMPANY, LIMITED., DURSLEY.



MOBILE LOADER.

Two machines for raising and loading cases, sacks, bales, etc., have been introduced by R. A. Lister and Company, Limited, Dursley, Gloucestershire. They are listed as 16-ft. and 24-ft. general-purpose loaders. The 16-ft. model, illustrated herewith, has a maximum delivery height of 12 ft. and the 24-ft. model delivers to a height of 18 ft. Each loader is balanced to enable one man to move and place it as required. The 16-ft. model weighs approximately 7 cwt. and the 24-ft. model weighs 10 cwt. The machines are constructed of rolled steel with box-section cross-bars to give rigidity. The moving platform, which is 2 ft. wide between the detachable side boards, consists of wooden slats bolted to heavy welded steel-link chain. The slats carry the load, and removable angle-iron stops are attached to the slats, as required, to prevent packages slipping back when loading. Two detachable wooden side-boards are provided, and the angle-iron stops can be replaced by adjustable attachments for use when dealing with unpacked material. The platform is raised and lowered by a mechanically-operated telescopic tube, built into the chassis frame. Stability when in position is obtained by use of an adjustable support strut set at an angle to the ground. The platform is driven by a 2½-h.p. air-cooled petrol engine (an electric motor may be fitted as an alternative) giving a platform speed of about 100 ft. per minute. The moving platform is started and stopped by a belt-guide jockey-pulley and clutch. The main drive is through two V-belts. Pneumatic tyres are fitted.

THE DOW PRIZE COMPETITION.—The first biennial competition, which was inaugurated by the Illuminating Engineering Society in memory of J. S. Dow to encourage collaboration between students of illuminating engineering and those engaged in other fields in which lighting plays an important part, was held towards the end of last year. The subject of the competition was the lay-out, artificial lighting and decoration of the ground-floor show room of a provincial shop selling sports goods, and the engineering and architectural teams entering were asked to submit drawings to the scale of ¼ in. to 1 ft. showing the plan, a portion of each internal wall face in colour, an elevation of the shop front and a lighting plan and schedule, as well as an explanatory report and, if desired, sketches of special features. Twenty-six entries were received, the winning team being Mr. W. D. Tyrrell (illuminating engineer), Croydon Polytechnic; Mr. T. A. D. Bindon (electrical engineer), South East London Technical College; and Miss S. M. Gray and Messrs. E. W. Uglow, C. G. Crowfoot and R. G. Smith, all of whom were architects from the Regent-street Polytechnic. The entries will be on view at the Lighting Service Bureau, Savoy-hill, London, W.C.2, on Wednesday, February 25.

LAUNCHES AND TRIAL TRIPS.

M.S. "FALCONER BIRKS."—Single-screw collier, built by the Grangemouth Dockyard Co., Ltd., Grangemouth, for the North Thames Gas Board, London. Managers: Stephenson Clarke, Ltd., London, E.C.3. Main dimensions: 257 ft. by 39 ft. 4 in. by 18 ft. 6 in.; deadweight capacity, 2,700 tons on a draught of about 17 ft. Clark-Sulzer eight-cylinder Diesel engine, developing 1,250 b.h.p. at 232 r.p.m., constructed by George Clark (1938), Ltd., Sunderland. Launch, November 21.

M.S. "WAIMEA."—Single-screw cargo vessel, built and engined by Alexander Stephen and Sons, Ltd., Glasgow, for the New Zealand to Australia service of the Union Steam Ship Co. of New Zealand, Ltd., Wellington, New Zealand. Seventh vessel of a series for these owners. Main dimensions: 325 ft. by 50 ft. by 26 ft.; gross tonnage, 3,550; deadweight capacity, 5,100 tons on a draught of about 22 ft. 4 in. Stephen-Sulzer six-cylinder single-acting Diesel engine, developing 2,410 b.h.p. at 128 r.p.m. Service speed, 12 knots. Launch, December 1.

M.S. "BEAVERBANK."—Single-screw cargo vessel, built and engined by Harland and Wolff, Ltd., Belfast, for the Andrew Weir Shipping and Trading Co., Ltd., London, E.C.3. First vessel of a series of six. Main dimensions: 450 overall by 59 ft. by 38 ft. 3 in. to shelter deck; gross tonnage, about 5,800. Harland-B. and W. six-cylinder single-acting crosshead Diesel engine. Launch, December 3.

M.S. "ATLANTIC LORD."—Single-screw oil tanker, built by the Furness Shipbuilding Co., Ltd., Haverton Hill, Co. Durham, for Mr. S. G. Livanos, London, E.C.3. Second vessel for this owner. Main dimensions: 525 ft. between perpendiculars by 71 ft. by 39 ft. 3 in., deadweight capacity, 18,200 tons on a summer draught of about 30 ft. 6 in.; oil-tank capacity, 17,000 tons. Wallsend-Doxford six-cylinder two-stroke heavy-oil engine, developing 7,600 b.h.p. at 117 r.p.m., constructed by Wallsend Slipway and Engineering Co., Ltd., Wallsend-on-Tyne. Speed, 15½ knots. Launch, December 15.

M.S. "LA HACIENDA."—Single-screw cargo vessel, built and engined by Swan, Hunter, and Wigham Richardson, Ltd., Newcastle-upon-Tyne, for Buries Markes, Ltd., London, E.C.3. Main dimensions: 435 ft. between perpendiculars by 60 ft. by 39 ft. to shelter deck; gross tonnage, about 6,000. Swan Hunter-Doxford four-cylinder heavy-oil engine, developing 4,400 b.h.p. at 115 r.p.m. Launch, December 17.

M.S. "BLANDFORD."—Single-screw oil tanker, built and engined by Harland and Wolff, Ltd., Govan, Glasgow, for the Blandford Shipping Co., Ltd., London. Main dimensions: 531 ft. between perpendiculars by 74 ft. by 38 ft. 3 in.; deadweight capacity, about 18,500 tons. Harland-B. and W. seven-cylinder single-acting two-stroke heavy-oil engine. Launch, December 18.

M.S. "NESSBANK."—Single-screw cargo vessel, built and engined by Harland and Wolff, Ltd., Belfast, for the Andrew Weir Shipping and Trading Co., Ltd., London, E.C.3. Second vessel of a series of six. Main dimensions: 450 ft. overall by 59 ft. by 38 ft. 3 in. to shelter deck; gross tonnage, about 5,800. Harland-B. and W. six-cylinder single-acting crosshead Diesel engine. Launch, December 18.

BRITISH MANUFACTURE OF X-RAY FILM.

SINCE 1948, the consumption of X-ray film by the National Health Service has increased from 11,700,000 to 16,000,000 sq. ft. per annum. The demand for other purposes has also risen with the result that shortages have been experienced and, in particular, exports have had to be curtailed. In the past practically all the film base upon which the sensitive silver coating is imposed has been imported, principally from the United States. To relieve these conditions, which were a serious embarrassment during the war, Ilford, Limited, Ilford, Essex, and BX Plastics, Limited, South Chingford, London, E.4, with the encouragement of the Ministry of Production, drew up plans for the construction of a factory to produce film base, while the former firm made similar plans for the erection of a film-coating unit of modern design. The first of these factories was established at Brantham, near Manningtree, Essex, and went into production in 1950, and the second has been built at Brentwood, Essex, and has just begun operations. It may be mentioned that Ilford, Limited, are the largest makers of X-ray film in Europe and supply about 60 per cent. of the amount used in the United Kingdom, as well as exporting a large proportion of their output, especially to Commonwealth countries. The opening of these new factories should, therefore, facilitate the provision of film both for medical and scientific purposes and should also have the result of reducing dollar expenditure.

The film used in X-ray work is fundamentally similar to ordinary photographic film, except that it has a thicker base and is coated with sensitive emulsion on both sides. It is manufactured in different forms to suit a number of radiographic techniques and to enable various subjects to be examined to the best advantage. The material used in the manufacture of the film base is cellulose triacetate, which, although similar to acetate rayon, has a higher tensile strength and is more resistant to water. It is non-inflammable, as are the solvents used in its manufacture. It is produced from cotton linters in the form of a continuous web the cellulose triacetate flake being first converted into a viscous solution by suitable solvents. This solution is next cast on to a highly polished moving belt, where the solvents are evaporated by heat and a self-supporting layer of base is formed. After further drying the base can be reeled, while the solvents are recovered, separated and used again. The sensitive coating contains a high proportion of silver, much of which goes into the fixing bath when the films are processed. Arrangements are now, however, in use which enable this to be recovered and employed again. During manufacture, the film is subjected to rigid inspection so as to ensure the absence of defects which might prevent accurate diagnosis.

STORING, HANDLING, SELECTING AND USING TIMBER.—The Ministry of Works have issued Advisory Leaflet No. 29, *Care in the Use of Timber*, giving advice on the storage, handling, selection and cutting of timber for building work, with notes on the effect of knots, and preserving timber from dry rot and exposure to moisture. The leaflet is obtainable, price 3*d*. net, from H.M. Stationery Office, Kingsway, London, W.C.2.

LIGHT-ALLOY ROLLING STOCK FOR LONDON TRANSPORT.—The use of a complete train of eight aluminium-alloy cars is now being studied by London Transport to determine the saving in electric power, as compared with the power required by a normal steel train, and to assess the value of not painting the aluminium alloy, such as economy in initial costs and maintenance costs and the reduced cleaning compared with that for a painted surface. The saving in weight on an eight-car train is almost 50 tons, each car weighing 5¾ tons or 16 per cent., less than a steel car. This is important on the District Line, on which the train is running, since frequent acceleration of the train from rest absorbs a high proportion of the total energy. The construction of the aluminium-alloy cars, for which the late Mr. W. S. Graff-Baker was responsible, was described in ENGINEERING, vol. 171, page 705 (1951).

ROAD-MAKING WITH SAND.

An extensive programme of road-building, using an oil-bound sand admixture, is now in progress in the Seria oilfield in British Borneo. Seria lies in a narrow coastal strip, five miles long, between the South China Sea and dense jungle, and the new roads are being laid to open up communications generally, as well as to provide access to a residential area recently built to accommodate employees at the oilfield. No local stone is available for use either as a foundation material or for surfacing, the nearest source of good-quality stone being about 150 miles away. Sand, however, is readily obtainable from the beach and has been used as the basic material for building the roads, thereby avoiding the use of the country's transport system, which is already fully occupied.

The first stage in the construction of these roads consists in the preparation of the sub-grade by removing the top-soil, which has a high content of decayed vegetation, and the cutting of side drainage adequate for the surface water during a tropical rainstorm. For the most part, the sand is being pumped from the beach to the road edge, where the mixing—91 per cent. sand, 4 per cent. hydrated lime (as an activator), and 5 per cent. special "cut-back" bitumen—is carried out in a simple paddle mixer operated by unskilled labour. The mixture is spread over the sub-grade by rakes to a depth of 4½ in. and consolidated by rollers. A curing period of between two and three weeks is allowed before applying the sealing coat; during this time the road is periodically rolled and it is open to light traffic. The sealing coat consists of a cut-back bitumen sprayed on to the surface, and on to it is thrown a thin layer of a mixture of sand and fine material obtained from rock crushing. The roads are immediately made available to all traffic, which includes trucks that may occasionally carry loads of 25 or even 30 tons. Where the traffic can be described as "medium," these roads have proved to be adequate, but where they are subjected to an intensive loading by heavy traffic, it has been found necessary to lay an additional surface after a lapse of three to six months. This additional surface consists of a chip carpet, 2½ in. thick, made from ⅜-in. wet gravel mixed with bitumen and lime, and sealed by a bitumen spray and fine gravel. During the period of placing, it has been found that these mixtures will remain stable and workable through the heaviest of tropical rain, although it may prove necessary to cease work because of the arduous conditions.

The Seria oilfield is operated by the Shell Petroleum Company, Limited, St. Helen's-court, London, E.C.3, who state that they developed this method of road-laying during the war, when it was used with success for the rapid construction of airfields. It is believed that the work at Seria, where 10 miles of roadway with a surface area of more than 100,000 square yards have already been laid, is the first extensive application of this method in the tropics.

Conference on Brittle Fracture in Steel.—A one-day conference on "Brittle Fracture in Steel" has been arranged by the West of Scotland Iron and Steel Institute and will take place on Friday, May 15, 1953, at 39, Elmbank-crescent, Glasgow, C.2. Copies of the programme and other particulars will be obtainable shortly, on application to the secretary of the Institute at that address.

Plastics Moulding Productivity Report.—A report on the findings of the British productivity team which visited the United States early in 1952, to study the American plastics industry, will be published on Monday, February 16, and copies will be obtainable from the offices of the British Productivity Council, 21, Tothill-street, London, S.W.1. A public meeting, open to all interested in plastics, has been arranged by the British Plastics Federation and will take place on Wednesday, March 4, at the Federation's offices, 47-48, Piccadilly, London, W.1, commencing at 2.30 p.m. Members of the productivity team will attend the meeting to answer questions and discuss their findings. Persons intending to be present are asked to notify the Federation well in advance. Other public meetings will be held in Birmingham and Manchester towards the end of March.

PROTECTION OF STEEL BY SPRAYED ALUMINIUM.

STEEL PROTECTION BY SPRAYED ALUMINIUM.

An interesting example of the prolonged protection afforded to a steel building by a sprayed aluminium coating was recently reported to the Protective Coatings (Corrosion) Sub-Committee of the British Iron and Steel Research Association. It was brought to the attention of B.I.S.R.A. by Mr. H. Bull, managing director of Brown Bayley Steels, Limited, Leeds-road, Attercliffe, Sheffield, 9, and concerns the test house built in 1937 at the company's works, where a highly corrosive atmosphere prevails. The company have expressed their willingness to make arrangements to receive those who are interested and wish to inspect the building.

The test house, which is shown in the accompanying illustration, is about 60 ft. long by 25 ft. wide; the height is about 15 ft. in the centre and 20 ft. at the near end, where there are two storeys. One of the long sides of the test house abuts against a workshop, so that the total exposed area of the walls, which are of ½-in. thick steel plate, is approximately 2,000 sq. ft. The outer surfaces of the steel plates were grit-blasted and, after the building was erected, sprayed with aluminium, after which a dado, about 3 ft. high all round the building, was painted with two coats of black bituminous paint and a single coat of lacquer. The cost, per square foot of treated area, was 3*s*. 3*d*. at the time of building. The work was completed in March, 1938, and the building was left as it was until the outbreak of war in September, 1939. Throughout the war, the test house was used as a strong point, for which purpose its walls were strengthened by a sand revetment to a height of about 10 ft. The presence of the sand may have slightly damaged the aluminium coating in places, but when the revetment was removed in 1946 the coating was virtually intact and it was considered sufficient to repaint the building. Two coats of bituminous paint were applied to the dado, and above the dado two coats of aluminium paint. In June, 1952, the Sub-Committee inspected the building. Patches of the steelwork were cleaned and it was found that the sprayed-aluminium coating was still in very good condition. Some slight rust-staining could be seen in places, and at others, where the coating had been in contact with the sand, there were small patches of rust about 1 sq. in. in extent. Appreciable rusting was only to be seen in one place where, in a narrow band about 3 ft. wide over a window, some 10 per cent. of rusting had occurred. In all other respects, the coating was in excellent condition. It will be advisable, however, to repaint it soon, for signs of pending breakdown are apparent and 15 years is thought to be the maximum life that can be reasonably expected from a sprayed-aluminium coating in such a highly corrosive works atmosphere.

In Engineering, vol. 168, page 90 and page 127 (1949), details were given of the treatment applied to the 20,000 tons of steelwork used in the construction of the Abbey Works, Margam, of the Steel Company of Wales, Limited. Here the steel was first cleaned by shot-blasting and then given a sprayed coating of aluminium, 0·004 in. thick, before painting. It has been stated that the cost of this work was not more than two and a quarter times that of the more usual specification of weathering and wire brushing before an application of red-lead primer and finishing paints, as was applied to the remainder of the steel at the Abbey Works. The life of the sprayed-aluminium coating is expected to approach 20 years, while the single coat of paint on top of it will be renewed every seven years, after washing down the old paint. In comparison, the life of the red-lead primer and finishing paints is not expected to exceed five years. The total cost at Margam, over a period of 50 years, of the anti-corrosive treatment by sprayed-aluminium is thus likely to be just under half that of the conventional paint treatment.

Doxford-Type Engine Built in France.—The first Doxford-type engine built in France, under licence from William Doxford & Sons, Ltd., Sunderland, has been completed by the S.A. des Chantiers et Ateliers de Provence, Marseilles, for installation in the French oil tanker Djemila.

Electricity Supply Statistics.—During December, 1952, 5,942 million kilowatt-hours were sold by the British Electricity Authority to the Area Boards, compared with 5,246 million kilowatt-hours in December, 1951, an increase of 13·3 per cent., or of 5·7 per cent. when adjusted to normal weather and standard working days. During the twelve months ended December 31, 1952, the sales were 56,585 million kilowatt-hours, an adjusted increase of 2·9 per cent. over that of the previous twelve months. The electricity sent out by the Area Boards during December, 1952, to "mainly industrial areas" was 3,618 million kilowatt-hours, an increase of 11·3 per cent. over that in the corresponding period of the previous year, and 2,258 million kilowatt-hours to "mainly non-industrial areas," an increase of 16·6 per cent.

FOLDING MACHINE FOR SHEET METAL.

F. J. EDWARDS, LIMITED, LONDON.

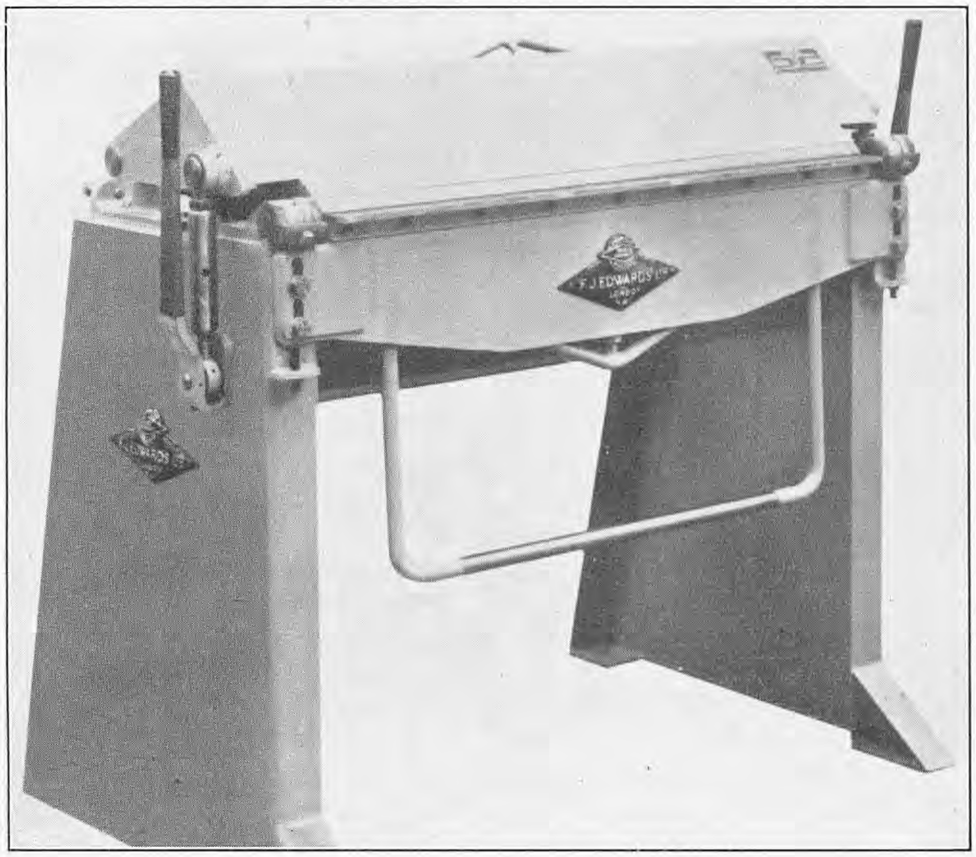


FIG. 1. OPERATING SIDE OF MACHINE.

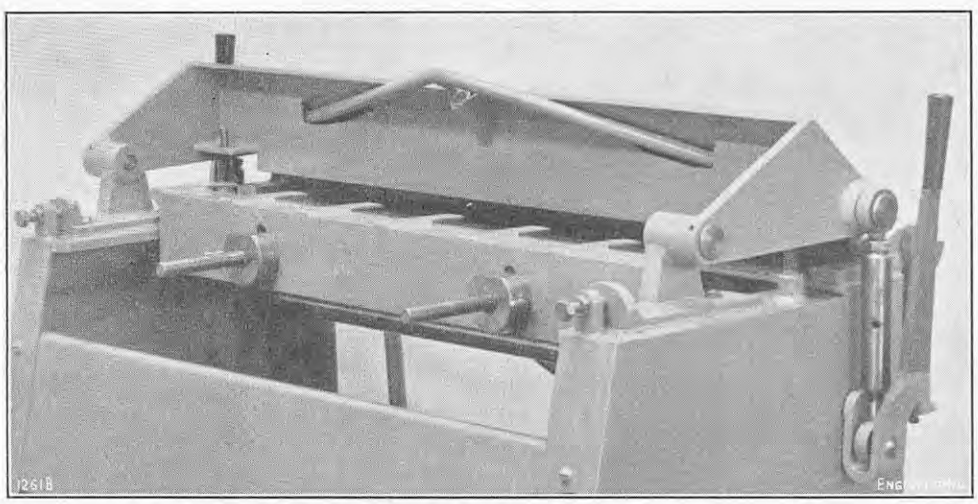


FIG. 2. BACK OF MACHINE, SHOWING CLAMPING BEAM.

FOLDING MACHINE FOR SHEET METAL.

THE Besco folding machine, Model No. 318, which is illustrated in Figs. 1 and 2, above, is made by F. J. Edwards, Limited, 359-361, Euston-road, London, N.W.1. It is a redesigned version of an earlier model, in which all castings have been replaced by fabricated parts in accordance with the policy recently adopted by the company. The machine is hand-operated and has a capacity in mild steel of 36 in. by 18 in. at a maximum thickness of 18 s.w.g. It will produce a bend with a maximum radius of 1 in. with a special blade, a minimum return bend of $1\frac{1}{4}$ in. with an auxiliary blade, and a minimum return bend of $\frac{1}{4}$ in. without a blade. The minimum included angle of bend that can be formed is 45 deg. The two end supports of the main frame are of welded sheet steel, connected by a heavy pressed-steel channel section. The clamping beam, which can be raised 3 in. from the bed for loading, is of triangular box section, with an adjustable stress bar welded at each end to the back and a threaded tensioning rod between it and the clamping beam. Clamping is effected by pulling down either of the levers provided, one at each end of the beam. Adjustment can be made for various thicknesses of material by a screw link, coupling the lever to the beam, and for alignment by a bolt and locknut at the back of each end of the bed, as can be seen in Fig. 2. A sharp-edged blade, 37 in. long, is fitted to the beam and can be replaced by radius blades as desired.

The folding beam is at the front of the machine and is operated by a direct pull upward. It comprises a steel plate to which is attached a 37-in. angle blade, a stress bar similar to that on the clamping beam, and a lifting handle. It is bolted to hinge brackets at each end, through slots that enable alterations in alignment and adjustment to the clearance to be made as necessary to produce radius bends, for which purpose radiused blades can be substituted for the sharp-edged blade. For sharp edged or "Z" bends in light material no blade is required. A stop for use in repetition work is fitted on the hinge brackets at each end. A gauge which will give a setting of 1 in. to 18 in. from the bending edge is mounted on rods at the rear. The bed has a bar of normal height at the clamping edge to give sharp bends in 18 s.w.g. material; this bar can be replaced by bars of less height which, together with the adjustment of the folding beam in the side arms and suitable round-nose blades, allow the radius bends to be formed.

ENGINEERING EDUCATION IN LONDON AND THE HOME COUNTIES.

SOME, at least, of the new technical colleges which are being built on the fringe of London are faced with a lack of students in the departments of advanced and specialised work. The new colleges have to contend with the longer tradition of university and other advanced work associated with the London Polytechnics, which many students still prefer in spite of the facilities which are being provided nearer their homes. The fourth annual report of the London and Home Counties Regional Advisory Council for Higher Technological Education states that colleges in the Home Counties are thus caught in a vicious circle: without the students they cannot easily develop strong departments of advanced and specialised work; yet, without these departments, they cannot attract the students, who know that their needs can be met in London. It is understood that a national committee is to be appointed to try to secure agreement on this "out-county" problem, and the Council, in their report, urge that the needs of the students shall be kept well to the fore. The freedom of the student to choose his own course can be restricted—by vouchers, permits and out-county fees—in the interests of the new colleges, but at the risk of introducing more complications into a system which is already complex.

The Council also record that the London County Council, having accepted advice tendered in 1950, have agreed to the appointment of 20 research assistants on the staff of technical colleges to encourage research in these institutions. The assistants will be full-time research students of the University of London, who will undertake, in addition to research, six hours' teaching or laboratory supervision weekly. Their annual remuneration will be not more than 350*l*. each. Following a recommendation of a committee of the Department of Scientific and Industrial Research, the Council have taken steps to increase the facilities for chemical engineering research in universities and technical colleges.

In the field of production engineering, difficulty has been experienced by colleges in recruiting students, due to the absence of any recognised national award on completion of a course. The Council have also found that the productivity team on universities and industry, who visited the United States, have revealed a gap in British education that needs, to fill it, a considerable increase in full-time technical education to a level rather below that of the present honours degree in engineering; and, to a lesser extent, by courses of equivalent length in which the students' time is equally divided between industry and college. This conclusion contrasts oddly with Professor S. J. Davies's statement that, in making a comparison of the annual output of graduate engineers per 100,000 of the population in Great Britain and certain European countries, it would not be justifiable to add to the figure for this country the number of men with Higher National Certificates, as these qualifications are not comparable with the diplomas of the Continental professional engineer. This conclusion was contained in an address which Professor Davies gave at the fourth annual meeting of the Council last year; the address was reprinted in ENGINEERING, vol. 174, pages 70, 116, 165 and 200 (1952). In view of the large number of holders of Higher National Certificates—many of whom fill responsible engineering posts—it seems unreasonable not to allow something for their influence in any comparison made with countries abroad.

ANNUALS AND REFERENCE BOOKS.

Fifty-Year Index to A.S.T.M. Technical Papers and Reports (1898-1950).

American Society for Testing Materials, 1916, Race-street, Philadelphia 3, Pennsylvania, U.S.A. [Price 6 dols.]

FOUNDED in 1898, the American Society for Testing Materials was known as the American Section of the International Association for Testing Materials for the first four years of its existence. In 1902, the Society obtained its charter and was re-organised under its present name. The *Fifty-Year Index* is concerned essentially with the technical papers which have appeared in the Society's *Proceedings* and the *A.S.T.M. Bulletin*, reports of technical committees, and special technical publications. Items contained in compilations of standard specifications, covering particular fields of engineering or technology and issued to provide ready reference to certain specifications and tests, are also included. The *Index* is divided into five main sections, namely, an author index, a subject index, a list of special technical publications issued by the Society, a list of the compilations of standard specifications, and a list of symposia and discussions on various subjects held at meetings of the Society.

Handbook of Engineering Fundamentals.

Edited by OVID W. ESHBACH. Second edition. John Wiley and Sons, Incorporated, 440, Fourth-avenue, New York 16, U.S.A. [Price 10 dols.]; and Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 80s. net.]

IN engineering, the trunk of the tree of knowledge is a massive structure, parts of it comprehended in student days, but much of it—to the individual engineer—either unknown or forgotten. With such a book as this, however, he may learn, or re-learn, what he needs to know from time to time. It covers the essential mathematics, mechanics, aerodynamics, thermodynamics, electricity and magnetism, radiation, light, acoustics, chemistry, metallurgy, non-metallic materials, engineering law (American) and physical units and standards. The first edition was published in 1936, and this second edition has been revised; in particular, the M.K.S. system of units has been brought into wider use in several sections. Some of the more elementary theories have wisely been omitted so that greater stress could be laid on items to which reference is more likely to be made. The bibliographies which are provided at the ends of some—but, unfortunately, not all—sections refer mainly to books, less frequently to papers presented to learned societies. Nevertheless, considered as a whole, this book of reference commands esteem.

Mechanical World Electrical Year Book, 1953.

Forty-sixth edition. Emmott and Company, Limited, 31, King-street, Manchester, 3. [Price 3s. net.]

THE latest edition of this long-established reference book contains a new section on electric lifts, which covers all the equipment involved in that type of mechanical handling, including completely-protected push-button control systems. The notes on the wiring regulations of the Institution of Electrical Engineers have also been re-written and further information has been added to the section on control gear. Generally speaking, a wide field is covered in a small space, the information giving being of what may be called the "first-year" rather than of a highly-technical character; and, naturally, it is very concise. One defect is that no reference is given to other sources. Numerous conversion and other tables are included.

Current British Directories, 1953.

Compiled by G. P. HENDERSON. Staples Press, Limited, Mandeville-place, London, W.1. [Price 30s.; 31s. including postage.]

THIS annual, first published a year ago, is divided into two parts, Part I being concerned with directories of localities and Part II with specialised directories. In Part I, note is made of the 50 different sections of the full telephone directory issued by the General Post Office, who also issue classified telephone directories for several of the principal industrial and commercial areas. To these must be added the references made in the directory to the many gazetteers and local directories that are published by authorities and individuals, and the attention of users of directories is drawn to the value of the electoral registers for checking private addresses. Part II contains 848 entries referring to directories of particular trades, the membership lists of professional bodies and trade associations as well as to *Who's Who* but no note is made of university or college calendars. An appendix to Part II gives a selection of 44 directories published abroad which might be of service to the British user. Each entry is accompanied by a brief synopsis of the principal contents of the directory concerned and, in the index, the entries are grouped into allied categories which are cross-referenced with the body of the directory.

Directory of Shipowners, Shipbuilders and Marine Engineers, 1953.

Tothill Press, Limited, 33, Tothill-street, London, S.W.1. [Price 40s. net.]

THIS is the 51st edition of a reference work which has grown steadily in size, usefulness, and favour among those who have to do with ships. It is compiled under the direction of the editor of *Shipbuilding and Shipping Record*, who has been responsible for its production now for some 40 years—a considerable feat in itself and one, we should suppose, with few parallels in comparable fields. The main sections are those listing the shipowning firms and their fleets, with particulars of the services provided, and the cargo capacities, tonnage, speed, passenger accommodation, etc., of individual vessels. The names of directors, managers and other executives are also given. In the shipbuilding section, similar details are given about the executives; and the capacities of the plants for building ships and main engines, and the docking facilities possessed by repairers, are also listed. Other sections deal with Government departments, classification societies, etc., concerned with ships, and the names and addresses of consulting engineers and marine surveyors; and there are comprehensive indexes of the names of ships, the companies in order of countries and towns, telegraphic addresses, personal names, and the general contents of the book.

HIGH-SPEED COUNTER.

THE high-speed counter shown in the accompanying illustration has been developed by Messrs. Boulton Paul Aircraft, Limited, Wolverhampton, for two main functions. For measuring the time interval between two events to an accuracy of ± 5 milliseconds, the instrument includes a highly stable 1,000-c.p.s. frequency source, which is connected to the electronic counting mechanism. The maximum interval counted directly is 10 seconds, but greater intervals can be measured by observing

the number of times the 1-second counter completes 10 steps. High-speed relays, actuated by push-buttons or remote switches, control the start and finish of a counting interval. The other function of the high-speed counter is to count pulses over a known period of time, and for this the internal frequency source is disconnected from the counter. The maximum counting rate is 1,000 pulses per second, and the maximum direct count is 10,000 digits. When used for indicating rotational speed, a detector element is coupled to the rotating shaft, so that an electrical pulse is fed to the counter with each revolution of the shaft. The number of pulses is counted during a fixed time-interval, using a stop watch.

1954 GAUGE AND TOOL EXHIBITION.—The fourth gauge and tool exhibition to be organised by the Gauge and Tool Makers' Association will be held in the New Hall, Horseferry-road, Elverton-street, London, S.W.1, from Monday, May 17, to Friday, May 28, 1954, both dates inclusive. Products on exhibition are expected to include a wide variety of gauges and measuring equipment, special-purpose machines, press tools, engineers' small tools, testing machines, diamond tools, jigs, fixtures, moulds and dies. Further particulars may be obtained from the secretary of the Association, Standbrook House, Old Bond-street, London, W.1.

TRADE PUBLICATIONS.

Mechanical Handling Equipment.—R. H. Corbett & Co., Ltd., Hydrum Works, Burgess Hill, Sussex, have issued an eight-page illustrated leaflet describing their range of "Hydrum" stacking, loading and mobile lifting machines.

Metal Detectors.—An illustrated broadsheet entitled "Metal Detection" has been published by Goring Kerr, Ltd., Clifton Works, 153, High-street, Slough. The leaflet gives details of two models, the standard bridge model for fitting over conveyor belts and a smaller "SJ" model for use where a small search head with high sensitivity is required.

Stone Crushers.—Sir W. G. Armstrong Whitworth and Co. (Ironfounders), Ltd., Close Works, Gateshead-on-Tyne, 8, have issued an illustrated leaflet, giving capacity ratings, powers, speeds and weights of their jaw crushers, available in capacities from 4 tons to 290 tons per hour, and their gyrating crushers, available in 18-in. and 36-in. sizes with maximum capacities of 40-49 and 80-111 tons per hour, respectively.

Aircraft, Engines and Propellers.—The de Havilland Enterprise, Hatfield, Hertfordshire, have issued a neat pocket-sized handbook giving particulars of all their activities, including a tabular summary of the principal characteristics of all the aircraft built by them since the inception of the company, and more detailed specifications, with illustrations of aircraft, engines and propellers in current production. The book also contains an illustrated note on their research facilities.

Petroleum.—The Anglo-Iranian Oil Co., Ltd., Britannic House, Finsbury-circus, London, E.C.2, have recently issued an illustrated brochure entitled "50 Years of Oil," giving a short history of the company from its inception in 1901 until the end of 1951, and a description of the company's wide field of activity.

Mechanised Handling.—We have received from Simon Handling Engineers Ltd., Cheadle Heath, Stockport, an 88-page brochure illustrating applications of mechanised handling of coal, grain, phosphates, miscellaneous bulk materials, and individual articles and packages. The brochure also contains sections illustrating pneumatic handling, electrical control and signalling, and various types of handling equipment.

Aluminium Equipment for Mines.—We have received from the Northern Aluminium Co., Ltd., Banbury, Oxfordshire, a booklet describing and illustrating various items of mining equipment, constructed of aluminium alloys. Such equipment is stated generally to weigh about one half as much as similar equipment fabricated wholly from steel, and this contributes to easier handling so reducing fatigue of the worker, and in the case of cages and skips, to increased payload per wind, or, to a reduced winding time owing to the reduced inertia in the system.

Radio-Frequency Alternator.—Particulars of the push-button variable alternators which they are now manufacturing for use on very high frequencies are given in a leaflet received from Standard Telephones and Cables, Ltd., Aldwych, London, W.C.2.

BOOKS RECEIVED.

Presswork and Presses. By J. A. GRAINGER. The Machinery Publishing Company, Limited, National House, West-street, Brighton, 1. [Price 55s.]

Atomic Theory for Students of Metallurgy. By DR. WILLIAM HUME-ROTHERY. Second revised edition. The Institute of Metals, 4, Grosvenor-gardens, London, S.W.1. [Price 21s.]

Thirtieth Annual Report on Safety in Mines Research. 1951. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 2s. 6d. net.]

Productivity Team Report: Metalworking Machine Tools. Report of a Productivity Team representing the British Machine Tool Industry which visited the United States of America in 1951. British Productivity Council, 21, Tothill-street, London, S.W.1 [Price 3s. 6d.]

Investment Castings for Engineers. By RAWSON L. WOOD and DAVIDLEE VON LUDWIG. Reinhold Publishing Corporation, 330, West 42nd-street, New York 36, U.S.A. [Price 10 dols.]; and Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 80s. net.]

Elasticity in Engineering. By PROFESSOR ERNEST E. SECHLER. John Wiley and Sons, Incorporated, 440, Fourth-avenue, New York 16, U.S.A. [Price 8.50 dols.]; and Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 68s. net.]

Radio and Radar Technique. By DR. A. T. STARR. Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, Kingsway, London, W.C.2. [Price 75s. net.]

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