

HYDRAULICS IN AGRICULTURAL ENGINEERING.

By H. J. HAMBLIN, B.A.

(Concluded from page 607.)

THE use of hydraulics for controlling agricultural implements is an established fact and so is its application, in testing and research work, to the actuation of instruments such as drawbar dynamometers, which are so well known as not to need

mechanisation of agriculture meant replacing a horse by a tractor. Now it is seen to involve the propulsion of a series of tools, ranging from simple tines to cotton harvesters, and the basic requirements arising from this development need to be considered without prejudice.

The requirements of a system of propulsion are that any desired forward speed may be selected and maintained and that the design of the tool carrier, whether tractor or special machine, should not be circumscribed by the arrangements made for propelling it, but should be determined entirely by

high loads to be applied to the machine if, for some reason, the wheels or tracks fail to slip. Normally, of course, ground adhesion will limit the output torque to an acceptable maximum, but it is an obvious advantage if this maximum cannot be exceeded; in other words, it is an advantage if the power transmission system is matched with the driving wheels or tracks.

The range of speeds required is wide, although even the maximum is low compared with any other type of vehicle. The slowest speed, for hand work from a travelling platform, is 400 ft. per hour, and the

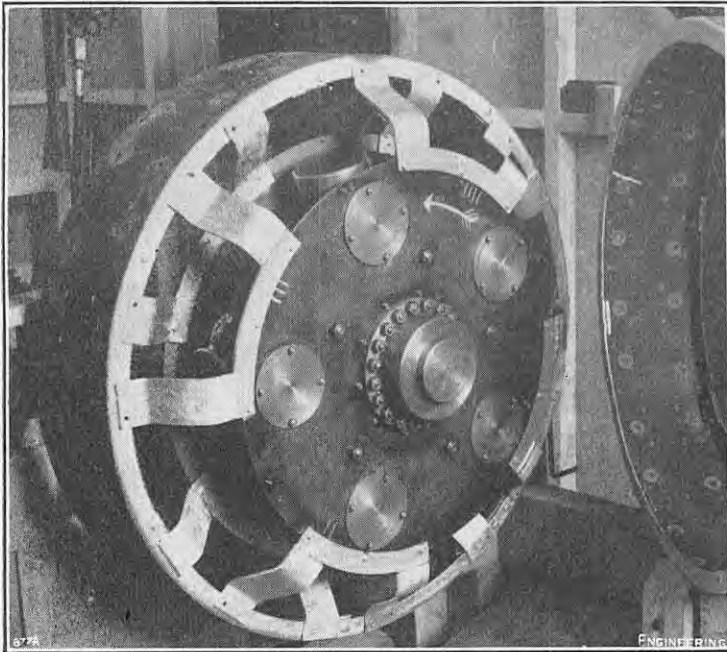


FIG. 6.

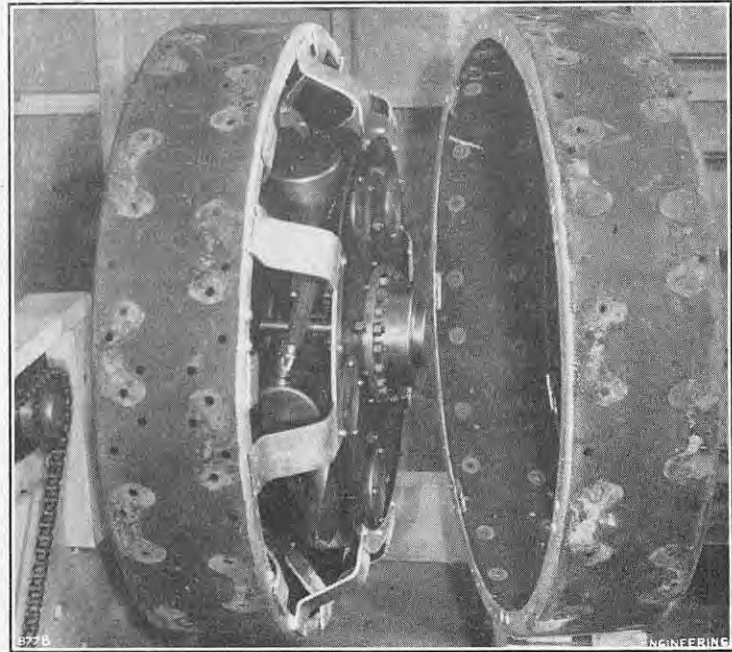


FIG. 7.

FIGS. 6 AND 7. HYDRAULIC MOTOR FOR TRACTORS.

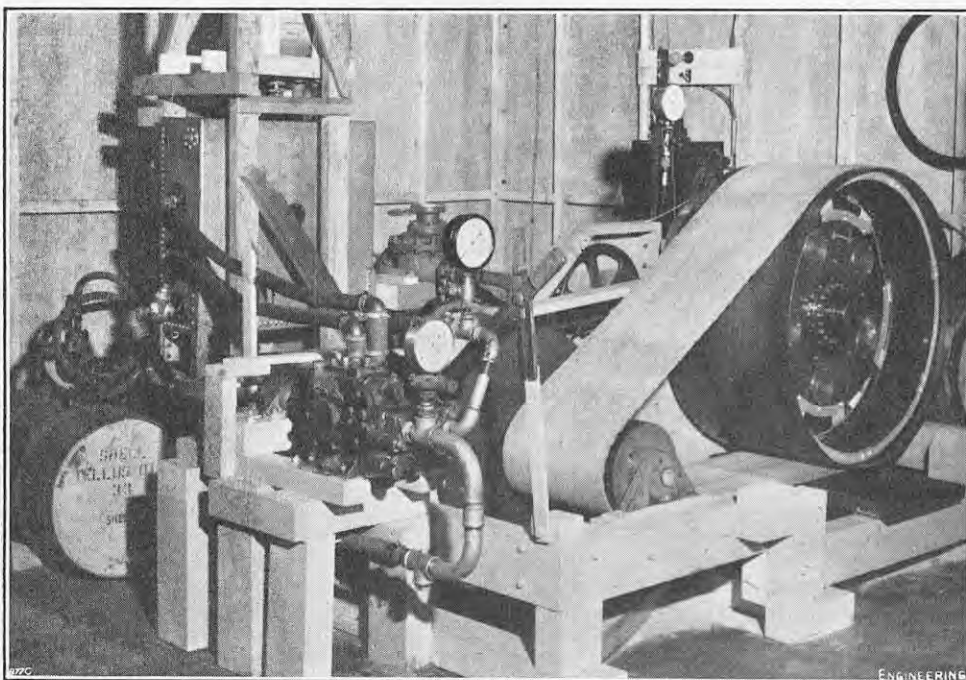


FIG. 8. MOTOR ON TEST.

further mention. A third possible use is in connection with the propulsion of implements and machinery where the problems arising with tractor-drawn, tractor-mounted or self-propelled equipment have not yet been solved satisfactorily. It is possible that existing methods represent the only economic solution and therefore must be accepted in spite of their limitations, but, at least, an examination of the whole problem needs to be made before doing so. This is particularly true now that tractor-mounted and self-propelled types of equipment are in ever-increasing use and the true nature of the problem is seen more clearly. There was a time when the

consideration of the agricultural work to be done. These are the essential features of an ideal system. A third feature, which, although not essential, can be borne in mind as desirable, is that the maximum torque supplied to the driving wheels or tracks is best limited to an amount only slightly in excess of the maximum that the wheels or tracks can transmit to the ground. The point here is that if, as with conventional gear transmissions, a substantially constant proportion of the full power of a prime mover is always available at the driving wheels or tracks and arrangements are made for a very slow forward speed, then it is possible for

highest, for transport, is from 12 to 15 m.p.h. Most agricultural operations are done at speeds of from 2 to 7 m.p.h., the upper part of this range being used more in the prairie type of farming than in countries such as Great Britain. The speed variation on any particular job will generally be relatively small and, in this respect, the problem is quite different from that arising in the use of large track-layers for earth-moving, where a wide range of speeds, forward and reverse, is often required in each cycle of operation. This type of operation is not unknown in agriculture, occurring, for example, when using a tractor-mounted loading fork; but it is not the most common requirement. Normally, a more-or-less constant speed is required, with an occasional slowing down either because the total power available cannot maintain the speed against an increase in load, as when a patch of heavier ground is encountered while ploughing, or because the machine cannot continue to perform its function at the speed at which it is travelling, as when a grain combine harvester reaches a patch of tangled crop and the threshing mechanism will choke unless the rate of feeding of the crop is lowered by reducing the travelling speed of the machine.

With the present-day conventional system of propulsion, consisting of an internal-combustion engine fitted with a variable-speed governor and driving through a mechanical transmission which gives a choice among a number of discrete speeds for any given engine speed, the operator often has to decide whether to run at a speed lower than that at which he could operate for most of the time or to waste some of the time changing gear, an operation which necessitates stopping. Whichever he chooses, the job is not done as quickly as it could be if he could use continuously the precise speed he wanted. His difficulty is reduced with an increase in the number of gears at his disposal and recent years have accordingly seen an increase in the number of forward speeds on agricultural tractors from three to five or six, or even more: there is, for example, a proprietary gearbox on the market in America which gives nine forward speeds when fitted to a well-known make of tractor.

The urgency of the problem depends on the particular application. One of the most important cases is the propulsion of a combine harvester where, because of the short period over which the crop is in perfect condition for harvesting, and the restriction of working hours by bad weather or prolonged periods of dew, it is vital that the maximum rate of working at any time shall not be reduced by limitations of the harvester. This is so important that particular solutions of the general problem have been found: one firm, for example, contrives, by the use of conventional gears and a V-belt drive, to give the operator a choice of 24 forward speeds, while, in America, a proprietary torque converter is advertised specifically for use with different makes of combine harvester.

The conventional hydro-kinetic torque converter does not, however, satisfy the requirements of a general agricultural engineering transmission system. In the first place, its use does not allow the designer to concentrate exclusively on agricultural considerations because he still has to arrange for mechanical connections to and from the torque converter. Furthermore, although a wide speed range can be covered with stepless variation, provided that provision is made for a choice of high, low and reverse gears, the overall efficiency of the system is low. In fact, it is difficult to envisage the further extension of this system much beyond the two applications already in use, namely, the combine harvester, where the power used in propulsion is small, and the large earth-moving tracklayer, with its wide range of speeds in each cycle of work. The alternative type of hydraulic transmission, a hydrostatic system with a controllable variable-delivery pump, is much more attractive, particularly if the possibility is envisaged of building driving motors into the wheels. With this arrangement, all the requirements of an ideal agricultural propulsion system would be met. In particular, the overall design of equipment would be simplified greatly, because a driving wheel could be attached at any point capable of withstanding the torque reaction provided that oil could be piped to and from it. The use of steerable driven wheels would be entirely practicable and thus the design of four-wheel-drive tractors would be much more straightforward than with a conventional transmission system. The possibility of using the same wheels for steering and driving would also be very attractive on machines, such as self-propelled combine harvesters, which have rear steering wheels.

The possibility of using a hydrostatic transmission for propulsion is not a new idea. According to one authority,* it was considered by many people during the first two decades of the automobile industry, the particularly attractive features being the stepless variation of the torque ratio obtainable and the ease of obtaining a reverse drive. In considering its possible application to agriculture, it is interesting to note the remarks of the same authority on the failure of any firm to produce a satisfactory transmission for automotive work, in spite of the efforts made. He says: "But to the author's knowledge, motor trucks with hydraulic drive have never gone into quantity production and where the firms continued the production of the hydraulic drives for any length of time, they usually found outlets in the industrial and other fields in which high speeds and low weight are not so essential." If this can indeed be taken as summing up the outcome of the development work at that time, it would appear to be most encouraging towards a reconsideration of the hydrostatic system for agricultural purposes because, as has been stated, this is not a high-speed application, and, of course, is not one where light weight is required: in fact, many tractors carry a considerable quantity of extra ballast for adhesion.

Even if the classical objections appear irrelevant, there are, doubtless, many problems which arise in applying hydrostatic transmission to an agricultural tractor and an investigation into the nature of these problems has been started at the National Institute of Agricultural Engineering. Figs. 9 and 10, on this page, show diagrammatically, but to scale, an arrangement of a hydraulic motor recently built

HYDRAULIC-MOTOR WHEEL FOR TRACTORS.

Fig. 9.

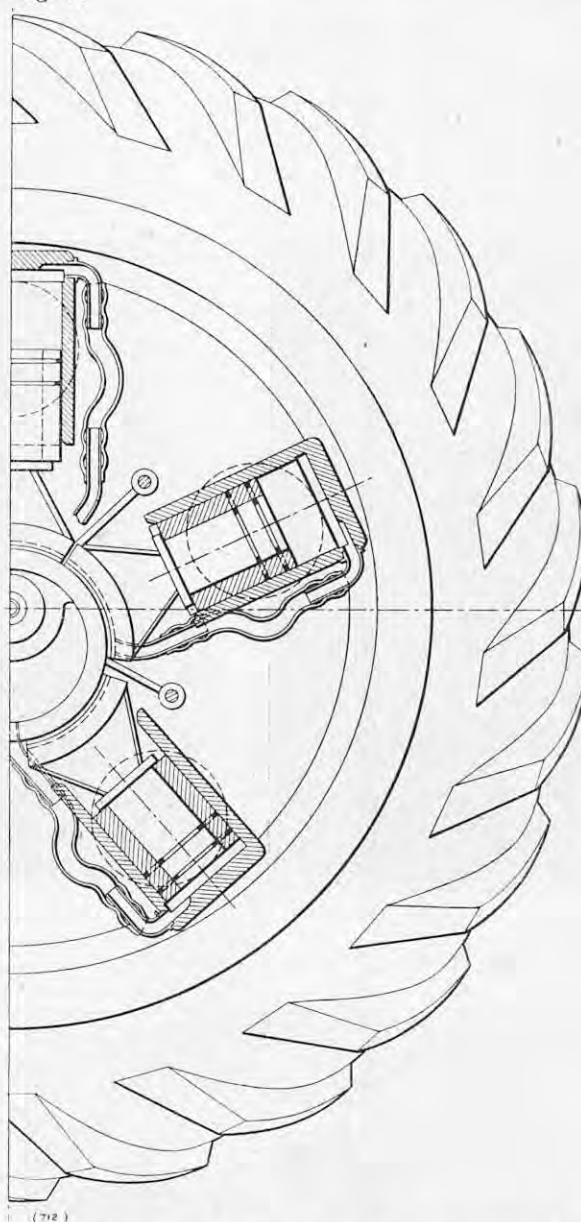
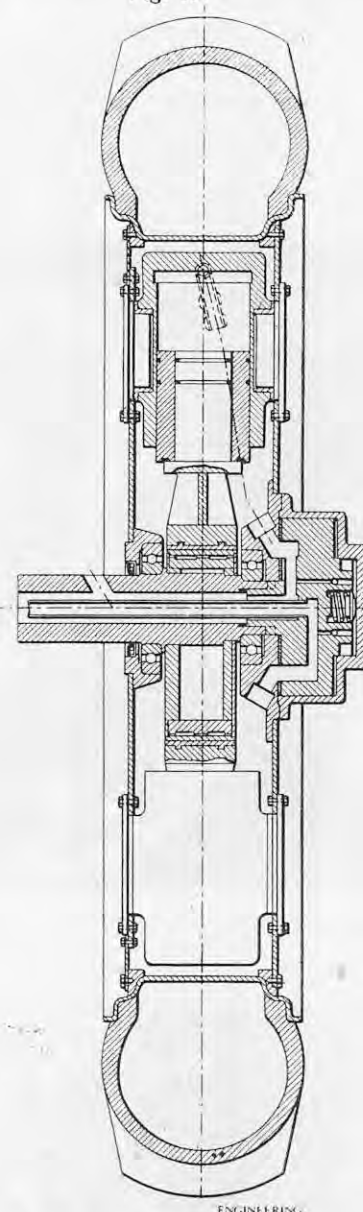


Fig. 10.



for research purposes. The motor is enclosed inside the rim of a 9-32-in. pneumatic tyre rim and is designed to give a thrust of 1,500 lb. per wheel when operating at 1,500 lb. per square inch; 1,500 lb. is a reasonable maximum-output thrust to expect from a tyre of this size, the motor being designed to match the tyre. The motor is arranged to rotate round a stationary shaft with a fixed eccentric carrying a roller race, on the outside of which bear thrust pads from each of the five pistons. The cylinders rock on trunnions in the side plates so as to avoid side load on the pistons; they can be seen in position in Figs. 6 and 7, on page 637, which shows the complete motor installed in a test rig. Distribution of oil to the cylinders is effected by means of a pipe through the fixed shaft and a rotary face valve, automatically loaded by oil bled from the pressure line. Exhaust oil is returned through the valve and the fixed shaft, reverse motion being obtained by reversing the oil circulation.

There does not seem to be any great advantage, with this system, in making the capacity of the motor steplessly variable, as the gain would appear to be disproportionate to the complication, but it is necessary to provide more than one speed range. For example, for economic utilisation of the prime mover, full power must be transmitted by the driving wheels at speeds of about 3 miles an hour and yet maximum speeds of 12 to 15 miles an hour are required. Therefore, unless an excessively large pump is to be used, some means has to be found for reducing the oil capacity of the motor. The means used in the motor shown is eminently suitable, as it can be operated by hydraulic pressure and so does not require any mechanical connection

to be taken to the wheel; this is particularly desirable with wheels that are to be steered. In the motor shown, each piston consists of a central portion surrounded by a sleeve. If the sleeve is secured at top dead centre by a hydraulically-operated catch, the effective piston diameter is reduced from that of the cylinder to that of the central portion of the piston, and the cylinder capacity is correspondingly reduced. There is obviously no difficulty in arranging for more than two speed ranges, if required.

The problems associated with a transmission of this type may be divided into two classes, namely, the fundamental ones of capital cost of equipment and efficiency, and the more practical, but extremely important, ones such as whether it is possible to design a system capable of continued operation with the standard of maintenance likely to prevail on a farm. It is difficult, and can be misleading in either direction, to consider too closely at an early stage the potentialities of any new development on a capital cost and, accordingly, the question of efficiency is being investigated in the first place, with due attention to practical points of operation. The efficiency of a conventional tractor transmission is generally about 87 per cent. and, under normal farm operation, the efficiency of the wheels or tracks may be anything from 90 to 45 per cent.; therefore, the drawbar horse-power may be anything from 78 to 39 per cent. of the crankshaft horse-power of the prime mover. It is thought that a hydrostatic transmission system would not be worth while unless its efficiency was at least 78 per cent. and this is regarded as the minimum acceptable. This gives a conversion of 70 to

* *Torque Convertors*, by P. M. Heldt; 1942nd edition, page 249.

† *Ibid*, page 251.

EXHIBITS AT THE BRITISH INDUSTRIES FAIR.

THE BRITISH INDUSTRIES FAIR AT BIRMINGHAM—IV.

(Concluded from page 614.)

SOME more exhibits at the Castle Bromwich section of the British Industries Fair, which closed last Friday, May 16, are described in this concluding article.

MALLEABLE-IRON AND ALLOY CASTINGS.

A comprehensive range of blackheart malleable-iron castings was being shown by Follis-Wycliffe Foundries, Limited, Lutterworth, Rugby. These ranged from mass-produced machine-moulded castings to intricate hand-moulded castings and included examples of fully-machined castings supplied by the firm. A selection of parts cast from C.Y. wear-resisting alloys were also exhibited. C.Y. alloy is a relatively tough homogeneous cast material possessing exceptionally good wear-resisting properties. It is not intended for resistance to shock, but, as the tensile strength is from 30 to 35 tons per square inch, it is somewhat stronger than cast iron. It can be turned, bored and drilled, but, as it is a wear-resisting material, machining is not easy and is therefore kept to a minimum. It is claimed that, so far as resistance to abrasion is concerned, the alloy compares favourably with manganese steel, and brake blocks cast from this material have lasted up to three years. Various components made from E.V. heat-resisting steel, Wynite heat-resisting cast iron, and mild steel impregnated by the Penetral process were also being shown. E.V. steel is a nickel-chrome alloy designed to resist temperatures up to 1,175 deg. C., maintaining its strength at elevated temperatures to a marked degree. The analysis of E.V. steel, however, is varied to suit particular conditions, and typical applications include furnace arches, retorts and carburising boxes. Impregnation by the Penetral process renders mild steel highly resistant to heat. Penetral treatment basically is an aluminium penetration to an appreciable depth, thus rendering the metal resistant to oxidation for temperatures up to 1,000 deg. C. Welds can be treated satisfactorily by this process and, in addition to giving the metal heat-resisting properties, the treatment makes it resistant to attack from sulphur and sea water.

SPEED REDUCERS.

The stand of Follis-Wycliffe Foundries, Limited, was shared by their associated company, Varatio-Strateline Gears, Limited, 278, Aberdeen-avenue, Trading Estate, Slough, Buckinghamshire, who were showing a selection of their reduction gear-boxes. As their name suggests, these gears have coaxial input and output shafts and can be run either clockwise or anti-clockwise without modification. The units on view included the new model illustrated in Fig. 66, herewith, which has been designed for vertical mounting and is intended for driving mixers, agitators, etc. It is supplied to give any reduction between 20 to 1 and 100 to 1, with a maximum torque of 16,000 lb. in. for an input of 5 h.p. at 750 r.p.m. The method of operation is the same as for the horizontal units and will be understood by reference to Fig. 67, herewith, which shows in diagrammatic form the working parts of a typical unit. The input shaft *a* carries a pinion *c* cut with external teeth. The involute pinion is free to rotate on the shaft and it will be noted that the pinion shaft *b* is eccentric to the axis of the input shaft. The pinion meshes with the outer gear ring *d*, which is clamped between the two parts of the gear-case *e* and is cut with internal involute gear teeth, the ring, as a rule, having one more gear tooth than the pinion. When the input shaft is turned, a "cranking" motion is transmitted to the pinion due to the eccentricity of the shafts *a* and *b*, and since there is a difference between the number of teeth in the pinion and ring, one revolution of the input shaft will cause the pinion to travel one tooth on the ring.

To permit free movement of the pinion, it is connected to the output shaft through an Oldham coupling. This is shown diagrammatically in Fig. 67, the driving member, which, of course, is integral with the pinion, being lettered *f*, the sliding member

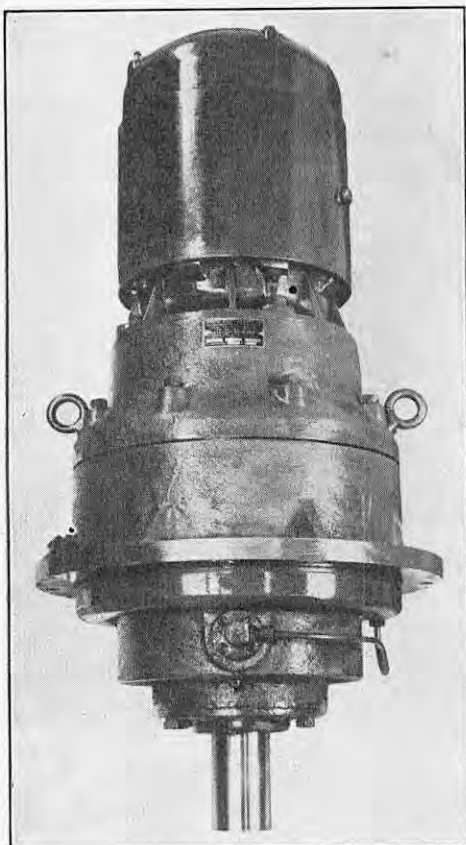


Fig. 66.

FIGS. 66-68. SPEED-REDUCING UNITS; VARATIO-STRATELINE GEARS, LIMITED.

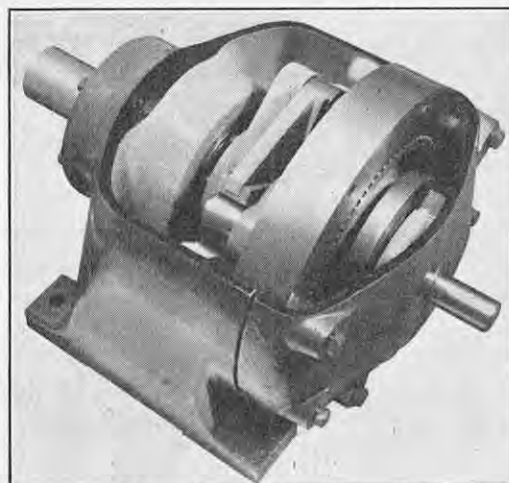
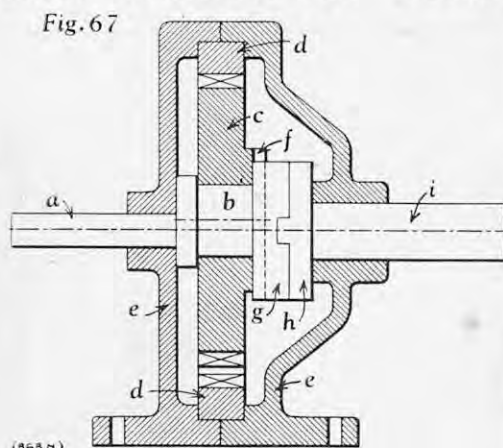


Fig. 68.

35 per cent. of the crankshaft horse-power into drawbar horse-power, but it must be remembered that the system will give better power utilisation than a stepped gearbox, as well as practical advantages.

As a starting point in the investigation, the trial rig shown in Fig. 8, on page 637, has been assembled for the measurement of the efficiency of a wheel-motor of the type described and an analysis of the losses taking place. The motor has been withdrawn from the 9-32-in. tyre rim and equipped with a wide 42-in. diameter pulley consisting of two steel tractor-wheel rims. This was done to allow observation of the working of the motor through the space between the rim and the outside circumference of the side-plates. Although, with this arrangement, the motor cannot be run submerged, as will presumably be the best final arrangement, the advantage of being able to observe its operation more than offsets any possible difficulties, particularly as there should not be any tendency on the trial rig towards over-running, with the possibility of sub-atmospheric pressures in the system and ingress of air. On the trial rig, the wheel-motor is mechanically connected to a V.S.G. oil pump through belt and chain drives, the oil pump being connected also to a variable-speed direct-current motor which makes good the losses in the system. The oil circulation is measured, and also the pressure drop across the wheel-motor, to give the energy input. The speed of the wheel and the torque reaction on the stub shaft give a measure of the motor output. At a later stage of the investigation attempts will be made to analyse the energy loss in detail.

In the meantime, broader questions are being considered, of points arising in the practical application of the system: for instance, from the hydraulic point of view the type of circuit to be used. Probably a closed, boosted circuit will be found most satisfactory, with the pump and all motors submerged. This has the advantage, *inter alia*, of automatically providing for the prevention of over-run, which is, of course, necessary to prevent equipment running away downhill. If, for any

reason, an open circuit is used, it will be necessary to make special provision against over-running. This would not be difficult, because it could be done by means of a valve to throttle the flow of oil from the wheel, the valve being held fully open so long as there was a positive pressure in the cylinders, but closing as soon as the pressure dropped to zero. It is doubtful whether this particular problem of preventing over-run with an open circuit will, in fact, have to be solved, but it, and many others arising from the use of hydraulics, have to be considered.

From the agricultural point of view, innumerable points arise, including, for example, the wide possibilities of mounting implements on a tractor of more or less conventional layout except that advantage is taken of the hydraulics to provide considerable free space between the rear driving wheels and for some distance forward of this, by mounting a prime mover and pump, side-by-side, well forward. Again, there is the possibility of designing a basic two-wheel-drive tractor capable of conversion, at relatively small extra cost, to a four-wheel-drive model. Perhaps the most interesting speculation is whether the development of a transmission system on the lines now being investigated might lead to a range of self-propelled machines using a common prime mover and transmission system, including the driving wheels; for example, a forage harvester, a combine harvester and a sugar-beet harvester. One thing is quite certain: if the present work proves that such a system is a practical proposition, there is considerable scope for its application in a field of engineering where the requirements are definitely not met satisfactorily by existing arrangements.

RECORD TIN-PLATE OUTPUT.—On Monday, May 5, during an eight-hour shift, the cold-reduction mill at the Trostre works of the Steel Company of Wales rolled 452½ tons of steel strip into thin tinplate gauges, twice as much as has ever been rolled before in this country in the same period. Production at the mill started last October. A description of the plant appeared on page 629 of last week's issue of ENGINEERING.

EXHIBITS AT THE BRITISH INDUSTRIES FAIR, BIRMINGHAM.

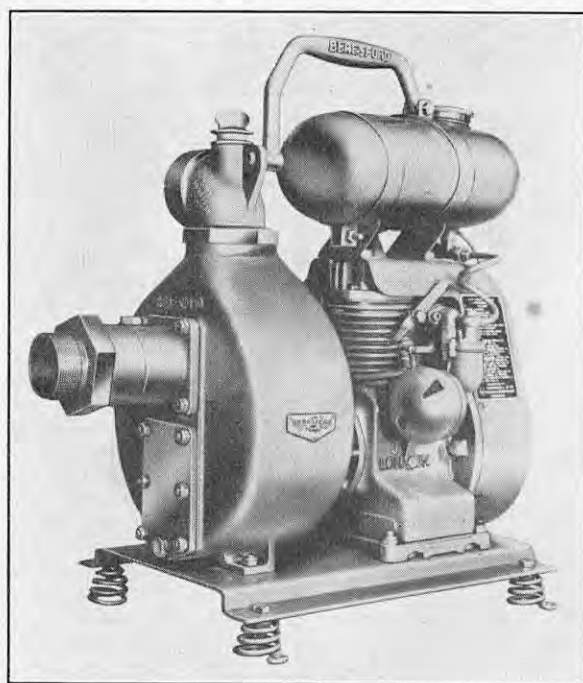


FIG. 69. CONTRACTORS' PUMP; JAMES BERESFORD AND SON, LTD.

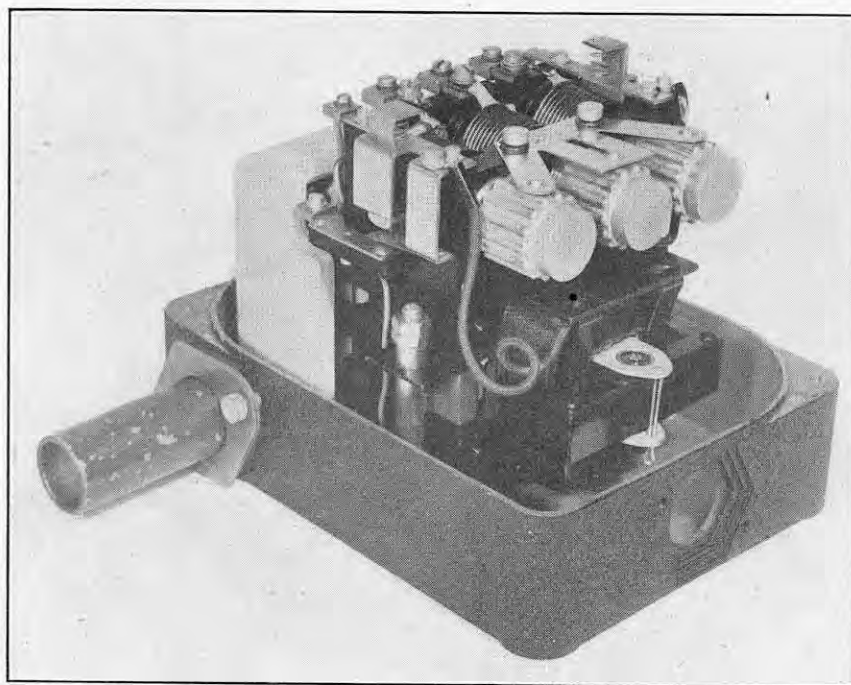


FIG. 70. DIRECT-ON STARTER FOR SQUIRREL-CAGE MOTORS; ELECTRIC CONSTRUCTION CO., LTD.

g and the driven member *h*, the last-named being integral with the output shaft *i*. To maintain the gears in static balance, a balance weight is provided at the driving end, but for the sake of simplicity this is not shown in the diagram. In practice, the Oldham coupling used is somewhat different to that shown in the diagram, the part lettered *f* being replaced by a driving flange provided with two rollers arranged diametrically opposite each other. These engage with a central plate and the power is transmitted to a driven flange also provided with two rollers arranged in a similar manner as for the driving flange, the central plate, as a consequence, having four machined slots at 90 deg. This arrangement will be clear from an examination of Fig. 68, which shows a typical unit with the top part of the gear-casing cut away.

It will be appreciated that, with the arrangement described, the drive is positive and coaxial and, as frictional losses are reduced considerably, the efficiency is high, the makers claiming efficiencies of between 90 and 95 per cent. for single-stage units. In general, reduction ratios from 20 to 1 to 100 to 1 can be obtained with a single-stage unit, but by using a double-stage unit reductions up to 10,000 to 1 can be obtained. All units are soundly constructed, the gears comprising a high-carbon forged steel pinion and a heat-treated cast-iron alloy ring. The shafts also are made from high-carbon steel forgings and ball or roller bearings are used throughout.

CENTRIFUGAL PUMPS.

Messrs. James Beresford and Son, Limited, Stork Works, Marston Green, Birmingham, 33, showed a wide range of centrifugal pumps. Illustrated in Fig. 69 is their 2-in. contractors' pump, with a petrol-engine drive mounted in a special "rough-handling" frame; the pump unit can alternatively be mounted on a wheelbarrow trolley, and an electric-motor drive is available in place of the petrol engine. The pump has a maximum suction lift of 25 ft. and can handle 1,000 to 4,000 gallons per hour of dirty water containing solids. Also on view was a submersible electric pump for deep-well pumping; it consists of a pump and motor built as one unit, and is available in sizes ranging from 3½ in. to 13½ in. diameter, capable of handling from 150 gallons to 110,000 gallons per hour at heads up to 1,100 ft. The complete unit is lowered into the well or borehole, only the rising main and the electric cable connecting the unit with the surface. The electrical switchgear can be remotely located, and no pump house at the surface is required. Examples from their range of self-

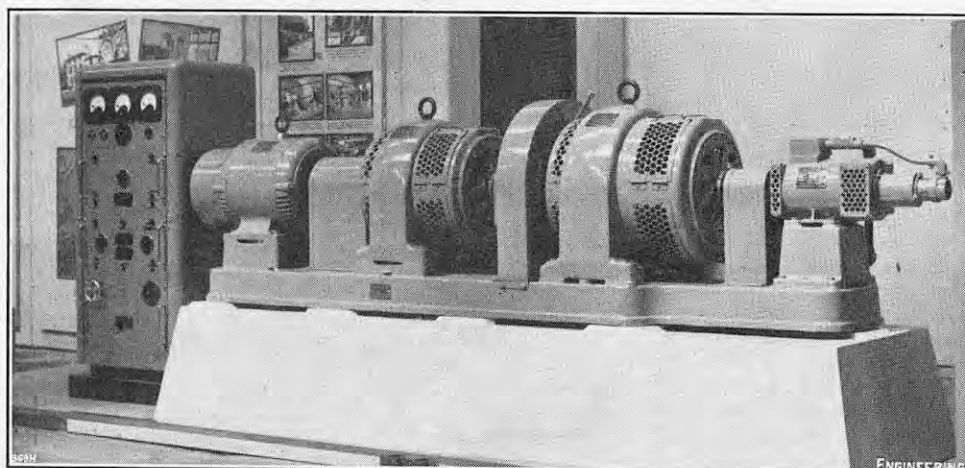


FIG. 71. MOTOR-ALTERNATOR GENERATOR SET; ELECTRIC CONSTRUCTION CO., LTD.

priming multiple-stage pumps, with outputs from 115 to 50,000 gallons per hour and heads from 10 ft. to 1,000 ft. were also displayed. They are available with petrol-engine drive or electric motor. Among their other exhibits may be mentioned an automatic-pressure water system, for shallow wells and boreholes, in which a self-priming surface-type pump is used to raise water to a pressure storage tank, from which the house system is supplied. For deep wells and boreholes, the submersible pump is used instead of the surface-type pump.

MOTOR-ALTERNATOR GENERATOR SET.

The supply of electricity for such services as telephones and radio links must be maintained in spite of interruptions and the changes in voltage and frequency which may occur on public systems. Interest therefore attaches to the "continuity" set, which was being shown by the Electric Construction Company, Limited, Wolverhampton. It consists of an alternating-current motor, an alternator and its exciter, a direct-current motor-generator and a tachometer, as illustrated in Fig. 71, above. All these machines are coupled to the same shaft and are so connected that when the voltage and frequency of the mains supply are normal the alternating-current motor drives the set and the alternator generates current. At the same time the direct-current motor-generator floats across the fully-charged battery. If, however, the mains supply fails current is drawn from the battery to drive the motor-generator, which, in turn, operates

the set so that the frequency is maintained with a range of ± 2 per cent. When the supply from the mains is resumed the alternating-current motor again takes up the drive of the set and the battery is charged from the motor-generator.

The alternator voltage is controlled by a static regulator of special design. When a number of sets are used, paralleling can be effected by an automatic synchronising unit comprising only one valve. This compares the voltage and frequency of the alternators it is desired to parallel and at the same time checks the rate of frequency change between the two sets. Provided that the voltage of the two alternators is within pre-set limits and the frequency change between the two is at a sufficiently slow rate, then the unit will automatically synchronise them at the correct time. Devices are fitted which prevent synchronisation taking place if any component fails. When the set is being driven by the direct-current motor the speed of the latter is electronically maintained within ± 1 per cent. by means of a signal received from the tachometer. The set shown was driven at a speed of 1,500 r.p.m. by a 6.5 h.p. 415-volt three-phase motor, the outputs of the direct-current motor and of the alternator being 6 h.p. at 170 to 148 volts, and 3.4 kW at 240 volts single phase, respectively. The exciter had an output of 5.1 amperes at 31 volts.

Another exhibit on this stand was the direct-on starter for squirrel-cage motors, illustrated in Fig. 70. This is of the air-break contactor type and is contained in a dust-proof case. The contacts, which are

EXHIBITS AT THE BRITISH INDUSTRIES FAIR, BIRMINGHAM.

(For Description, see Page 639.)

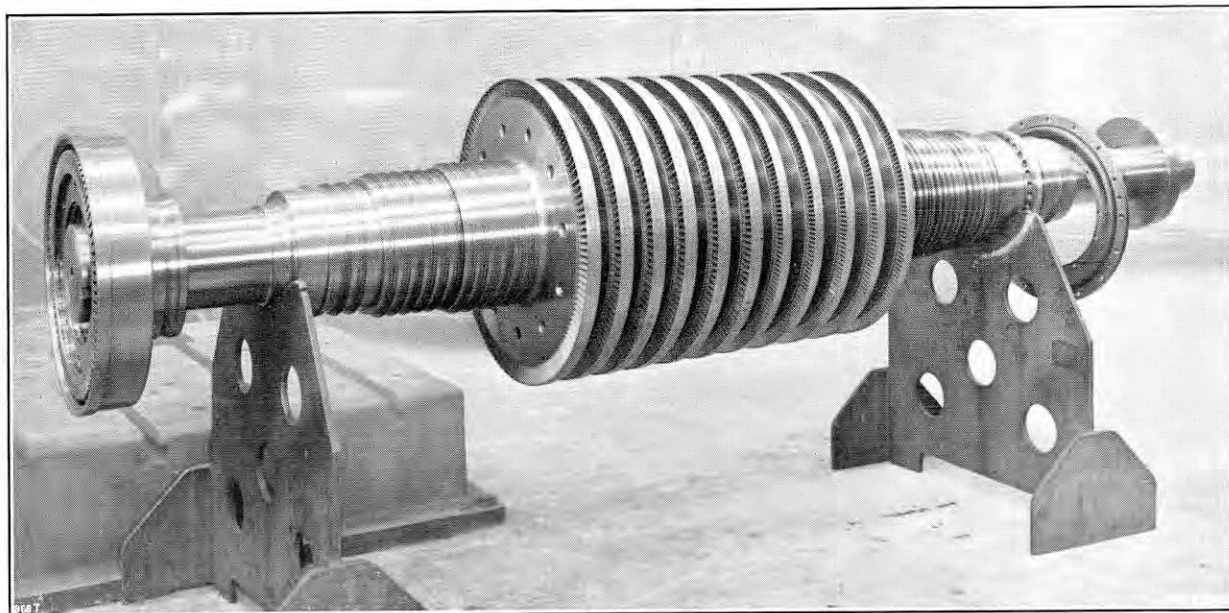


FIG. 72. HIGH-PRESSURE ROTOR FOR 60-MW STEAM TURBINE; METROPOLITAN-VICKERS ELECTRICAL Co., LTD.

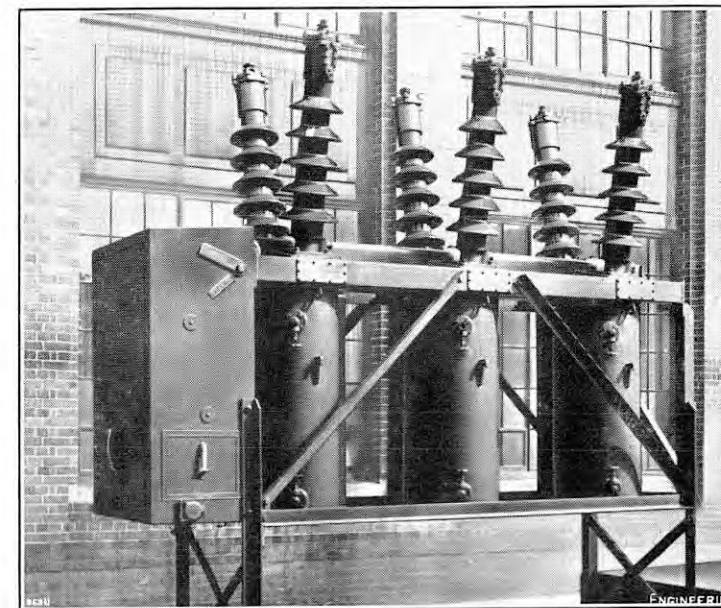


FIG. 73. 66-KV OUTDOOR OIL CIRCUIT-BREAKER; METROPOLITAN-VICKERS ELECTRICAL Co., LTD.

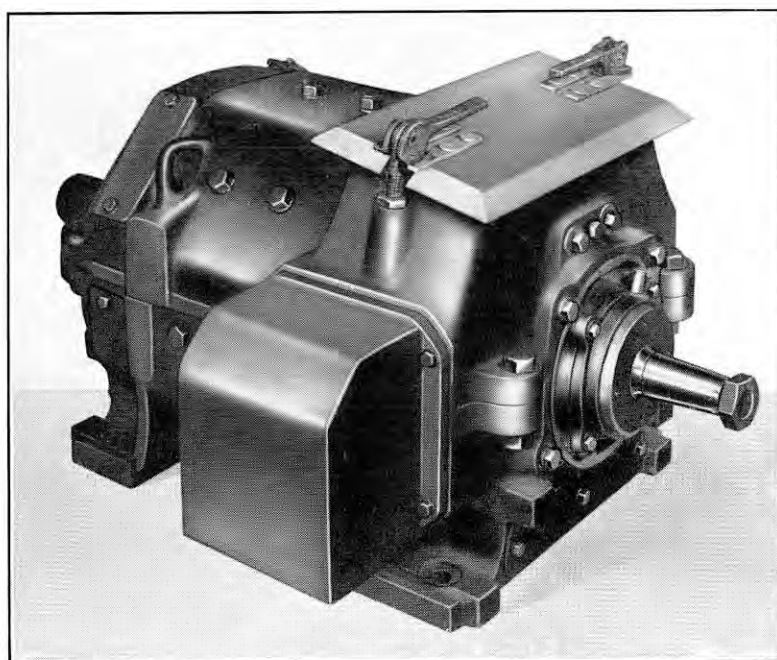


FIG. 74. 50-H.P. DIRECT-CURRENT STEELWORKS MOTOR; METROPOLITAN-VICKERS ELECTRICAL Co., LTD.

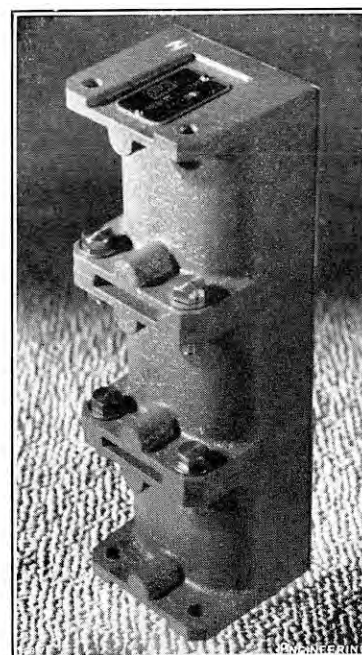


FIG. 75. MAGNETIC "FLOATER"; JAMES NEILL AND COMPANY (SHEFFIELD), LTD.



FIG. 76. MAGNETIC HOLDER; JAMES NEILL AND COMPANY (SHEFFIELD), LTD.

EXHIBITS AT THE BRITISH INDUSTRIES FAIR, BIRMINGHAM.

(For Description, see Page 639.)

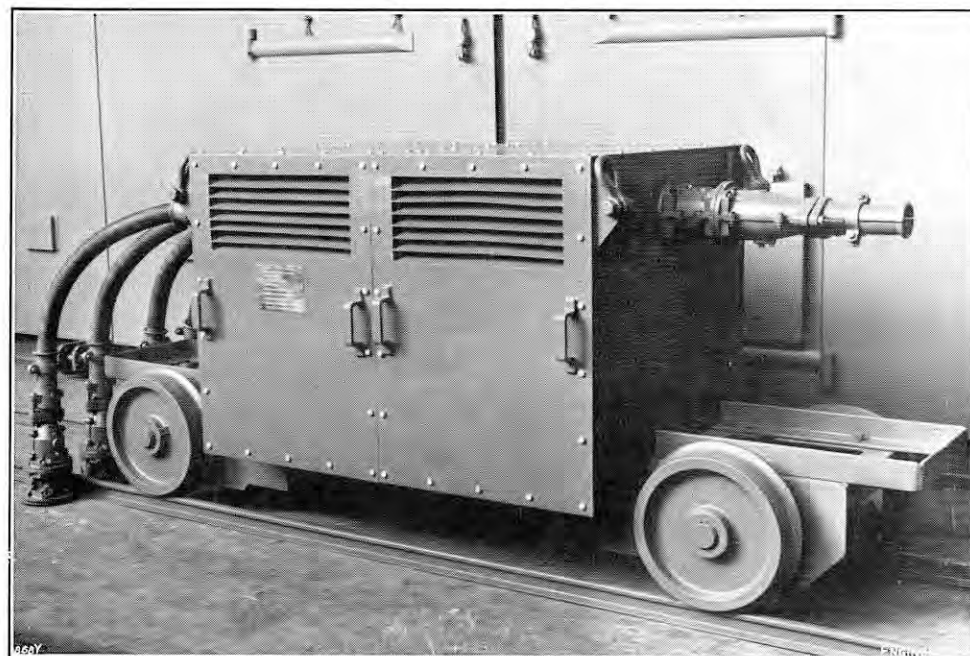


FIG. 77. 50-KW MINING RECTIFIER; ENGLISH ELECTRIC CO., LTD.

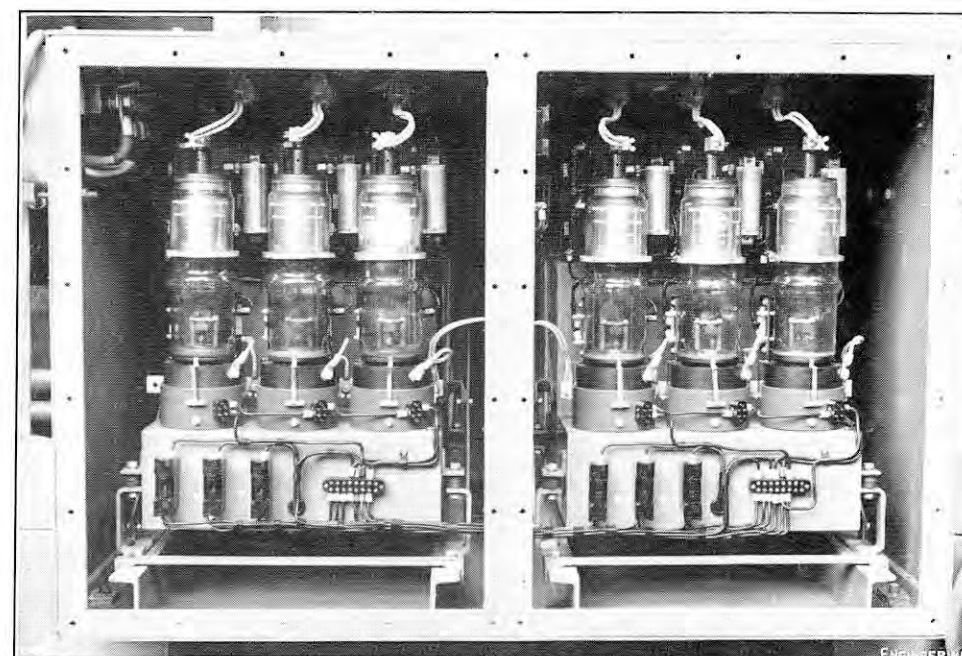


FIG. 78. 50-KW EXCITRONS; ENGLISH ELECTRIC CO., LTD.



FIG. 79. 25-KW INDUCTION HEATER; ENGLISH ELECTRIC CO., LTD.

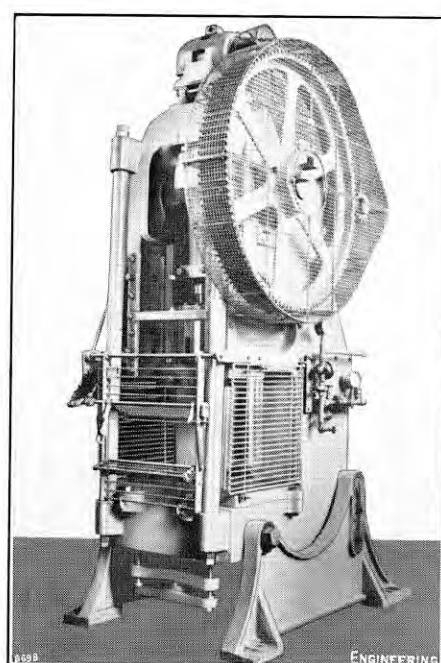


FIG. 80. 100-TON PRESS; COWLISHAW, WALKER AND CO., LTD.

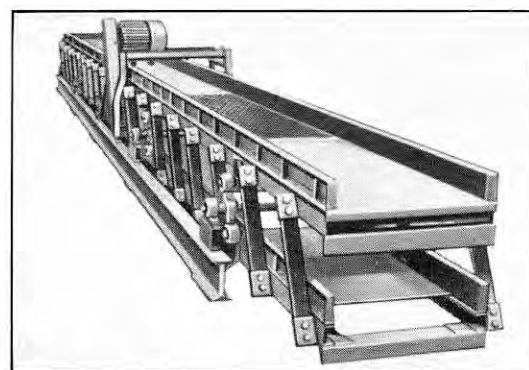


FIG. 81. VIBRATORY TROUGH CONVEYOR AND SCREEN; MCKENZIE AND BROWN, LTD.

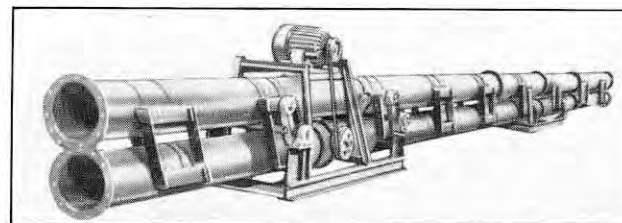


FIG. 82. VIBRATORY-TUBE CONVEYOR; MCKENZIE AND BROWN, LTD.

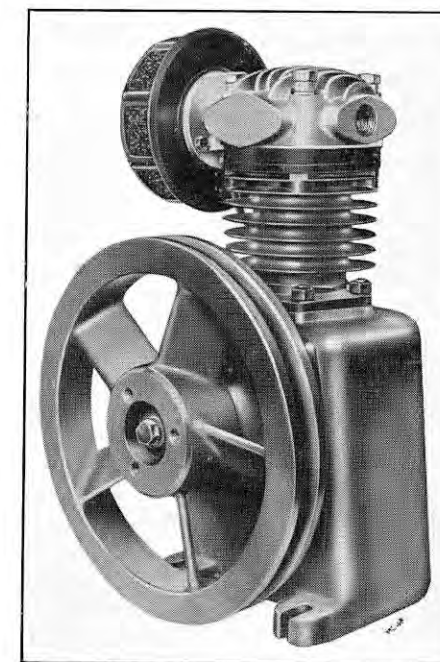


FIG. 83. AIR COMPRESSOR; HYMATIC ENGINEERING CO., LTD.

readily interchangeable, have solid silver faces and are keyed in position with a single screw fixing. The terminals for the incoming and outgoing cables are of the self-clamping type. Flash-overs between phases when breaking heavy current are prevented by arc-suppressing mouldings. The starter is fitted with magnetic overload releases with oil dashpot time lags. Both the "start" switch and the vibration-proof "stop and re-set" switch are fitted with silver contact tips. The starter is designed for motors with capacities up to $7\frac{1}{2}$ h.p. at 380/440 volts.

ROTOR FOR HIGH-PRESSURE TURBINE.

A prominent exhibit on the stand of Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, 17, was a panel giving details of their training schemes for apprentices. These schemes cover a two-year course for graduates; a four-year course, combined with part-time technical studies leading to the Higher National Certificate; and a five-year course, leading normally to employment as craftsmen, but allowing for advancement to the drawing office or other staff employment.

An example of the firm's heavy engineering products which was on view was the high-pressure steam-turbine rotor illustrated in Fig. 72, Plate XXXII. This rotor forms part of a 60-MW 3,000-r.p.m. three-cylinder set, which is to be installed in the Chadderton station of the British Electricity Authority. It weighs $3\frac{1}{4}$ tons. It will be carried in two bearings and be located axially in the casing by a thrust bearing, which will be incorporated in the inlet-end bearings. The steam conditions at the stop valve will be 900 lb. per square inch and 900 deg. F., and, after expansion through eleven high-pressure stages developing 12,000 h.p., the steam will be exhausted to the intermediate-pressure cylinder at a pressure of 342 lb. per square inch and a temperature of 679 deg. F.

The rotor, which is a fine example of British engineering skill, has been machined from a high-grade carbon-steel forging, the eleven discs being forged in one piece with the shaft. There are 1,812 stainless-steel blades, which are held in T-shaped root fastenings to the peripheries of the discs and are separated from each other by mild-steel distance pieces. Steam leakage at the points where the steam enters the cylinder will be prevented by labyrinth glands. The moving portion of these glands consists of steel sleeves which are secured to the shaft. Radial fins on these sleeves register, with running clearance, against spring-backed cylindrical-shaped fins on the stationary packing rings which are housed in the cylinder casing.

OIL CIRCUIT-BREAKER.

Another exhibit on this stand was the 66-kV oil circuit-breaker illustrated in Fig. 73, Plate XXXII. This unit has a rupturing capacity of 1,000 MVA and embodies a number of improvements compared with the earlier G3C breaker. The tension mechanism used for lifting the contacts has been replaced by a positive mechanical linkage and the tank has been designed so that the quantity of oil required is reduced to about 60 per cent. of that usually required in a "dead" tank circuit-breaker of this class. The arrangements for winding the tank have also been improved. The current transformers are arranged so that they need not be disturbed when the bushings are removed and all the control wiring is now carried in the hollow structure, instead of being accommodated with difficulty in conduit. The condenser bushings are of the spring-loaded type, so that any shock is absorbed instead of being transmitted to the rigid flange connections.

50-H.P. STEELWORKS MOTOR.

Fig. 74, Plate XXXII, shows a 50-h.p. totally-enclosed direct-current motor which runs at 500 r.p.m. This forms one of a range which has been designed by Metropolitan-Vickers to conform with the standards of the American Association of Iron and Steel Engineers. While the design of these machines is basically that of the company's steelworks motors, the use of new constructional materials and better cooling facilities have enabled a number of improvements to be introduced. The result is that a greater output for a given frame size is obtainable, commutation has been improved, the

weight and overall length have been reduced, and the maximum safe speed has been raised, as have the efficiency and the quality of the insulation, while the armature inertia has been reduced.

MAGNETIC APPLIANCES.

Messrs. James Neill and Company (Sheffield), Limited, Napier-street, Sheffield, 11, were showing a wide range of their tools, including a pad handle for accommodating broken hacksaw blades, as well as pad saw blades and other small tools. The body is of tough plastic material and the design has been improved to give a comfortable and effective grip. Mention may also be made of the V-blocks and angle plates, which were being exhibited with both webbed and open ends, and of the V-vice, a tool which combines the function of an engineer's V-block and clamp with that of a small precision vice.

Among the magnetic appliances on this stand mention may be made of the magnetic float unit illustrated in Fig. 75, Plate XXXII. This has been designed for handling ferrous sheets and other parts and is made in two standard sizes which can be used either singly or in groups. These floaters can be fixed either to a machine or to a bench and their position can be adjusted, as may be required. In operation, the floaters are placed against the edges of the workpiece, which are thus magnetised by induction, the action being such that a repelling action is set up and the piece floats. Another magnetic device on this stand was the holder illustrated in Fig. 76, Plate XXXII. It is for holding work that has to be welded, or secured to machine tools. It comprises a permanent magnet, the flux from which can be adjusted by a rotating handle. It is primarily intended for use as a portable unit, but a $\frac{1}{2}$ -in. Whitworth, tapped hole is provided in the base so that it can be secured, if necessary. It is, of course, independent of the mains supply and the only maintenance necessary is occasional oiling and truing up of the magnet faces, which must be flat and smooth if the maximum holding power is to be exerted. It can be provided with three V-pole faces for holding round bars or tubes at different angles, or with plain faces for securing flat sections.

50-KW MINING RECTIFIER.

The exhibits on the stand of the English Electric Company, Kingsway, London, W.C.2, included one showing a typical lay-out for a Diesel power house. This comprised one of the firm's 300-h.p. Diesel engines, which was coupled to an alternator and exciter, and an example of their type O.B.2 switchgear and a combination fuse switchboard. A number of interesting examples of rectifier equipment were shown, including the 50-kW 250-volt unit for use in mines, which is illustrated in Fig. 77, Plate XXXIII. This consists of transformer and rectifier sections, both of which are mounted on flanged wheels and are of compact design. The transformer, which is oil-immersed in a welded-steel tank and is naturally cooled, has a delta-connected primary and a six phase double-star connected secondary. An inter-phase transformer is contained in the same tank. The normal primary voltage is 3.3 kV, but an off-load tapping switch allows this to be varied from $+2\frac{1}{2}$ to -5 per cent. The circuit is controlled by an automatic breaker of the mining type. The tank is fitted with wheel assemblies at each end, which can be adjusted for track widths from 18 to 36 in., while the clearance from the floor can be either 1 in. or 5 in.

The rectifier consists of six excitrons, which are mounted in a cubicle, the wheel assembly of which is similar to that used for the transformer. These excitrons are single-anode mercury-pool cathode rectifiers, which are contained in a glass envelope. As will be seen from Fig. 78, Plate XXXIII, they are arranged in groups of three on two carriages and can be easily removed for maintenance and inspection. These carriages also support the ignition and excitation components, as well as the cooling fan and motor and the necessary ducting. They are each mounted on four soft-rubber bushes and the cooling air is drawn in through louvres in one side and then passed through glass-wool filters and finally, exhausted through louvres on the other side.

Thermostats are fitted on each excitron to interrupt the supply after prolonged overload or

shortage of air. The main and auxiliary connections are provided by four flexible cables with flameproof plugs which fit into sockets on the transformer. A relay actuated by current flowing to earth from the centre point of a resistance connected across the direct-current output excites a current transformer with the result that current is set up to trip the alternating-current circuit-breaker.

25-KW INDUCTION HEATER.

Fig. 79, Plate XXXIII, illustrates a 25-kW induction heater, which has been produced by the same firm for heating ferrous and non-ferrous metals prior to forging, and for melting them. In addition, the through and surface hardening and the annealing and brazing of these materials can be effected. As will be seen, the heater is housed in a sheet-steel cubicle within which the components are mounted on vertical panels, thus saving floor space and facilitating access. The oscillator valve, which was made by the English Electric Valve Company, Limited, is air-cooled and the rectifiers are of the mercury-pool type with grid control. The three-phase input is supplied to a transformer and then rectified, the grid control allowing stabilisation of the high-tension voltage, manual adjustment of the output from zero to full load, rapid switching and variation of the oscillation grid current. The input power is 50 kW at 360 to 440 volts on the three-phase system at a frequency of 50 and the output 25 kW at 450 kilocycles per second. An output of 30 kW can, however, be obtained on intermittent operation if the output circuit is suitably designed.

The circuit-breaker incorporated in the O.B.2 switch mentioned above is of the air-break type, in which the arc is interrupted in an air path at normal atmospheric pressure. It consists of a one-piece frame for each pole, the three frames comprising the unit being mounted on a common panel of insulating material and being coupled by an insulated bar, so that they can be simultaneously operated. These frames carry the individual contact system as well as the operating and tripping mechanisms. The contact system comprises main contacts of wedge-shaped copper blocks, which are carried by a pivoted central arm. This arm is spring-loaded to ensure high-pressure line contact. In their closed position these blocks bridge two fixed contacts, which are connected to the circuit-breaker terminals. There is also an arcing contact above each main contact. The operating mechanism is of the trip-free type and a high speed of breaking has been obtained by making the moving parts as light as possible and using powerful springs to produce the initial acceleration.

POWER PRESS.

Messrs. Cowlshaw, Walker and Company, Limited, Railway Engineering Works, Biddulph, Stoke-on-Trent, Staffordshire, exhibited an OT-100 open-fronted geared inclinable press with a rated capacity of 100 tons, a photograph of which is reproduced in Fig. 80, on Plate XXXIII. In common with all the power presses made by this company, the OT-100 press is of robust construction, with heavy-duty cast-iron frames. It has an oversize crankshaft, so that it can, in fact, be operated at overloads. The press is driven by a 10-h.p. motor through a single-reduction gear, at a speed of 30 strokes per minute. The stroke is 8 in. It is fitted with an electro-pneumatic clutch-brake unit of the type exhibited at Castle Bromwich last year, and described on page 551 of our 171st volume (1951), which provides two running sequences and inching for tool setting. The shut height, from the slide face to the top of the bed, is 20 in. The slide is 14 in. deep and 17 in. wide, with a hand adjustment of $3\frac{1}{2}$ in. The bolster is 27 in. deep, 37 in. wide, and $3\frac{1}{2}$ in. thick. The company also displayed examples of large and small pressings made on their machines.

VIBRATORY CONVEYORS AND SCREENS.

Messrs. McKenzie and Brown, Limited, Caernarvon, North Wales, exhibited examples from their Macbee range of vibratory conveyors and screens for use in the coal and mining industries, cement manufacture, plastics and food processing, chemical works, etc. Two of the exhibits are illustrated in Fig. 81, Plate XXXIII, which shows a trough conveyor and screen for general purposes, and in

Fig. 82, Plate XXXIII, which shows a tube conveyor recommended for finely-powdered materials, such as cement or flour. In all Macbee machines, the upper and lower tubes or troughs, which are balanced, are arranged to oscillate in opposition by an eccentric drive; they are linked by steel leaf-springs and centrally-pivoted link arms mounted on Silentbloc bearings, so that no vibratory forces are transmitted to the frame. Since elaborate foundations are not necessary, they can be quickly installed. The material is conveyed in a series of small jumps, and it is claimed that the abrasion on the conveyor troughs is practically negligible. They are thus particularly suited to such materials as hot cement clinker.

The KR III-500 trough conveyor and screener comprises two heavy built-up steel troughs, the lower trough being provided with wire screens. The springs, mounted on each side of the built-up steel-plate link arms, are of silicon manganese steel. It is made in a range of lengths from 19 ft. 8 in. to 39 ft. 3 in. A 2-h.p. electric motor is required to drive a 32-ft. 9-in. unit which weighs approximately 35 cwt. The eccentric drive, connected to the bottom tray, excites 1,250 vibrations per minute. Only four bearings on the eccentric drive require greasing; all the other bearings are rubber mounted. The conveyor has a capacity of 66 cubic yards of coal per hour, 51 cubic yards of gravel, 18 cubic yards of sand, 44 to 55 cubic yards of chalk, or 49 cubic yards of finely-powdered limestone. The trough will withstand materials at temperatures up to 400 deg. C. It is possible to convey certain material up a 15-deg. gradient. A screening efficiency to within 4 per cent. of hand screening can be obtained.

The KR 31 tube conveyor illustrated in Fig. 82, consists of two 12-in. diameter tubes of $\frac{1}{8}$ -in. steel plate; in other respects its construction is similar to that of the KR III-500. It is manufactured in a range of lengths from 32 ft. 9 in. to 163 ft. 9 in., with electric motors ranging from $1\frac{1}{2}$ h.p. to 6 h.p. A 32-ft. 9-in. unit weighs about 34 cwt. The carrying capacity is slightly less than that of the KR III-500—for example, it will convey 45 cubic yards of finely-powdered limestone per hour.

SMALL COMPRESSOR UNIT.

The Hymatic Engineering Company, Limited, Redditch, Worcestershire, displayed stationary and mobile compressor sets and ancillary equipment, spray guns, nozzles and air hammers. Fig. 83, Plate XXXIII, shows a new compressor, the 100 S.A.S., designed for such duties as pneumatic braking, tyre inflation, paint spraying, operating pneumatic tools, etc. It has a displacement of 7.5 cub. ft. of air per minute at 2,000 r.p.m. at a pressure of 80 lb. per square inch. The maximum delivery pressure, at 1,500 r.p.m., is 100 lb. per square inch. At 2,000 r.p.m., the compressor absorbs 1.34 h.p. It weighs 36 lb. It is an air-cooled single-cylinder compressor with a bore of 1.97 in. and a stroke of 2.16 in., giving a cubic capacity of 6.56 cub. in., and may be belt driven or directly coupled to the power unit. The V-belt pulley, 8 $\frac{1}{2}$ in. in diameter, assists in the circulation of cooling air. The cylinder comprises a cast-iron liner fitted in a barrel, of finned aluminium, to give high heat dispersion. Low-lift plate-valves are fitted; the suction and delivery valve assembly can be removed as a single unit to facilitate servicing. The piston is of light alloy, with one oil-scraper ring and two compression rings. An I-section forged-steel connecting rod is fitted with roller bearings in the big end; the small end has a phosphor-bronze bush. The overhung crankshaft, of copper-brazed construction, has an integral balance weight, and is carried in a wrapped-bush type of main bearing. Splash lubrication is provided to the cylinder, piston, big-end and main bearings. The oil sump has a capacity of 1.5 pints; the oil consumption is 2.25 c.c. per hour. An oil-wetted air filter is supplied to prevent foreign matter entering the air inlet.

MOULDING MACHINE FOR PLASTICS.

Messrs. R. H. Windsor, Limited, Chessington, Surrey, showed a range of plastics-moulding machines, among which was an automatic injection moulding machine with a capacity of 1 oz. per

EXHIBITS AT THE BRITISH INDUSTRIES FAIR.

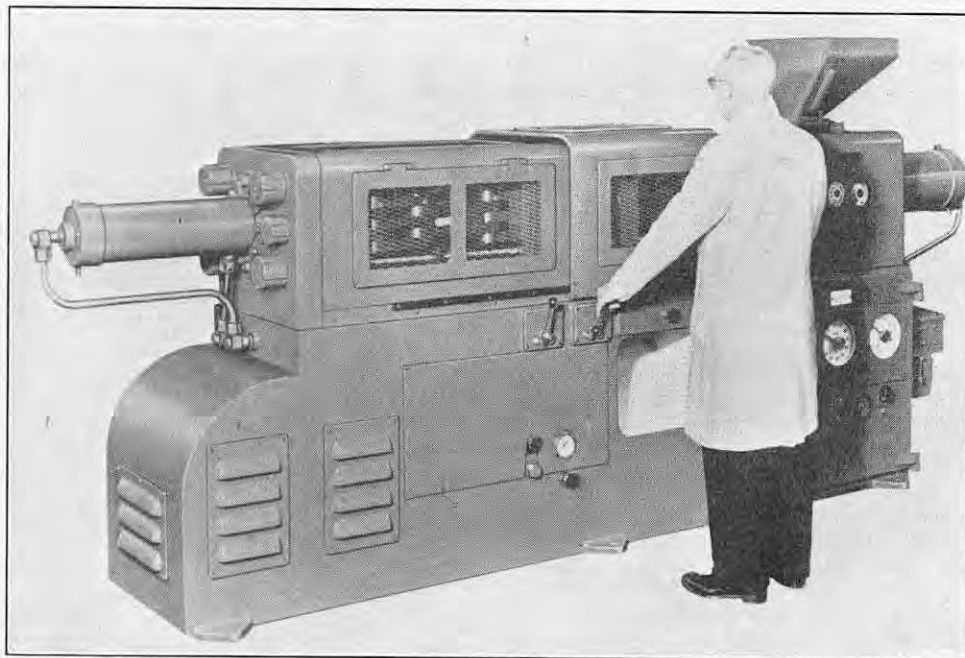


FIG. 84. 4-OZ. INJECTION MOULDING MACHINE: R. H. WINDSOR, LTD.

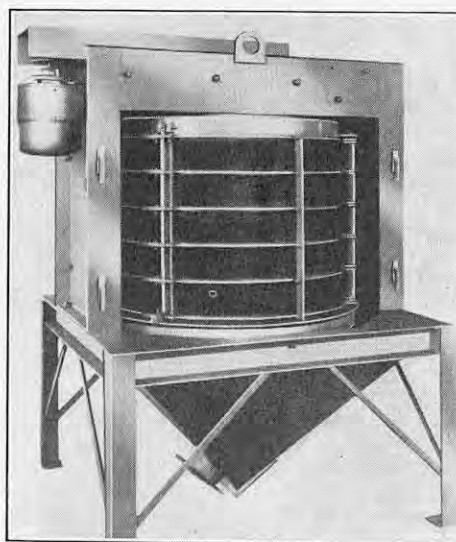


FIG. 85. SYMONS V-SCREEN; NORDBERG MANUFACTURING CO.

shot, displayed for the first time. It is capable of 420 shots per hour on a dry run. With 16 in. by 11 $\frac{1}{2}$ in. mould plates, the maximum area moulded is between 10 and 12 sq. in. It has a hydraulic locking load of 30 tons and an injection pressure of 20,000 lb. per square inch on the thermoplastic material. Hydraulic pressure is supplied by a Vickers V-139 US7 double pump, driven by a 7 $\frac{1}{2}$ -h.p. motor. The pump and motor are mounted on a cradle as a unit, housed within the welded-steel base of the machine. The lower part of the base forms a hydraulic reservoir. The control gear for operating the machine on a semi-automatic cycle is mechanical. As in the larger injection-moulding machines manufactured by Messrs. R. H. Windsor, the injection unit, comprising the material cylinder, the hydraulic-pressure cylinder, and the feed hopper and mechanism, is retractable to give easy access to the sprue bush and material cylinder. The injection is interlocked with the clamp, to ensure that injection cannot take place until the machine is locked.

Another moulding machine shown by Messrs. R. H. Windsor, the SH4, illustrated in Fig. 84, had an electrical controlling unit, demonstrated for the first time. This unit provides completely automatic control of a continuous operating cycle, and stops the machine if the mould plates are obstructed by any foreign matter thicker than

0.005 in. The SH4 moulding machine has a capacity of 4 oz. per shot, and can operate 180 shots per hour. The locking load on the mould plate is 150 tons. The injection pressure on the material is 13,850 lb. per square inch. Hydraulic pressure is supplied by a Vickers balanced vane pump driven by a 15-h.p. electric motor. Also being demonstrated on this firm's stand was the extrusion, using their 100-ton twin-screw extruding machine, of chemical tubing from polyvinyl chloride powder, without an added plasticiser which reduces the chemical resistance of the material. Normally, the powdered form of polyvinyl chloride has to be converted to pellets before feeding to the extrusion machine, because the powder tends to flow back over the extrusion screw. The twin-screw arrangement adopted in the Windsor multi-screw extruders eliminates this disadvantage. A plant for colouring and pellet-forming powdered polystyrene, incorporating a multiple-screw extrusion machine, was also demonstrated. The polystyrene powder, known as Distrene, has been specially developed for use with multiple-screw extruders by Messrs. British Resin Products, and is a cheaper raw material than the coloured pellets usually supplied to moulders.

SCREENING AND CRUSHING MACHINES

The Nordberg Manufacturing Company, Brook house, Park-lane, London, W.1, were showing, on an outdoor stand, a range of crushing machinery, among which was a new type of fine-mesh rotary screen, known as the Symons V screen, illustrated in Fig. 85. In this machine, the screening surface, a vertical cylinder 3 ft. high and 12 ft. in circumference, has imposed upon its rotary motion an eccentric gyratory movement. The material to be screened is fed on to a cupped feed plate, with radial vanes; and is thrown by centrifugal force against the screening surface, which allows the fines to pass through. Fourteen times in each rotation the gyratory motion exerts an inward force on the material, which drops through a short distance, and clears the screening surface; the oversize material at the bottom of its downward travel is discharged through the base of the drum. The Symons V-screen has been tested successfully on both wet and dry products. The centrifugal action is highly effective in de-watering; and owing to the fanning action, the screen is particularly suitable for very fine dry materials.

Another Nordberg screen shown at the Fair was the Symons Rod Deck screen, primarily for mine screening, in which the screening surface comprises spring-steel rods held in position by moulded-rubber spacers. It is particularly suited to wet and

EXHIBITS AT THE BRITISH INDUSTRIES FAIR, BIRMINGHAM.

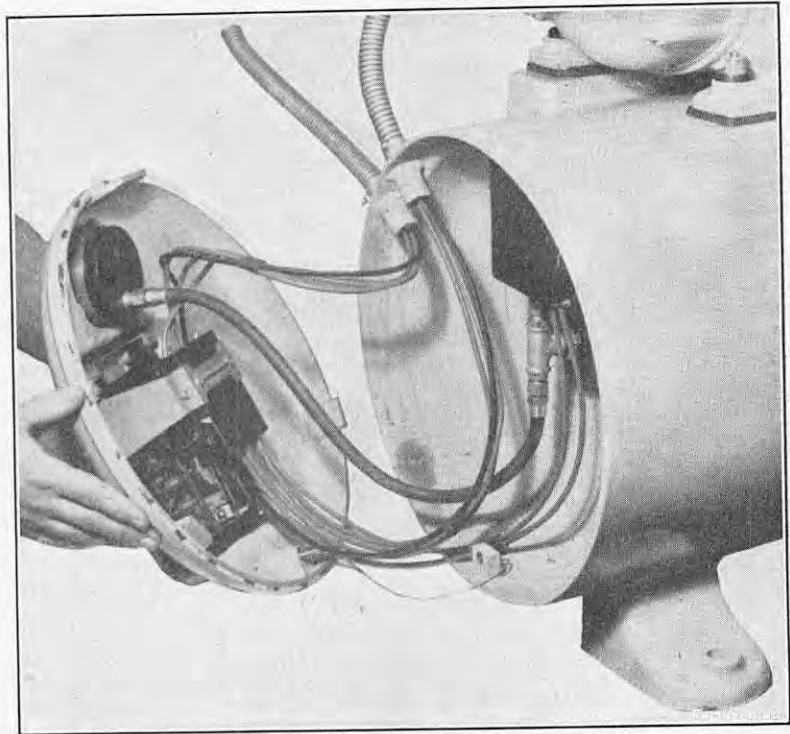
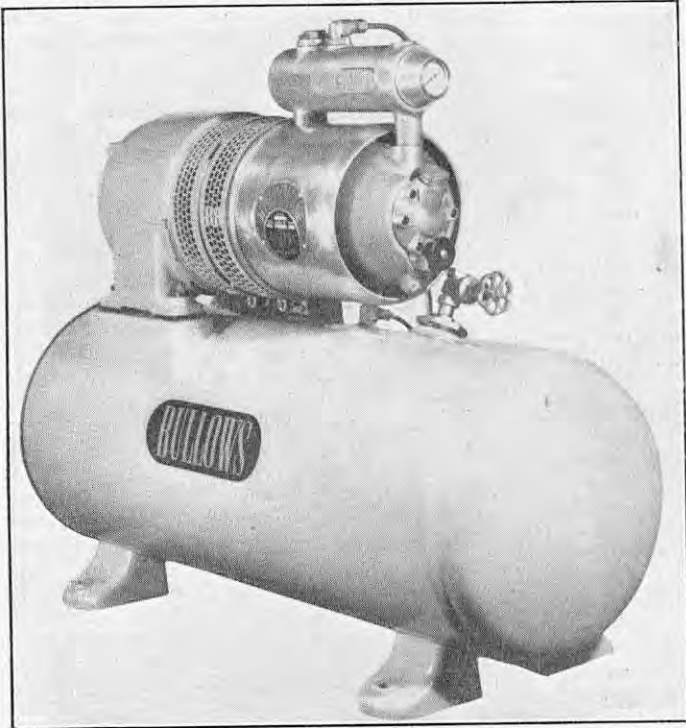


FIG. 86.
FIGS. 86 AND 87. "HYDROVANE" AIR COMPRESSOR; ALFRED BULLOWS AND SONS, LTD.

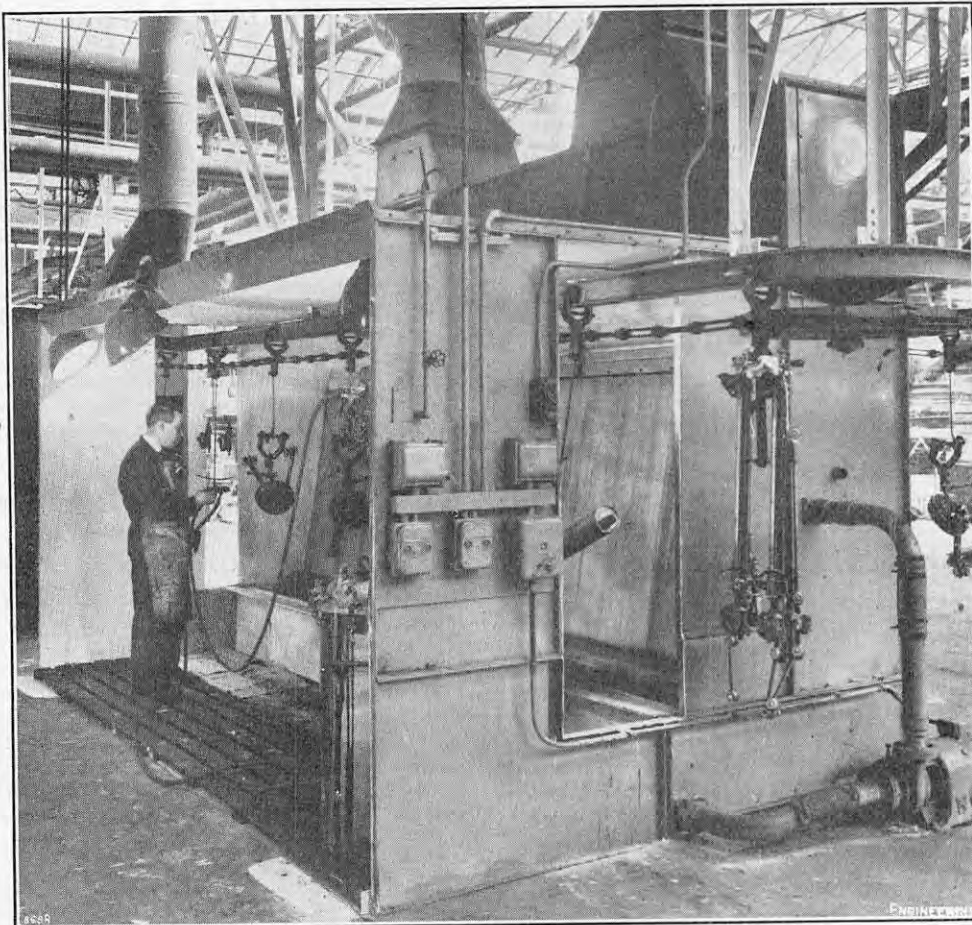


FIG. 88. WATER-WASH SPRAYING BOOTH; ALFRED BULLOWS AND SONS, LTD.

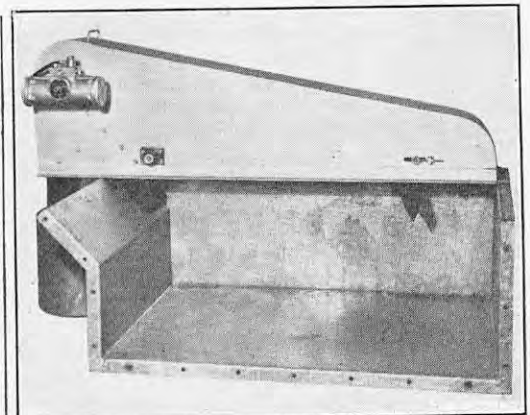


FIG. 89. AUTOMATIC SCUMMER; ALFRED BULLOWS AND SONS, LTD.

sticky ores, and is available in widths of 3 ft., 4 ft., and 5 ft., with lengths of 6 ft. and 8 ft. Also on view was the Symons 22-in. intermediate cone crusher, a compact general-duty machine suitable for small and medium-size plants.

ROTARY-VANE COMPRESSORS.

The exhibits on the stand of Messrs. Alfred Bullows and Sons, Limited, Long-street, Walsall, Staffordshire, included a selection from their new

range of rotary compressors. Known as the Hydrovane series, these machines are of the sliding-vane or crescent type. The problems of leakage inside the compressor and efficient lubrication have been overcome by introducing a sufficient quantity of oil into the compressor to keep all the internal parts flood-lubricated, the oil providing a seal for the internal clearances in addition to carrying out its normal function of lubrication. Oil contamination of the discharge air is prevented by means of a

simple labyrinth which removes over 99 per cent. of the entrained oil, the remainder being removed by a separate filter. The oil is contained in an annular chamber which surrounds the compressor and into which the compressor discharges; it is, therefore, always subjected to the discharge air pressure and, as a consequence, is circulated through the lubricating system without recourse to a separate pump. On leaving the sump, the oil passes through a filter and, when fitted, a cooler, and is directed into ports incorporated in the end covers. These ports are connected to all the leakage paths in the compressor which, as a result, are always full of oil at the discharge pressure, leakage thus being prevented. The rate of oil flow is uncontrolled except by the actual clearances and the air pressure, so that the flow adjusts itself to the requirements of clearances and load. Use of this method for lubricating and sealing the compressor gives an added advantage, as the thermal capacity of the oil in circulation is so large in relation to that of the air that nearly all the heat generated during compression is transferred to the oil.

The only moving parts of the compressor are a slotted Meehanite rotor and a number of alloy cast-iron vanes. The compressor, oil vessel, air vessel, etc., are designed so that they form a single unit which is spigot-mounted on the driving motor. As will be seen from the unit illustrated in Fig. 86, herewith, this arrangement gives a neat appear-

ance. These machines are controlled by the manufacturers' hydraulically-actuated constant-pressure system which operates to adjust the volume of air admitted to the compressor and thus balance exactly and continuously that drawn from the receiver. A stop-and-start control is also provided, consisting of an adjustable automatic pressure switch and a contactor starter, the pressure switch carrying the current in the pilot circuit only. The switch is adjustable for cut-out pressures from zero to 200 lb. per square inch and is contained in a false end of the air receiver, which acts as a cover. This cover is shown removed in Fig. 87, on page 643.

WATER-WASH SPRAYING BOOTH.

Other exhibits on the stand of Messrs. Alfred Bullows included a water-wash paint-spraying booth of the type illustrated in Fig. 88, on page 643. This shows a booth in use at the works of the Standard Motor Company, whereas the one exhibited, which is similar, was intended for installation in an aircraft factory. These booths are designed so that the paint is removed from the water at the earliest possible moment to a point where it is isolated and cannot re-enter the circuit and can easily be extracted. This is accomplished by directing the return water from the screens and washing chamber into a V-shaped channel designed to give a high rate of flow, thus ensuring that all particles are carried down with the water, and arranging for the discharge end of the channel to be submerged below the surface of the water in the return tank and so preventing any possibility of the particles being picked up in the air flow. The water entering the tank has sufficient momentum to carry all floating material to the far end of the tank, where it is held in a special section and compacted by an air jet. It is removed by the automatic scumming device illustrated in Fig. 89, on page 643; this consists of a series of buckets fastened to an endless belt driven by a Bullows type L 20 air motor, the buckets continuously collecting and removing the floating deposits of paint. Special care has been taken also with the design of the filtration system, the filters consisting of a series of removable coke-filled baskets supported by frames in the bottom of the tank. The filter baskets cover the complete plan area of the tank, the total area being sufficient to ensure that the water velocity never exceeds 6 in. per minute through the filters. The spray nozzles are of a simple non-clogging design and can each pass a $\frac{3}{8}$ -in. diameter solid. The associated pipe-work, etc., is arranged so that rodding-out, or cleaning can be effected with the pipes *in situ*.

FILLET-ROLLING MILL AND DRAWING PRESS.

Messrs. Taylor and Challen, Limited, Constitution-hill, Birmingham, exhibited the mill and press shown in Fig. 90, Plate XXXIV, and Fig. 95, Plate XXXV, as well as an inclinable single-action press of 20 tons capacity. The 14-in. diameter fillet-rolling mill (Fig. 90) is used in mints for breaking down and thinning gold, silver, bronze and nickel fillets and strips. The rolls are of chilled iron, turned, lapped and polished. The top roll and bearings have spring suspension, and are adjustable by a scaled handwheel. Both rolls can be removed without disturbing the housings. The drive is by an 80-h.p. motor through machine-cut double-helical gearing contained in a sealed gear-case. All bearings, and also the gear teeth, are lubricated automatically by a mechanical pump system. The roll faces are 16 in. wide, and the mill rolls fillets up to 2 in. thick at a speed of 120 ft. per minute. The double-action drawing press, size 3 $\frac{1}{2}$, which is shown in Fig. 95, is used in the hollow-ware industry for deep-drawn articles in sheet metal, brass or aluminium. It will admit a blank up to 14 in. in diameter, and will draw a cup up to 10 in. in diameter and 2 $\frac{1}{2}$ in. deep, or 5 $\frac{1}{2}$ in. diameter by 5 in. deep. The pressure on the blank during the drawing process is obtained from cams, thus eliminating the need for expensive combination tools and power-absorbing pressure devices. The press is double-geared and is controlled by a Taylor and Challen patent key clutch and one-stroke trip. The press is driven by a 7 $\frac{1}{2}$ -h.p. motor running at 950 r.p.m. An operator's guard is fitted. The press at the Fair was used to

demonstrate the drawing of a typical deep seamless cup.

DIESEL GENERATING SET.

Messrs. Houchin, Limited, Garford-street, London, E.14, displayed their HLD alternators in several forms. That illustrated in Fig. 91, Plate XXXIV, is the 93-kW type BH 3/8 machine coupled to a Dorman Diesel engine. An 83-kW alternator was shown coupled to a Crossley engine and a 360-kW alternator, for 400-volt three-phase 50-cycle current, was shown with its control panel. The BH 3/8 machine (Fig. 91) has been designed for operating at a power factor of 0.8. It is of the salient-pole rotating-field type, and runs at a speed of 1,500 r.p.m. It is wound for 400/440 volts three-phase 50-cycle current, and is star-connected with a neutral link brought out for four-wire operation. The alternator is made and continuously rated in accordance with B.S. 168-1936. The all-steel stator is arranged for semi-recessed mounting and is fitted with an accurately-machined end cover. The rotor, also of steel, has a heavy-duty steel shaft supported by a spherical-roller bearing, and is of the enclosed ventilated type, with the windings cooled by a large fan. The 110-volt direct-current 2-kW exciter is bolted by its body flange to the alternator end-shield, with its armature carried wholly by an extension of the alternator shaft. The efficiency of the machine is not less than 89.5 per cent. at full load and three-quarter load, and 87.7 per cent. at half load. The voltage regulation is not more than 15 per cent. at unity power factor and 35 per cent. at 0.8 power factor, in accordance with B.S. 1084-1942. An enclosed control panel is mounted above the alternator. It is fitted with a triple-pole totally-enclosed switch-fuse; three ammeters reaching from 0 to 200; a voltmeter reading from 0 to 500; a frequency meter; instrument fuses; and A.V.R. control gear.

The Dorman engine to which the alternator is coupled is a six-cylinder unit running at 1,500 r.p.m. Its continuous 24-hour rating is 131 h.p.; continuous 12-hour rating is 145 h.p.; and the one-hour maximum overload is 160 h.p. The fuel consumption, assuming a fuel with a net calorific value of 18,500 B.Th.U. per pound, is about 6.4 gallons an hour at the 93-kW rating. The coupled set is mounted on a heavy folded-section steel base, arranged for bolting to a concrete foundation. A 40-gallon daily-service fuel tank is provided in the base.

PELLETING MACHINE FOR PLASTICS.

British Industrial Plastics, Ltd., 1, Argyll-street, London, W.1, and their subsidiary companies, exhibited, on several stands, a wide range of mouldings, Bipel hydraulic moulding presses, sand cores bonded with Beetle resin W20, a complete induction-heating button mould, and the plastics-pelleting machine illustrated in Fig. 92, Plate XXXIV. This machine, which is made by B.I.P. Engineering, Limited, Aldridge-road, Streetly, Staffordshire, is designed for producing standard pellets of large size, say 2 in. and upwards. It applies a controlled pressure for a predetermined time and therefore produces pellets which are standard in size, weight and density. It overcomes certain inherent difficulties obtaining in mechanical presses, namely, the risk of an overload of powder; the shock loads on the links and pins caused by the cam operation; the inconsistency of the "fill," and therefore of the density of the pellets; and the short pressure application, which makes it impossible to pellet difficult powders. The number of pellets that can be made per minute on the machine varies slightly with the weight, the rate being approximately 22 small ($\frac{3}{8}$ in. thick) to 18 large ($1\frac{1}{8}$ in. thick). With a full pressure of 35 tons it is possible to exert 5 tons per square inch on a 3-in. pellet. Due to variations in the powder, however, 2 $\frac{3}{8}$ in. is a safer maximum working diameter, giving 8 tons per square inch on the powder. The makers claim that the main advantages of this horizontal machine over conventional machines are complete freedom from machine damage, ease of cleaning, no powder loss, equal pellet density, no jamming of the punches in the die, simplicity of control, and lower power consumption. The machine will handle some powders which cannot be pelleted by normal means. This is the result of the hydraulic squeeze applied

and the length of time during which it can be made to act.

The principle of the machine is shown in Figs. 101 to 104, on page 645. Referring to Fig. 101: *a* is a fixed punch, *b* is a moving punch attached to hydraulic ram *c*, and *d* is the die, to which the hopper is attached. The distance between *a* and *b* can be varied to alter the weight of pellet produced; this is done by means of an adjustable back stop for the ram *c*. The die, together with the hopper, is moved by hydraulic jacks. The filling position is shown in Fig. 101, the gap between the punches being in the lower part of the hopper. The die and hopper are then moved to the left, to the position shown in Fig. 102, with the gap between the punches full of powder, enclosed within the die. Fig. 103 shows the pellet being made; the ram *c* has moved forward, carrying the moving punch *b* with it and compressing the powder in the die. Finally, the die and hopper are moved to the extreme left, as shown in Fig. 104; the pellet is ejected while the ram *c* is moving back. The die and hopper are then returned for the next cycle.

1 $\frac{1}{2}$ -IN. SELF-PRIMING PUMP.

The Saunders Valve Company, Limited, Cwmbran, Newport, Monmouthshire, showed various types of diaphragm valves, including several designed for special purposes, also the 1 $\frac{1}{2}$ -in. self-priming pump illustrated in Fig. 93, Plate XXXIV. This unit is intended for contractors, civil engineers, etc., and has been designed for heavy and continuous duty. It is automatically self-priming and is fitted with a mechanical seal. The impeller, mounted on the engine shaft, is capable of dealing with dirty water containing solids up to $\frac{3}{8}$ in. in size. The pump may be fitted with either a petrol engine or an electric motor, forming a readily transportable unit.

LIGHTWEIGHT PUMP.

The new Pegson-Marlow "Mud-Hog" pump illustrated in Fig. 94, Plate XXXIV, was exhibited by Messrs. Pegson, Limited, Coalville, Leicestershire. It is intended for ditch work and seepage control, and is easily wheeled by one man or lifted into a truck by two men. The pump is fitted with a Gould No. 3 diaphragm, and readily-accessible quick-opening clean-out and drain hole, and replaceable self-cleaning valve seats. Power is provided by a J.A.P. petrol engine which develops 1 $\frac{1}{2}$ h.p. at 1,800 r.p.m. and 1 $\frac{3}{4}$ h.p. at 2,500 r.p.m. An enclosed chain drive with a reduction ratio of 5:1 transmits the power to a crankshaft which runs in two bronze-lined bearings. The pump is made in two sizes, namely, 2 in. for the Model 202, and 3 in. for the Model 302. The capacities of each, assuming clear water, an open discharge and 60 strokes per minute, are as follows: Model 202, 37 gallons per minute with a 10-ft. suction lift and 25 gallons with a 20-ft. lift; Model 302, 43 gallons per minute with a 10-ft. lift and 34 gallons with a 20-ft. lift.

SAND-RAMMERS.

Foundry Equipment Limited, Linslade Works, Leighton Buzzard, Bedfordshire, showed two sand-rammers, a batch-type sand mill, and a disintegrator. Their Junior and Major sand rammers are self-contained units, each with an output of 600 lb. of rammed sand per minute. The Junior machine, which was exhibited at the 1951 Fair, is designed to cover a maximum box size of 4 ft. 6 in. square by a rotary movement, whereas the Major, now shown for the first time, covers a maximum box size of 2 ft. 10 in. square by a rotary and reciprocating motion.

Fig. 96 on Plate XXXV illustrates the Major sand-rammer, which was shown with a vertical electric skip-hoist loader. It consists of a self-contained hopper; the ramming assembly is mounted on the base of the main structural unit carrying the hopper. If desired, a larger independent hopper and a belt can be provided where repetition or continuous ramming is required. The standard 10-cwt. hopper is fed from the hopper by a 15-in. wide conveyor belt, chain-driven by a 1-h.p. geared motor. The sand from the hopper is delivered on to a belt mounted on the arm carrying the impeller head. The impeller and the belt are both driven by a 10-h.p. motor through a horizontal universally coupled shaft. Both the Major and

EXHIBITS AT THE BRITISH INDUSTRIES FAIR, BIRMINGHAM.

(For Description, see Page 639.)

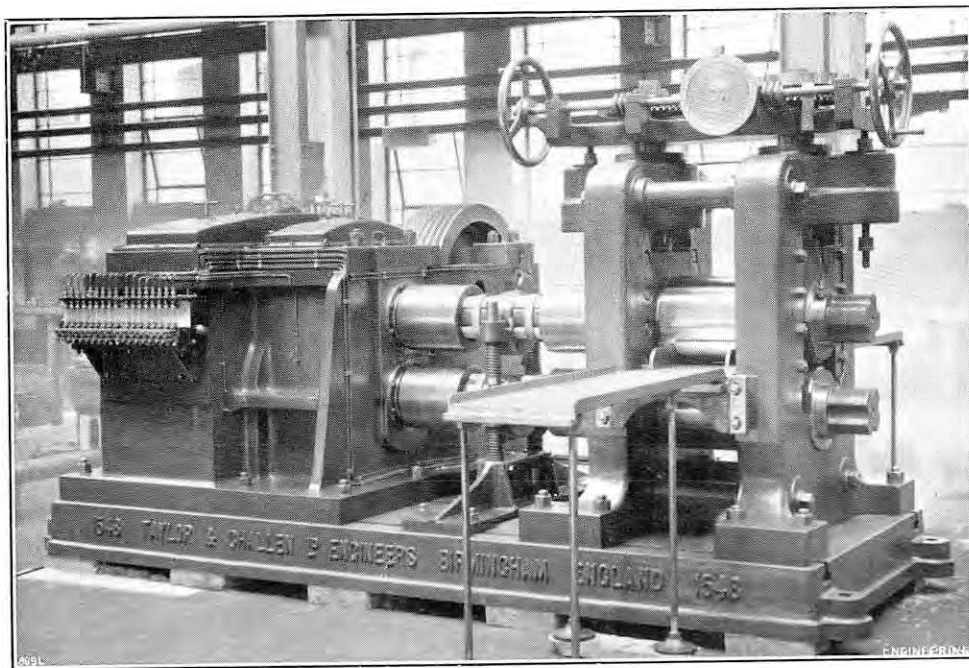


FIG. 90. FILLET-ROLLING MILL FOR MINTS;
TAYLOR AND CHALLEN, LTD.

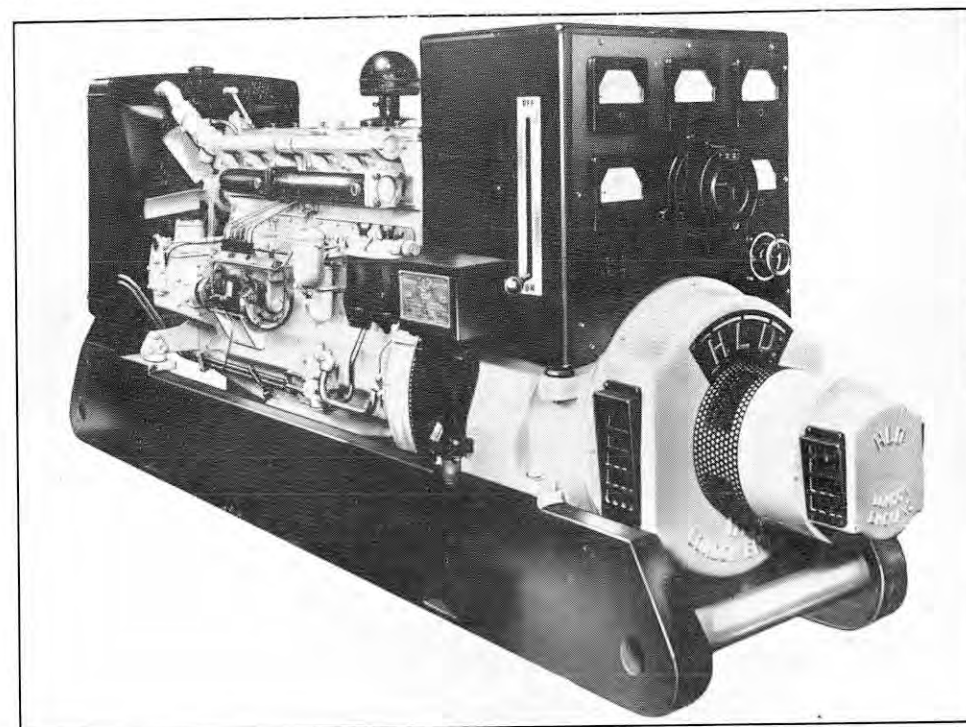


FIG. 91. 93-KW DIESEL-ALTERNATOR SET; HOUGHIN, LTD.

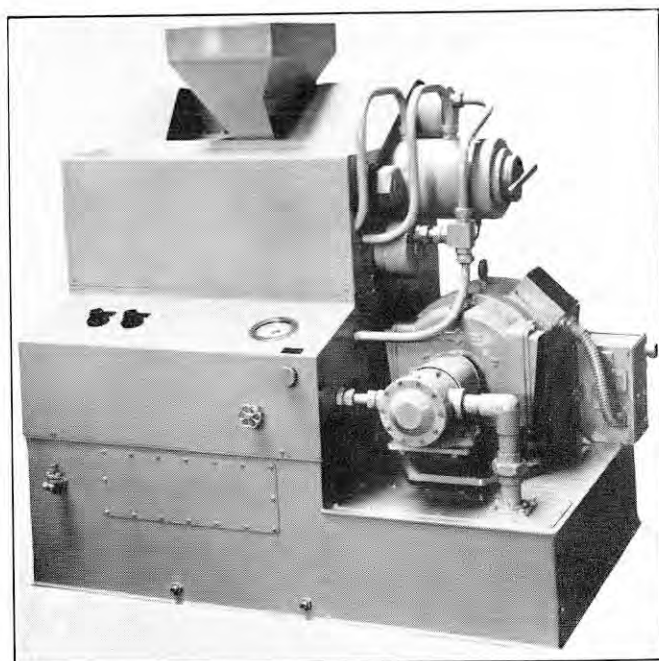


FIG. 92. HYDRAULIC PELLETING MACHINE FOR PLASTICS;
BRITISH INDUSTRIAL PLASTICS, LTD.

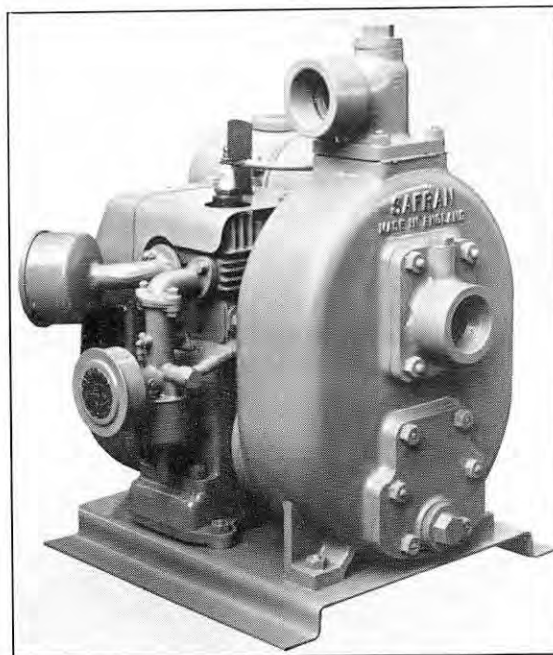


FIG. 93. 1½-IN. SELF-PRIMING PUMP SET; SAUNDERS
VALVE CO., LTD.



FIG. 94. "MUD-HOG" PUMP; PEGSON, LTD.

EXHIBITS AT THE BRITISH INDUSTRIES FAIR, BIRMINGHAM.

(For Description, see Page 639.)

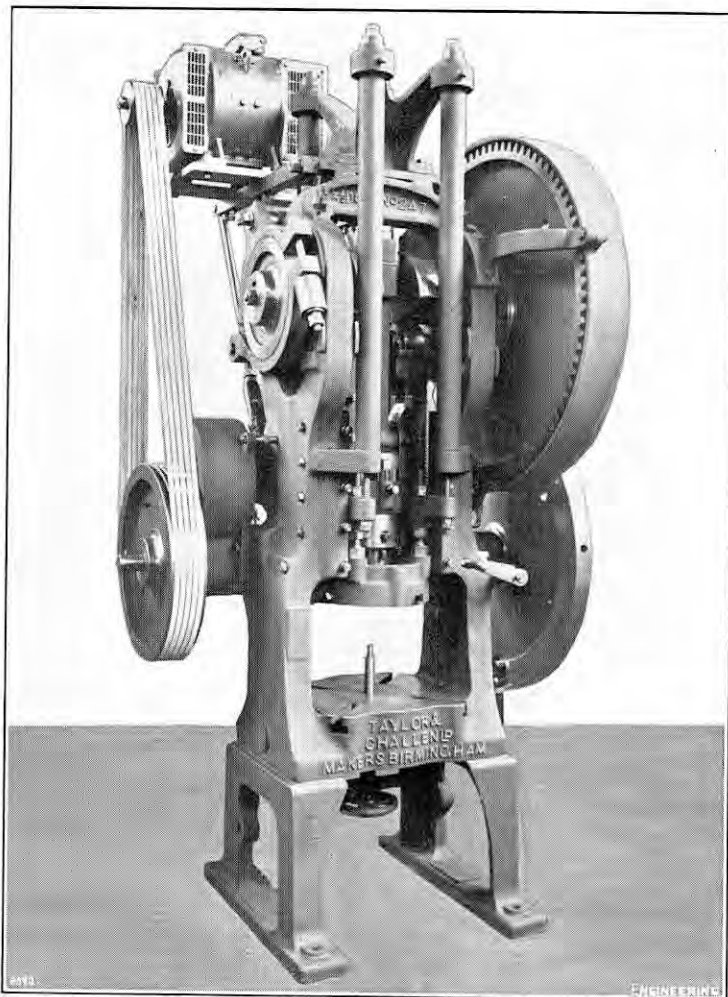


FIG. 95. DOUBLE-ACTION DRAWING PRESS; TAYLOR AND CHALLEN, LTD.

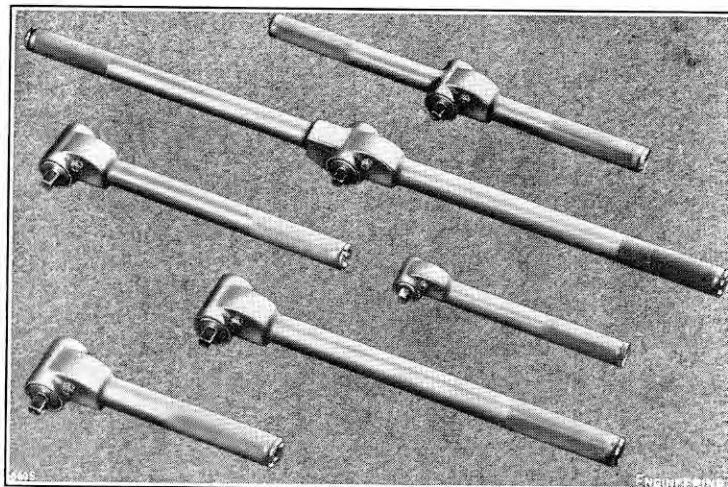


FIG. 97. RANGE OF TORQUE SPANNERS; ACROTORK ENGINEERING CO., LTD.



FIG. 98. BAKELITE-LAMINATED COMPONENTS; BAKELITE, LTD.

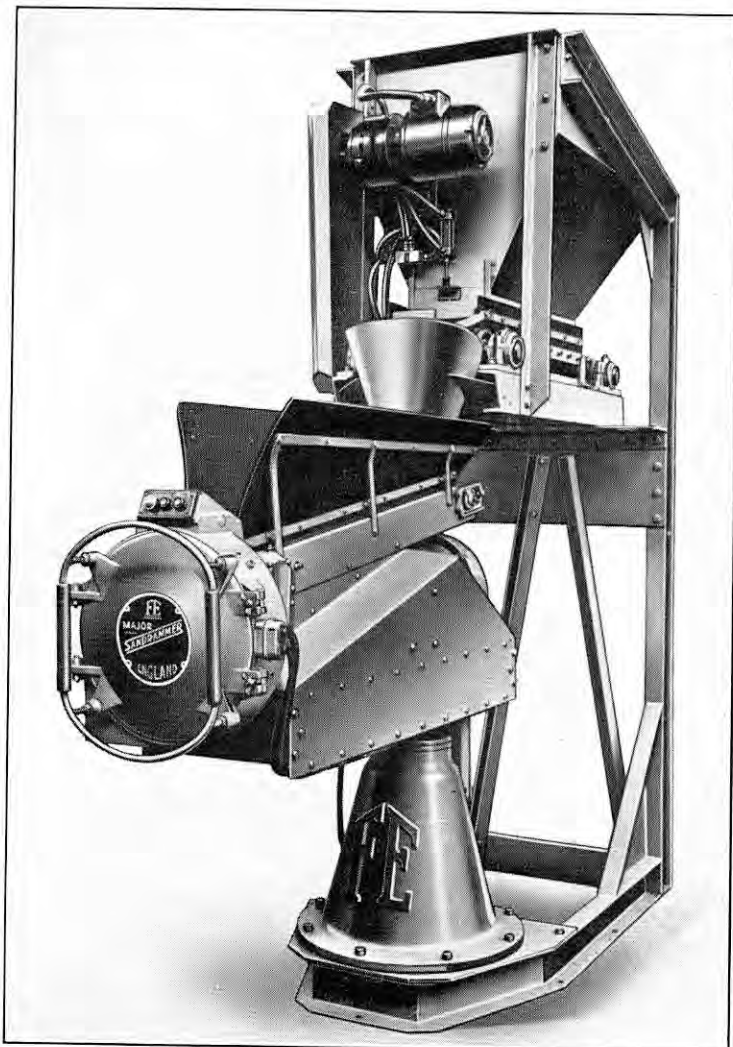


FIG. 96. "MAJOR" SAND-RAMMER; FOUNDRY EQUIPMENT, LTD.

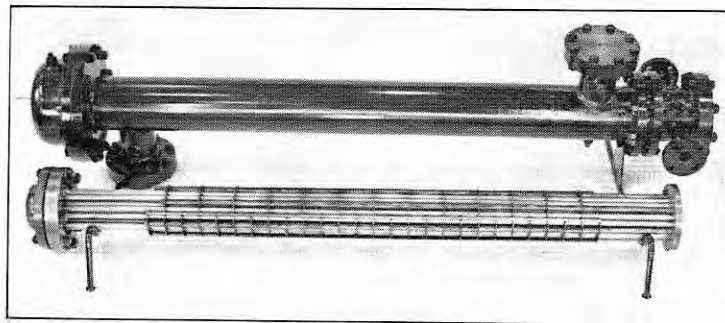


FIG. 99. HEAT EXCHANGER; WELLINGTON TUBE WORKS, LTD.

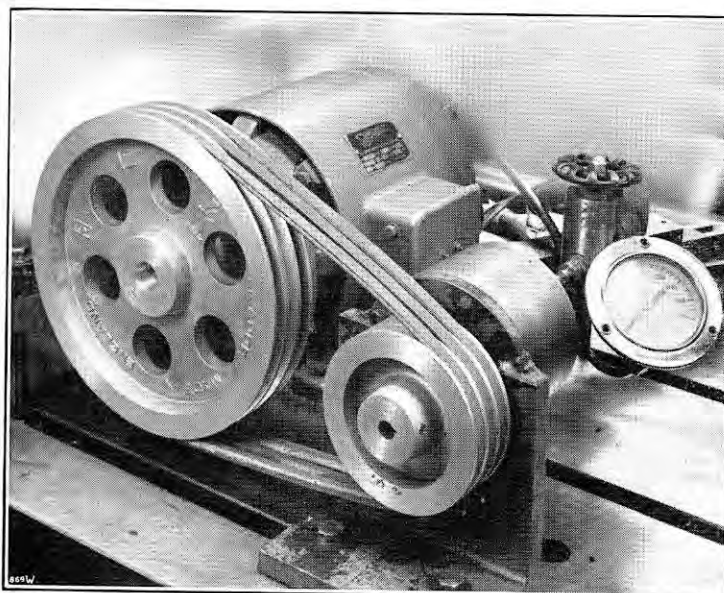


FIG. 100. HIGH-PRESSURE PUMP; KEELAVITE ROTARY PUMPS AND MOTORS, LTD.

Junior machines are fitted with a standard impeller head with improved twin adjustable blades; these, it is claimed, have a longer wearing life and are easier to service than those used hitherto. It is designed so that replacements can be quickly made when necessary. An adjustable pneumatically-operated gate is fitted to the head of the machine, controlled by push-buttons to regulate the sand feed.

TORQUE SPANNER.

On the stand of Messrs. Powell Duffryn, Limited, was exhibited a new range of torque spanners by an associate company, Acratork Engineering Company, Limited, Cory's Buildings, Cardiff. The Acratork Mark 6 spanners, illustrated in Fig. 97, on Plate XXXV, are fully automatic and cannot exceed the torque that is set by the operator. Their accuracy is not affected by side loads or by the speed of operation. The mechanism of the spanner comprises a cam, which rotates between two ball races, and carries at one end a male square for attaching the nut socket. Running on the cam is a roller, housed in a rocker pivoted to the body. The load is applied by a coil spring which presses the roller down on the cam. In order to turn the handle about the cam, the roller has to force the rocker through the medium of the cam against the pressure of the coil spring and its adjusting nut. The cam is so designed that, as soon as the pre-set load is applied, the spanner becomes free. The spanners are not solid in reverse, and are therefore protected against heavy reverse loads. The torque exerted in reverse is about 25 per cent. greater than the set loading. The smallest Acratork spanner available has a torque range from zero to 3 lb.-ft., and the largest from 20 to 250 lb.-ft.

LAMINATED PLASTICS.

Messrs. Bakelite Limited, 12-18, Grosvenor-gardens, London, S.W.1, displayed raw materials and examples of products made from their wide range of moulding plastics, laminates, adhesives, lacquers, and varnishes. Fig. 98, on Plate XXXV, shows a group of Bakelite laminated components made by Messrs. H. Comoy and Company, Limited, for the de Havilland Comet air liner. Paper-based and fabric-based grades of laminated Bakelite are available. Other laminated products displayed included silent gears and components for electric razors. Laminated materials incorporating glass in fabric form, providing rigidity and resistance to water, were also on view; one of these laminates can withstand temperatures up to 250 deg. C. and another has particularly good anti-cracking properties. Among the moulding materials exhibited may be mentioned a rubber-filled material, produced in the first place for the textile industry, which gives improved mechanical strength and anti-cracking properties; and a glass-filled moulding material which has a high impact resistance.

HEAT EXCHANGER.

Wellington Tube Works, Limited, Great Bridge, Tipton, Staffordshire, showed a range of gas tubes and fittings, a 10-in. nominal bore steam tube, and a small shell-and-tube heat exchanger with an internal floating head. The heat exchanger, illustrated in Fig. 99, on Plate XXXV, was constructed for research work in the firm's laboratory, but it is typical of much larger plant used widely in the chemical and petroleum-refining industries. High fluid pressures may be used in both the shell and the tubes. Facilities are provided for inspecting and cleaning the tube bundle.

HIGH-PRESSURE ROTARY PUMPS.

Recent additions to their range of high-pressure gear pumps, exhibited by Keelevite Rotary Pumps and Motors, Limited, of Allesley, Coventry, included units of capacities up to 60 gallons per minute at a continuous working pressure of 2,240 lb. per square inch. These pumps, known as the GH series, can be run at speeds up to 3,000 r.p.m., and are designed for hydraulic power transmission. The gears have a patented tooth form designed to prevent the building up of pressure between successive lines of tooth contact. The hydraulic balancing system employed to centralise the gears in the pressure casing is stated to be so responsive that volumetric

efficiencies of over 90 per cent. can be maintained under all loading conditions. The pump illustrated in Fig. 100, on Plate XXXV, is the type GH101A, the smallest in the series, and is shown in operation on a test bench at 3,000 r.p.m., the drive being by V belts to the pump shaft. At this speed, the pump has an output of 3.5 g.p.m. at 2,240 lb. per square inch. All the pumps in the series have an integral belt-drive adaptor which absorbs end and side loads on the driving shaft, so preventing displacement of the gears and consequent destruction of the hydraulic balance. The adaptor is carried in an extension of the front cover and consists of a short external drive-shaft connected to the gear shaft by a floating centre coupling. The front cover also incorporates the three mounting holes and spigot, and is designed to enable the pump to be mounted inside an oil tank, the seal being made by an "O" ring fitting in a groove on the spigot.

Fig. 101.

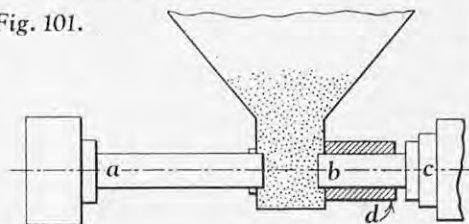


Fig. 102.

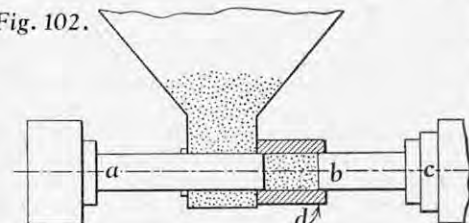


Fig. 103.

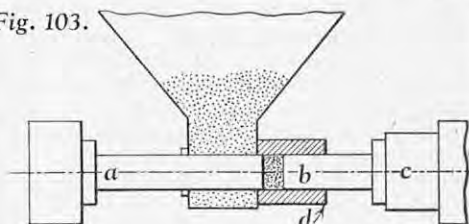
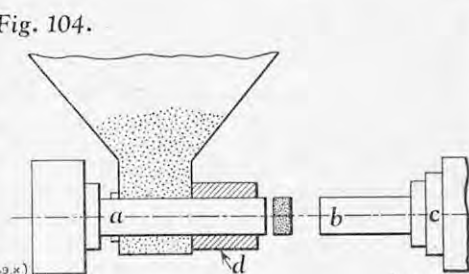


Fig. 104.



FIGS. 101-104. PLASTICS PELLETING MACHINE; B.I.P. ENGINEERING, LTD.

STEELS.

Messrs. Edgar Allen and Company, Limited, Imperial Steel Works, Sheffield, 9, are showing for the first time a 24-in. diameter circular saw employed for sawing magnesium and aluminium at the works of Messrs. Sterling Metals Limited, Nuneaton. The saw cut about 160 castings a day, and has a life of about ten days between regrinds. They also showed a range of steels for dies working on aluminium, copper-base alloys, etc., with examples of dies made from them; a range of small tools; a variety of steel castings, including a crawler truck frame designed for a large excavator; Imperial manganese-steel liners for axleboxes; a model of a Stag tube mill for fine grinding; and permanent magnets for a wide range of applications.

FABRICATED STEEL COMPONENTS.

The main feature on the stand of Messrs. G. A. Harvey and Company (London), Limited, Greenwich Metal Works, London, S.E.7, was the ellipsoidal spun head which was shown outside the Dome of Discovery during the Festival of Britain. This head is 12 ft. 6 in. in diameter and 3 ft. 6 in. deep

and is intended for a vessel designed to withstand a working pressure of 270 lb. per square inch. It was spun from a 1½-in. thick 14 per cent. chromium Colclad flat disc 15 ft. 10 in. in diameter, and is typical of the components produced by Messrs. Harvey in connection with the fabrication of high-pressure vessels. During the past few years, the company have added considerably to their facilities for carrying out this work and they are able now to manufacture pressure vessels, autoclaves, and fractionating and absorption towers from steel plate up to 3 in. in thickness, and of almost any diameter and length, to Lloyd's Class 1 rules. Obviously, it would have been impracticable for the firm to show representative samples of such products, so this class of work was portrayed on their stand by means of photographs. Other exhibits on this stand included a selection of Harco perforated metals and woven-wire cloth, the display being arranged to show how these materials can be used in such equipments as radiator covers, pipe guards, ventilating panels, etc.

DRAFTING MACHINES.

Mavitta Drafting Machines, Limited, Highlands-road, Shirley, near Birmingham, showed a complete range of drafting machines, including one designed primarily for the production of full-scale drawings, which can be supplied for boards up to 50 ft. in length; it consists of a travelling drafting head counter-balanced for easy vertical movement. The Major machine is intended for use on boards 84 in. long by 44 in. deep. It is constructed in steel tube with adjustable ball bearings. The scales are provided with inlaid celluloid edges. The main angles are located automatically, and the square can be locked at intermediate angles.

FUEL-INJECTION PUMPS, ETC.

The exhibits on the stand of C.A.V. Limited, Acton, W.3, included a wide selection of fuel-injection equipment suitable for use on commercial-vehicle, industrial, agricultural and marine engines. C.A.V. fuel-injection pumps are built in sizes suitable for engines up to 500 brake horse-power per cylinder, and those on view included both flange-mounted and enclosed-camshaft types. Cut-away models of injection pumps fitted with centrifugal and pneumatic governors were shown and the injection nozzles on view covered single-hole, multi-hole, pintle and Pintaux types. C.A.V. Limited were also showing engine starters, the latter including the 5-in. and 6-in. diameter axial types and a 7-in. diameter 24-volt heavy-duty type for two-stage operation, suitable for starting marine and heavy industrial engines. The new C.A.V. type VP60 combined stop and tail lamp for commercial vehicles was also exhibited. This has been developed to meet the need for better lighting on commercial vehicles and is suitable for use either singly or in pairs. The new lamp is considerably larger than usual, having a 3½-in. aperture, thus ensuring adequate visibility. It is strongly built to withstand road shocks and, to give additional safety, incorporates twin tail-light bulbs connected in parallel. To render the lamp weatherproof, the complete assembly is encased in a thick rubber moulding which is cut away to illuminate the number plate.

PUBLIC-HEALTH ENGINEERING AT DURHAM UNIVERSITY.—The post-graduate course in public-health engineering, now well established at King's College, Newcastle-upon-Tyne, is available to graduates in civil engineering or to those who possess an equivalent qualification. The course is of one year's duration, from October to June, and leads to the award of a certificate in public-health engineering. The course has been designed in such a manner that, while students are given an introduction to the engineering works carried out for the protection of public health, they are also trained to appreciate the biological principles involved. This is achieved by including in the study programme lectures given by members of other faculties of the University. Practical work in the laboratories and in the field forms part of the training in most of the subjects attended, and a number of small-scale plants offer opportunities for experimental study in the public-health engineering laboratory. The tuition fee for the course is 447.; further details and application forms may be obtained from the registrar of King's College, University of Durham, Newcastle-upon-Tyne, 1.

THE INSTITUTION OF NAVAL ARCHITECTS.

(Continued from page 616.)

We continue below our report of the Spring Meeting of the Institution of Naval Architects, held in London on April 2, 3 and 4, by summarising below, with an abridgment of the discussion, the paper by Mr. J. A. B. Gray and Mr. F. E. Smith on "The Prediction of Thermal Conditions in H.M. Ships in Tropical Waters," which was presented during the morning session on Friday, April 4. The chair was taken by Sir Charles Lillicrap, K.C.B.

THERMAL CONDITIONS IN SHIPS IN TROPICAL WATERS.

The high air temperatures and humidities experienced in some of H.M. ships during the recent war, the authors stated, resulted in the upper permissible limits of the thermal environment being defined as 80 deg. F. for the upper desirable limit and 86 deg. F. as the upper allowable limit. Those standards, however, were recognised to be of little value unless steps could be taken to ensure that they were not exceeded, which involved testing the ventilation equipment under temperate conditions and devising some means of assessing its effectiveness under tropical conditions. The difference (heat gain) between the total heat content of the air within a compartment and that of the external air was found to be independent of the temperature and humidity of the outside air, provided that the ventilation was unchanged. The distribution of the heat gains was shown to approach normality; and it was found that the compartment wet-bulb temperature could be predicted by adding the heat gain to a given external total heat content and converting the result to wet-bulb temperature. For mess decks, a technique was used (as described in the paper) for converting the predicted wet-bulb temperature into effective temperature for air speeds between 20 ft. and 300 ft. a minute, and a nomogram was constructed, by means of which it was possible to ascertain the extent to which the effective temperature might be reduced by either increasing the speed of air movement; for example, by fitting circulating fans, or by reducing the heat gain, e.g., by increasing ventilation.

DISCUSSION.

The discussion was opened by Professor A. J. Sims, who observed that the desirable effective temperature limits given in the paper could be very difficult of attainment by the designer; indeed, there were some external conditions in which they would certainly be exceeded if the ventilation was by means of fans alone. Twenty miles off shore, the heat content of the outside air would generally be much less than in harbour. Moreover, it was arguable that the success of a ventilation system should be judged by its performance at sea, since shore facilities should assist to some extent in harbour. Once again, the reliability of the existing effective temperature charts, when the temperature approached the body temperature, was brought into question by the paper. The authors implied that the wet-bulb temperature became the effective temperature above 87 deg. F., inferring that the zero velocity line, at least, should coincide with the wet-bulb scale at about that temperature. That doubt had been recognised for some time, and should be resolved so that designers could rely on one chart and one set of criteria only. It was not clear whether the authors considered that air velocity reduced the "effective" wet-bulb index above 87 deg. F. The method they proposed might be of considerable help, at least to warship designers; but he hoped that the conclusion would not be drawn that it replaced the need to get early experience of the performance of a new design in the tropics and in the Arctic under war conditions, so that the difficulties which could arise might be known with certainty.

Dr. T. Bedford considered that the paper was a really important one. It was good to be able to predict, with a fair measure of accuracy, what

would be the heat gain in a ship in the tropics, and it was a further advance to be able to translate that heat gain into terms of the physiological index of effective temperature. Air-conditioning engineers were accustomed to use that index, and to be able to get the answer from a graph was valuable. Professor Sims had referred to the difficulty of attaining the recommended standard conditions. If those standard conditions were exceeded, there would be some loss of efficiency, but experiments had confirmed that the ranges were reasonable.

Mr. S. J. Jones said that the paper seemed to be a statistical examination of the increase in the heat content of air on mess decks above the total heat content of the external air, and the deviations above and below that mean increase; but it was a weakness in the paper, he thought, that no attempt was made to find out the cause of those deviations. With constant ventilating quantities, constant ambient temperature conditions and constant internal heat generation, it was axiomatic that deviations would not exist; the heat gain being constant, the increase in internal heat content would also be constant. Variations in ventilating quantities would naturally create variations in the increase of heat content of the air on the mess deck or compartment in relation to the ambient conditions. Assuming, however, constant ventilating quantities and constant heat generation or leakage into the compartment, the only deviations which would occur would be those arising from the fluctuating ambient temperature. It was worth while, therefore, to consider the effect of periodic variations in outside temperature on the deviation from the mean temperature or heat increase in the inside conditions. A compartment had a definite heat capacity, which had the effect of making inside fluctuations of smaller amplitude than outside fluctuations. A sudden fall in the outside temperature towards the minimum, or what might generally be night conditions, was not followed so quickly by the inside temperature, because the heat capacity of the structure and equipment delayed the effect on the inside temperature, resulting in the difference between the inside heat content of the atmosphere and the heat content of the outside atmosphere tending towards a maximum at this period. In the same way, when, with the effect of the rising sun, the outside temperature tended towards its maximum in the daily variation, the rate of rise of the inside temperature lagged behind it, so that the difference between the inside and the outside tended towards a daily minimum. In fact, with high ventilating quantities, the heat gain could, on occasions, be a negative quantity. This would suggest that, when predicting internal conditions on the basis of maximum external conditions, the association of positive units of standard deviation with the maximum temperature might tend to exaggerate the probable internal conditions.

Dr. S. Livingston Smith said that the British Shipbuilding Research Association had been carrying out research on the environmental conditions in the machinery spaces of merchant ships, and a survey was made in the first instance of the conditions existing in 25 ships of different types. This was followed by more detailed tests on another 13 ships. From this survey, an analysis was made of the relation between the total heat content of the air at the various test positions on each ship and that of the outside air. The calculations were made according to the method given by Dr. Bedford,* and good agreement was found with the conclusion of the authors that the increase in the total heat content was independent of the external conditions, provided that the rate of ventilation was unaltered. Taking, for instance, the results at the centre of the manoeuvring platform in the combined engine and boiler room of a cargo liner of about 8,500 tons gross, the increase in the total heat content and the heat of the water vapour of the inside air at the manoeuvring platform had been plotted against the corresponding outside conditions. The plotting showed that the increases in heat content were constant over the range of outside conditions taken, which was from 62 deg. F. (wet bulb) and 64 deg. F. (dry bulb) to 83 deg. F. (wet bulb) and 88 deg. F.

(dry bulb). He thought that was complete confirmation of the authors' work.

There was another problem to which the method could be applied. In the analysis of tests to ascertain to what extent conditions in steamships could be improved by practicable measures to reduce moisture escape and the escape of heat from hot surfaces in the machinery spaces, it was found that, as the tests were all of short duration, common outside temperatures were not always available to allow direct comparison of the inside temperatures; and, of course, it was not satisfactory to compare differences between inside and outside temperatures for different outside temperatures. Using the finding of the authors concerning the constant difference in total heat content, the method of analysis was to calculate from the available results, whatever the range of outside conditions, the increases in the sensible and water-vapour heat contents at all positions in all ships over those of the outside air, and then to determine the inside conditions for assumed outside conditions; that enabled results to be compared directly.

The nomogram given in the paper, which was to be used for determining effective temperature on mess decks, had been found to give good agreement with tests made on passenger and crew accommodation in upper decks, but it was not applicable to conditions in machinery spaces. This was implied by the authors, but was not specifically mentioned. The nomogram took no account of radiant heat. As an example, in two sister ships with different arrangements of turbine insulation and gland-steam exhausts, consideration was given to the conditions at the upper grating between the high-pressure and low-pressure turbines. In ship A, the increase in total heat content was 6.4 B.Th.U. per pound and the calculated effective temperature from the nomogram would be 87½ deg. F. (effective) for outside conditions of 80 deg. F. (wet bulb) and 85 deg. F. (dry bulb) and air movement of 100 ft. per minute. For the same outside conditions and air movement, the actual effective temperature was 95 deg. F. In ship B, the increase in total heat content was 5.5 B.Th.U. per pound, and the calculated effective temperature from the nomogram would be 86 deg. F., while the actual effective temperature was 90.5 deg. F. The paper was a well-reasoned and valuable contribution to a complex and significant problem.

Professor G. L. Brown assured Professor Sims that work on the effective temperature scale was still in progress, and, no doubt, would go on for a long time, for a complete solution was some way off. Since most of the work by the authors of the paper was done, a considerable amount of experimental work had been carried out jointly by the Royal Navy, the Medical Research Council and the Tropical Research Unit in Singapore, and much more was becoming known about the effects of high temperatures upon men, both from their physiological behaviour and their psychological performance. Unfortunately, such work was extremely laborious, not only to do, but also to calculate. The experimental work in Singapore would probably finish within the next few months, but the necessary study of the results would occupy another year. In connection with the remarks of Dr. Livingston Smith, he added that the effect of radiant heat on man had hardly ever been properly studied. The Unit in Singapore seemed to be the only one having a properly constructed radiant-heat tunnel, which would enable something to be learned, from the physiological point of view, of the effects of radiant heat in H.M. ships.

Mr. A. J. Merrington recalled that, in 1940, he served in a warship in the West Indies under war conditions. The ship was a new cruiser, the first of her class, so that he had first-hand experience of some of the conditions which the authors hoped to predict. It would have been invaluable to the design side of the Admiralty, and would have given a good deal of comfort to the ship's company, had those predictions been made before the ship sailed and had some effective action been taken in respect of the hot spots. They had found from experience that conditions at night, under darkened-ship conditions, were the worst, and there were some very trying cases to be dealt with. The difficulties at night were overcome to some extent by improvi-

* *Environmental Warmth and its Measurement*, by Dr. T. Bedford. H.M. Stationery Office, 1946.

sation. What was the remedy arising from the predictions? The authors pointed it out by saying that the ventilation systems must be tried under reasonably the same conditions as in the tropics. That was a very difficult thing to do, particularly in the shipyard; but it was absolutely vital that it should be done if the predictions were to be of any value. The ship must be closed down at night, with the machinery running; then some useful data would be obtained.

The authors spoke of improving conditions by increasing the speed of air movement or by increased ventilation. The nomogram suggested that increased air speed was not very effective; it would be necessary to increase the air speed from about 80 ft. to, perhaps, 200 ft. per minute for a temperature drop of about 1 deg. F. Certainly, his own experience in the cruiser at night during the war was that air movement, rather than increased ventilation, was invaluable. He asked whether the authors would comment on how they measured the air movement. His experience was that air movement, particularly by means of the slow-running overhead punkah fan, effected a great improvement in living conditions. Increase of ventilation, unless there were punkah louveres, did not seem to help much. A good deal of the discussion, apart from the contribution by Dr. Livingston Smith, had referred to warships; but certainly other ships were known to be rather hot, and some of his colleagues had asked him particularly to mention the problem of troopships passing through the Red Sea in war time, shut down and blacked out at night. He also invited the authors to comment on the possibilities of their predictions being of value in air-conditioning compartments.

Captain (S) A. D. Duckworth, R.N. (ret.), speaking as one who had spent many years in big and small ships in the tropics, welcomed anything that could be done to make conditions on board more comfortable. During the last war, in the Warspite, he had 17 days at sea in the Indian Ocean with the cabin temperature at 92 deg. F. continuously, night and day. The ship was battened down and the electric lights were on; they never went out of the cabins or turned the lights off. It seemed that great potential sources of heat were electric light, the fans running, and the funnel uptakes. It was in the cabins that the heat was felt more than anywhere else. From the practical point of view of the seaman, so long as this work led to something being done, the men at sea would be extremely grateful. In ships' galleys, the temperature was something like 112 deg. Often a ship would swing round into the sun, and that would upset everything. One side of the ship would become hotter than the other, and nothing could be done about it; in harbour, the ship could be swung to the wind so that the air flowed past. At action stations, men were swathed in action clothing, dressed as though for the Arctic in a compartment at a temperature of nearly 100 deg. F. for hours on end.

Mr. M. G. Bennett thought it singularly fortunate that the paper was to be followed shortly, at a meeting of the Institution and the Institute of Marine Engineers on April 8, by a paper by Dr. Mackworth, in which he was to discuss the effects of extremes of climate on man's efficiency. The two problems were obviously linked, and it seemed that the point was being approached at which it would be possible to indicate what conditions must not be exceeded if efficiency was to be maintained, and also how those conditions could be achieved in practice. The discussion of the present paper seemed rather to have stressed its value from the point of view of the design of ships' ventilating apparatus; but he thought it had possibly a more immediate value, in that it gave ships' executive officers a method by which they could anticipate the conditions to which their men might be subjected, so that they might vary the crew's activities to counter any adverse effects on efficiency.

Captain J. P. Thomson said that mechanical ventilation had gone through various stages; there had been improvement during the past 15 years, but still sailors did not know enough about it. Mechanical venting and heating required adjustment with every change of atmospheric conditions, and if some guidance could be given on how to operate the plant, better results might be achieved.

In the days before mechanical ventilation, in a part of the world where the temperature was about 85 deg. F., the effect on his crew was that, every time the ship reached Tampico, about 25 of them wanted to see a doctor. He turned the ship round from time to time, particularly in the evenings, before the men went down for the night. A most important matter was the position of the air intake. In 1945, in Bombay, his attention was called to two ships, built by the same builders, which were in for repair. One of those ships was really hot, whereas the other was relatively cool. In the ship which was hot, the air intake was against a steel bulkhead on to which the sun was beating, so that the system was just circulating hot air. In the other ship, the intake was under the awning, so that it was drawing in cool air and circulating it around the ship. The difference between the conditions in those two ships was noticed by everyone, and care was taken to correct the situation at the earliest opportunity.

Mr. Gray, replying to the discussion, said that it had raised questions on two separate lines. One of them was the question of the desirable limits of the scales of temperature; that was a little outside the scope of the paper. Those questions had been posed to many people working in hot rooms and other such places, and their conclusions had been taken and attempts made to predict the conditions on the scale which they had provided. It was true that the effective temperature scale, while probably the best and the most universally used at the moment, was not ideal, and there were suggested alternatives; but that did not affect what the authors had put forward, which was how to predict conditions. The two conditions they had been able to predict were the heat content for wet bulb and, in the specific case of the messdeck, and only that, the effective temperature. On Professor Sims' question as to whether the readings were taken in harbour or at sea, the answer was that, in the main series, of some 80 or 90 observations, about 30 were made in harbour and the rest at sea.

Some interesting points were made by Mr. Jones about the causes of the deviations. There were many. The more obvious ones were wind direction and, related to that, the position of the air inlet. As Captain Thomson had indicated, an air intake could sometimes be in such a position that it would take in quite foul air. He had seen an exhaust from a galley next door to an inlet to the mess deck; in some wind conditions, the atmosphere in the mess deck was decidedly uncomfortable, whereas in other wind conditions it was comfortable. They had taken temperature measurements as far as possible under all conditions, with head wind or tail wind, the wind on one side or the other.

He was interested to hear the results in merchant ships, and it was most encouraging that, in fact, their effective temperature nomogram, which they could only expect to work in mess decks, had, in fact, proved successful in its application to other compartments. It was not to be expected that it would work in engine rooms. The essential factor was that they had to assume a constant difference between dry-bulb and wet-bulb temperature. Fortunately, that was more or less constant in mess decks and in some other compartments, but in the engine room the dry bulb was a very long way above the wet bulb, and it would be most unlikely that the nomogram would in any way relate to the values experienced there.

The air movement was measured by finding the cooling rate of the katathermometer; but the point about the effect of air movement on the nomogram was really unrelated to the method of measurement, because that part of the nomogram was derived from the effective temperature curve. From the point of view of improving the conditions, examining the state of the air as it reached the compartments was a worth-while procedure. While in the East, taking a number of observations, in about two-thirds of the compartments investigated, most of the heat gain took place before the air reached the compartments it was meant to ventilate. Sometimes the air inlet was just inside a bulkhead or near an exhaust from a machinery space, and sometimes there was uninsulated ducting close to hot compartments.

(To be continued.)

PRODUCTION OF MEDIUM-SIZE DIESEL ENGINES BY R. A. LISTER AND CO., LTD., DURSLEY.

BEFORE the last war, Messrs. R. A. Lister and Company, Limited, Dursley, Gloucestershire, decided to design and develop an entirely new range of Diesel engines in preference to producing their CD and CE types in additional multi-cylinder units. Prototypes of the new units were built and used for industrial, marine and agricultural purposes, in which fields they were subjected to exhaustive tests. The development programme, however, had not been completed before the outbreak of war, when work on these engines had, naturally, to be curtailed. At the conclusion of the war, the company once more were able to concentrate on the development of the new range and took the opportunity of incorporating into the design those characteristics which experience gained during the war had shown to be desirable. Development work has now been completed and the company are now marketing a complete series of new Diesel engines, known as the Freedom range, having one, two, three, four or six cylinders, which develop 8 h.p. per cylinder at 1,500 r.p.m. and with the exception of the single-cylinder unit, 9 h.p. per cylinder at 1,800 r.p.m.

A typical unit from the new range is illustrated in Fig. 1, on page 648. This shows a two-cylinder engine rated to develop 16 h.p. at 1,500 r.p.m., coupled to a 10-kVA alternator, the engine and alternator being fitted to a common bedplate. In general, the design of the engine is the same throughout the range and many of the components, such as pistons, connecting rods, cylinder heads, etc., are, as a consequence, interchangeable. Particular care has been taken to ensure good accessibility and, though the engines are totally enclosed, easy access can be gained to most of the working parts through detachable covers. Two features which have proved successful on previous Lister engines, namely, the dual combustion chamber and wet liners chromium-hardened by the Listard process, have been incorporated in an improved form in the new range of engines. The dual combustion chamber is designed to give a high compression ratio for starting and the lowest practicable compression ratio for normal running. It is in two parts, an inner chamber joined to an outer chamber by a throat which is closed by a hand-operated plunger to give the higher compression ratio for starting. The hand levers for operating the plungers can be seen in Fig. 1.

The crankcase for each size of engine is an iron casting which, as previously indicated, is fitted with wet cylinder liners. The crankshaft is machined from a 60 to 65-ton manganese-molybdenum steel forging, all bearing surfaces being ground, and is supported in the crankcase by steel-backed white-metal-lined bearings. The number of bearings varies with the size of engine, but, in every case, there is a main bearing at each side of the crank-throw. Oval-turned pistons of low-expansion aluminium are used and these are fitted with three compression rings and two oil-control rings, the latter being disposed one above and one below the gudgeon pin. The forged-steel connecting rods have the bottom ends fitted with lead-bronze bearings of the same type as fitted to the crankshaft journals. The camshaft is located fairly high in the crankcase and is driven from the crankshaft by a train of helical gearwheels at the flywheel end of the engine. The gearwheels also drive the other auxiliaries, such as the water-circulating pump, lubricating-oil pump, governor, etc. There are two valves for each cylinder, namely, inlet and exhaust, and these are operated by push rods and rocking levers in the usual manner. An individual rocker assembly, however, is used for each valve and this has resulted in a more compact cylinder head and has assisted in the correct location of the valves and injectors. The valve rockers are supplied with oil under pressure, the oil being delivered through a rotary metering device embodied in one end of the camshaft.

To aid in standardisation, an individual injection pump is provided for each cylinder, one size of pump, as a consequence, covering the complete range of engines. The engine speed is controlled by a centrifugal governor driven independently from the gear train at the flywheel end of the engine, the governor being sufficiently sensitive to control the speed within 2 per cent. and incorporating an automatic release which limits overloading to 10 per cent. The lubricating system is fed by a gear pump, also driven from the gear train, the oil being drawn from the sump through a removable strainer and delivered to a gallery which communicates with all moving parts. Provision is made for the incorporation of an independent oil filter, should the engine be operated in exceptionally arduous circumstances. Either tank or radiator cooling can be employed, the water being circulated through the engine by an impeller-type pump designed to give a minimum output of 250 gallons per hour for each cylinder. The pump driving shaft is mounted in ball bearings which are disposed at each side of the

impeller and the shaft is extended to provide a drive for the tachometer and dynamo. A novel method of constructing and accommodating the fuel filter has been employed. This consists of a large-capacity element wound in spiral form in a special container, the complete unit being situated in a settling chamber which is located at the forward end of the cylinder block and is integral with it.

Twelve-volt electric-starting equipment can be fitted, if required, to all engines. The starter motor engages with a replaceable gear ring shrunk on to the flywheel rim, the drive being totally enclosed on the four-cylinder and six-cylinder engines, with the motor mounted on a No. 1 S.A.E. flywheel housing. The dynamo is coupled to the water-pump shaft on all but the single-cylinder engine, a belt drive being employed in the latter case. A large air cleaner is a standard fitting on all engines. This is designed to impart a swirling motion to the air, the foreign matter being deposited in an oil-filled trough, which can be removed easily for cleaning. The air cleaner also contains a silencer so as to reduce the intake noise to a minimum. The single-cylinder, twin-cylinder and three-cylinder models can be provided with alternative power take-offs, consisting of a clutch and a two-to-one reduction gear, arranged so that the clutch can be incorporated before or after the reduction unit. Built-in clutches are available also for the four-cylinder and six-cylinder models.

To achieve efficient quantity production of the new range of engines, the engine side of the Lister factory has been entirely reorganised. This work has involved the moving of complete departments from one end of the works to the other, and the expenditure of 250,000*l.* on new plant and equipment. The castings for the engines are produced in the company's own iron foundry, which is probably one of the most highly mechanised foundries in the country. The cores for the crankcase castings are blown mainly on an Osborn machine and then baked in a continuous core-stove, after which they are finished, pre-assembled and gauged before being fitted into greensand moulds. The moulds are poured on a double-loop plate-type conveyor, which is routed so that, after pouring, the moulds pass below a hood designed to extract the escaping steam and fumes, and thus avoid pollution of the foundry atmosphere. On leaving the extraction hood, the moulds are pushed mechanically from the conveyor on to a vibratory knock-out, from which the boxes are carried back to the machines on a pendulum-type conveyor. The castings, once they are free of the moulding sand, slide into the buckets of an overhead conveyor which carries them to the fettling shop, situated outside the foundry. After shotblasting and fettling, the castings are gauged and inspected, and, where applicable, location spots for the subsequent machining operations are ground on them. Crankcase castings were then water-tested at a pressure of 100 lb. per square inch in a pneumatically-operated fixture, washed, dried and spray-painted with a sealing paint before being transferred by an overhead conveyor to the machine shops.

Machining of the crankcase is carried out on a line of 33 special machine tools and three standard radial drills. These machines, together with their associated jigs and fixtures, have been designed so that all five types of crankcase can be handled with equal facility and with the minimum of alteration, either to the machines or the fixtures. The six external faces are machined on three separate Cincinnati duplex milling machines, using 20-in. diameter carbide-tipped cutters, running at 49 r.p.m., with a feed of 10 in. per minute. One of these machines is illustrated in Fig. 2, herewith, this particular machine being set up for milling the two end faces. After the end faces have been milled, the crankcases are passed to a Cincinnati special-purpose milling machine, set up for cutting the bearing channels. This machine has both vertical and horizontal spindles, the horizontal spindle being fitted with a pair of staggered-tooth side and face cutters which remove the bulk of the material, and the vertical spindle with a standard face mill which finish-machines both the bottom and side faces of the channel. The bearings are milled to width on the Cincinnati horizontal machine illustrated in Fig. 3, herewith. This machine is fitted with multiple-tipped cutters, mounted on a long arbor and fed at a speed of 1 in. per minute, the cutters for this and the previous operation being set to the correct positions on the arbor by the tool maintenance department before they are issued to the machine setter.

On completion of the milling operations, two dowel holes are drilled and reamed in the pump face. These are used to locate the casting during all subsequent machining operations, which include boring the main-bearing and camshaft bearing housings; boring the liner recesses; drilling and reaming the tappet-guide holes; drilling, counterboring, reaming and tapping the main-bearing stud holes; and drilling and tapping the various holes in the top, bottom, side and end faces. The main-bearing and camshaft-bearing

PRODUCTION OF MEDIUM-SIZE DIESEL ENGINES.

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

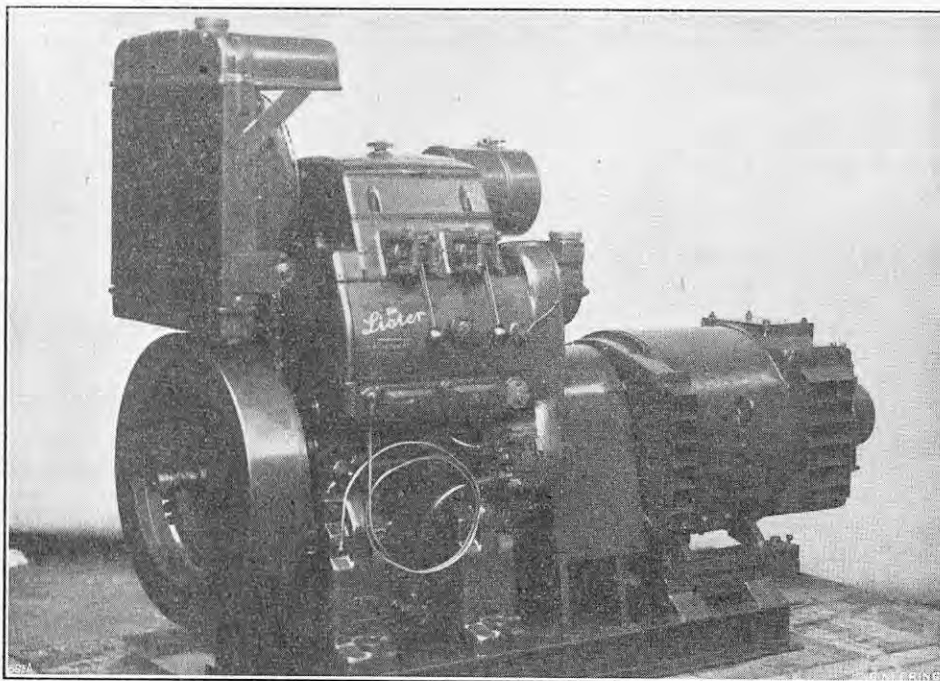


FIG. 1. TWO-CYLINDER ENGINE COUPLED TO 10-KVA ALTERNATOR.

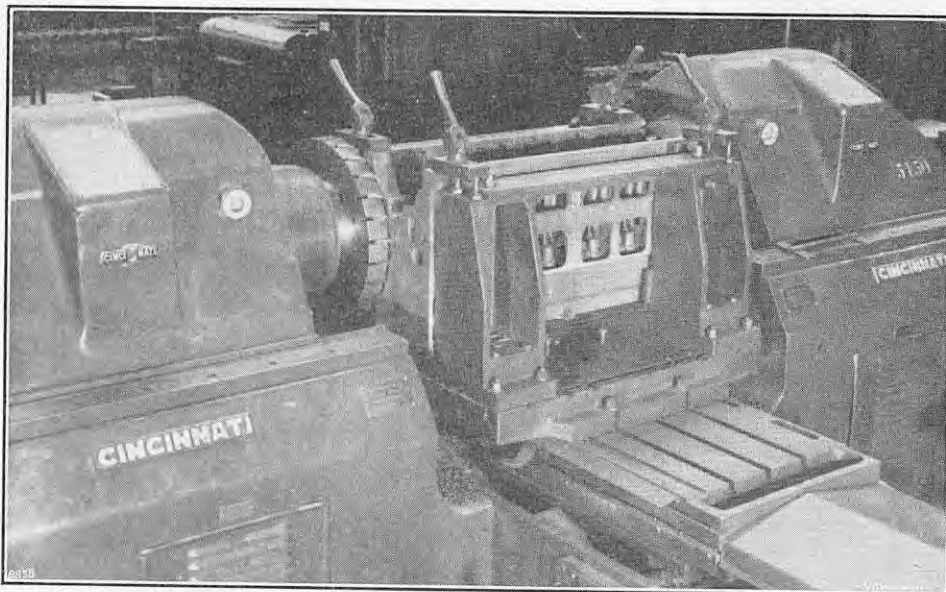


FIG. 2. MILLING ENDS OF SIX-CYLINDER CRANKCASE.

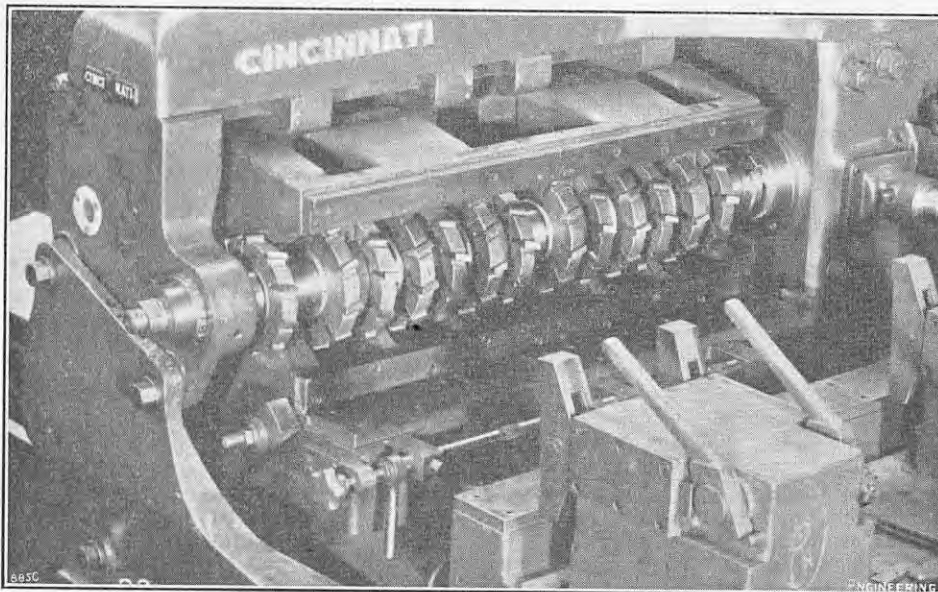


FIG. 3. MACHINE FOR MILLING MAIN BEARINGS TO WIDTH.

PRODUCTION OF MEDIUM-SIZE DIESEL ENGINES.

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

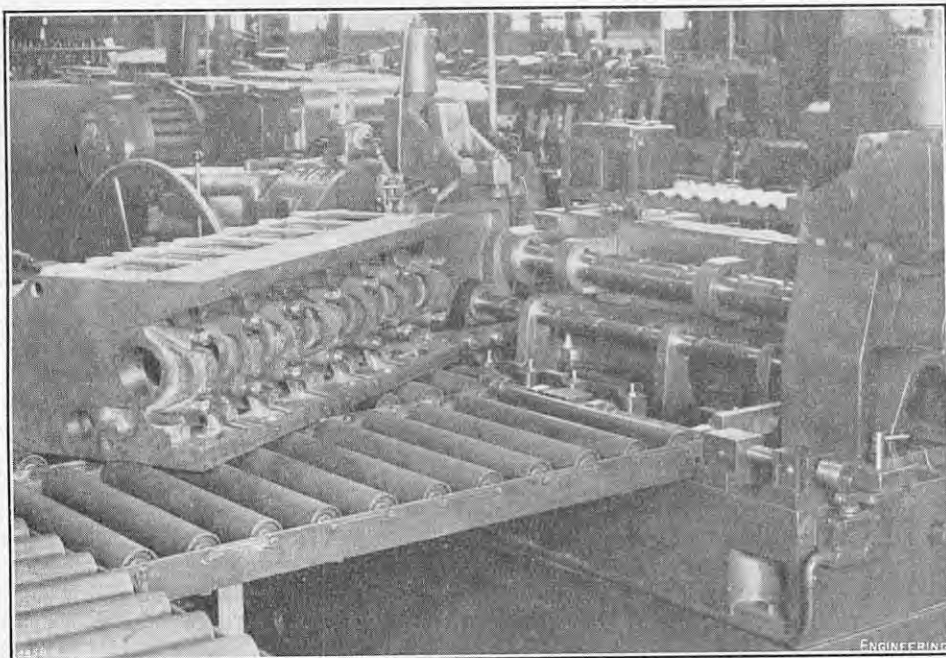


FIG. 4. MACHINE FOR BORING MAIN AND CAMSHAFT BEARINGS.

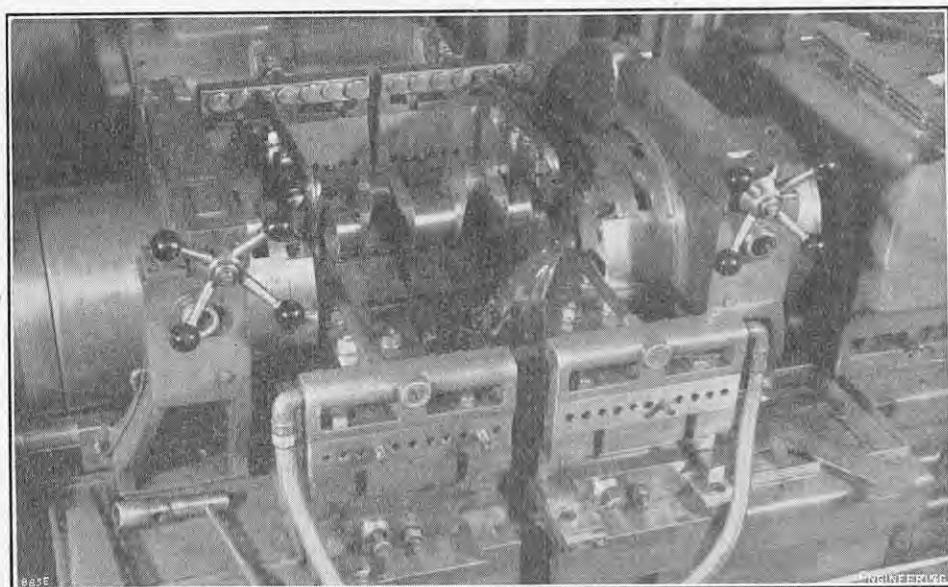


FIG. 5. FORMING TWO CRANKPINS ON FOUR-THROW CRANKSHAFT.

housings are bored in three stages, namely, rough-bore, semi-finish bore and finish bore. For the semi-finish and finish-boring operations, the main-bearing and camshaft-bearing housings are machined together in a two-spindle Archdale horizontal boring machine of the type illustrated in Fig. 4, herewith, the machine illustrated being that employed for finish boring. The liner bores, or recesses, are also machined in three stages, being rough-bored and semi-finish bored in Archdale six-spindle vertical and horizontal machines, respectively, and finish-bored in an Asquith vertical six-spindle machine. The six faces of the crankcases are drilled, reamed where necessary, and tapped in a series of Archdale multi-spindle drilling and tapping machines, the number of spindles varying from 12 to 67. To reduce manhandling of the castings to a minimum, they are moved from machine to machine, and in and out of the various fixtures, on roller conveyors, provided at the appropriate points with turntables and rollover cages so that they can be reversed or inverted and thus brought into the correct attitude for the ensuing machining operation. The greatest possible use is made of locating jigs and fixtures, and in most cases these are operated pneumatically.

All crankshafts are produced from 60 to 65-ton manganese-molybdenum steel forgings which are supplied in the heat-treated condition. As the sequence of operations is more or less the same, irrespective of the type of crankshaft, the following notes, which refer to the two-cylinder version, may be taken as a general

guide to the methods employed in their production. After preliminary operations such as removing the scale and flashes, the forgings are centred on a double-ended centring machine and a small portion is turned and ground for initial location in the first of a series of Drummond Maximatic lathes. In this machine, the locating and centre bearings and the small taper for the drive coupling are rough-turned at a speed of 45 ft. per minute, with a turning feed of 0.010 in. and a forming feed of 0.003 in. On the second machine, the opposite end of the shaft, including the flywheel taper, is rough-turned at the same speed and feeds. Two registers are then ground on the journals and a location spot is milled on one web for subsequent setting in the crank-pin forming machines. Two further Maximatic lathes are used for this purpose, each having front and rear forming slides and being driven by variable-speed motors to give a constant cutting speed of about 34 ft. per minute, with an approach feed of 0.009 in. and finishing feed of 0.004 in. The shafts are then finish-turned with a similar set-up. One of the crankpin-turning machines is illustrated in Fig. 5, herewith.

On completion of turning, the crank webs are milled for balance-weight location on a Herbert 47-V machine, after which the balance-weight stud holes are drilled and tapped. The oil holes are then drilled on the group of special-purpose Archdale deep-hole drilling machines illustrated in Fig. 6, on page 652. These machines are fitted with a hydraulic feed and an auto-

matic release mechanism which ensures that the drill is returned when a hard spot is encountered and thus guards against drill breakage. The location and intermediate bearings are then ground on a standard grinding machine and this is followed by two form-grinding operations, the pinion diameter and coupling taper being ground by means of a 5½-in. wide wheel in the first operation, and the flywheel taper and corresponding diameters at the other end of the shaft by an 8½-in. wide wheel in the second operation. The pins are then ground on a Landis hydraulic pin-grinding machine and the shaft is completed by cutting the keyways.

A range of special-purpose machines has been installed also for producing the camshafts. One of the first operations is the drilling and reaming of one of the oil holes, which is then used for locating the shaft radially during all subsequent operations. Turning of the camshafts is carried out on two Drummond Maximatic multi-tool lathes, fitted with compensating carriers to allow for any irregularities in the forgings. The cams on all shafts are turned on a Scriveners cam-profile lathe, designed to turn the 18 lobes on the six-cylinder shaft simultaneously; this machine is shown at work in Fig. 7, on page 652. After being rough-ground, the shafts are case-hardened and are then semi-finished and finish-ground on the automatic Landis cam-grinding machine illustrated in Fig. 8, on page 652.

Special machines have also been installed for machining the flywheels. The tapered bore, and all diameters on one side of the flywheel are machined on a Bullard Man-au-Trol automatic boring mill, fitted with a hydraulic chuck. The opposite face is then machined on a manually-operated Bullard boring mill, after which the wheel is drilled and tapped and the keyway broached, a horizontal Weatherley oil-gear machine being used for the latter operation. Other items which are being produced on special machines include the cast-iron gearcases which are fitted to the end of the crankcases. In common with all cast-iron components for the new range of engines, these castings are given a coat of paint, resistant to oil, water and heat, before they are issued to the machine shops. After preliminary milling and surface-grinding operations have been completed, the cases are passed down the line of special-purpose Pollard vertical drilling and boring machines, illustrated in Fig. 9, on page 652, on which all drilling, boring and tapping operations are carried out on an automatic cycle. Several new machines have been installed also in what can best be termed the general machine shop. These include a group of three six-spindle Ryder No. 8 Verticalautos.

INDUCED-CAVING AND BLAST-HOLE METHODS IN NICKEL-ORE MINING.—Engineers of the International Nickel Company of Canada, Ltd., at the nickel-ore mines in the Sudbury district of Ontario, have recently adopted a mining technique by which large masses of ore, deep underground, are induced to cave and disintegrate by their own weight. The new technique is based on the observation that lower-grade ore has a tendency to subside and break up after higher-grade ore beneath it has been mined out. Called "induced caving," this low-cost bulk mining method, together with improved metallurgical practice, makes it practicable for the company to recover and treat ore lower in grade than they have worked in underground mining. In practice, a "slice" which may contain as much as 1,500,000 tons of ore is undercut. As ore from the undercut slice is withdrawn, the mineral strata above it break away and start to disintegrate as they move downward, the weight of the upper part of the mass crushing the ore at the bottom. In the "blast-hole" method, explosives are used to break the slices of harder, tougher ore from the solid material.

SYMPOSIUM ON CONCRETE SHELL ROOF CONSTRUCTION.—The Cement and Concrete Association are arranging a symposium on concrete shell roof construction, to be held in London from July 2 to 4. Applications for membership of the symposium, which is free, should be made to the organising secretary of the symposium, Cement and Concrete Association, 52, Grosvenor-gardens, London, S.W.1. The first day's papers will deal with architectural aspects and will be given at the Royal Institute of British Architects. Meetings on the second and third days will be held at the Institution of Civil Engineers and will be devoted to design, research and construction; the names of authors and papers on these days will be as follows: Dr. J. J. McNamee, "Existing Methods for the Analysis of Concrete Shell Roofs"; Mr. A. Goldstein, "Flexibility Coefficient Methods and their Application to Shell Design"; Dr. P. B. Morice, "Research on Shells"; Mr. R. S. Jenkins, "New Forms of Shell"; Mr. C. V. Blumfield, "The Combination of Shells and Prestressing"; Mr. H. G. Cousins, "Design and Construction from the Economic Aspect"; Mr. H. E. Manning, "Construction of Skelton Grange Power Station and a Factory at King's Lynn"; Mr. H. F. Rosevear, "Formwork Used on a Factory at Greenford"; and Mr. A. Paduart, "Travelling Formwork as Used on Sheds at Antwerp."

NOTES FROM THE INDUSTRIAL CENTRES.

SCOTLAND.

OUTPUT OF IRON AND STEEL.—The production of steel ingots and castings in the Scottish district increased during April to an annual equivalent of 2,172,600 tons, as compared with 2,161,100 tons in March. The corresponding rate in April, last year, was 2,398,900 tons. Pig-iron output continued to expand, reaching a rate of 918,300 tons per annum. This contrasted with 906,000 tons in March and 715,900 tons in April, 1951.

LEVEN PURIFICATION SCHEME.—A River Leven purification scheme, involving a 14-mile pipeline from points as far inland as Leslie to an outfall 400 yards out in the Firth of Forth, was officially opened on May 5, the ceremony being performed by the Earl of Home, Minister of State, Scottish Office. The scheme, which will serve five burghs, will deal with the industrial effluent of many factories.

DOXFORD DIESEL-ENGINE BUILDING AT ABERDEEN.—John Lewis & Sons, Ltd., shipbuilders, Aberdeen, have completed preliminary tests on their first Doxford opposed-piston oil engine, and, on May 13, began full-power trials. The firm intend to reorganise their engine works. The range at present built is between 600 and 2,000 b.h.p., but this may be extended, on the one hand, to 3,000 b.h.p., and, on the other, to 400 b.h.p.

THE LATE MR. G. M. COWAN.—Mr. George Middleton Cowan, a son of the late Sir John Cowan, a former chairman of Redpath, Brown & Co., Ltd., constructional engineers, Glasgow, died in London on May 15. Mr. Cowan, who had served the company for many years, was attached to the London office, where he was concerned principally with the export trade.

EXTENSION OF ELECTRICITY SUPPLIES IN THE NORTH.—A scheme, prepared by the North of Scotland Hydro-Electric Board, for the transmission of electricity from the power stations at Garry and Moriston to a transforming station to be erected at Fort Augustus, where they will be connected up with the Board's grid, has been confirmed by the Rt. Hon. James Stuart, M.P., Secretary of State for Scotland. The scheme will also provide power initially for the construction of the Garry and Moriston works. It is estimated to cost £30,000. The amenity committee of the Board, who were consulted about the possible effects of the scheme on the amenities of the districts through which the lines will pass, recommended certain minor alterations in the route proposed, which have been accepted by the Board.

THE S.S. "DUCHESS OF ARGYLL."—The turbine steamer Duchess of Argyll, a well-known vessel in the Clyde-coast passenger service for nearly 50 years, made what will probably be her last passage down the Firth on May 16. She was taken out of the Victoria Harbour, Greenock, where she had lain for some time, and is now being towed to Portland, where she will be based for experimental purposes, having been purchased by the Admiralty.

LARGE GRANITE BLOCK AT STIRLINGHALL QUARRY.—A block of grey granite, weighing over 600 tons, has been quarried at Stirlinghall, near Peterhead. It is the largest block to be dislodged in the district for many years. The block measures 28 ft. by 20 ft. by 16 ft. After it has been cut and dressed, its value is expected to be about £6,000.

NEW PIER IN ISLE OF JURA.—The first official call at the newly constructed pier at Craighouse, Jura, was made last week by the mail boat Lochiel. The pier cost £40,000. Built of reinforced concrete, it is 456 ft. long, which is 100 ft. longer than the old pier it replaces. To facilitate berthing in stormy weather, it is provided with fenders on three faces.

CLEVELAND AND THE NORTHERN COUNTIES.

PROPOSED MERGING OF TEES-SIDE LOCAL AUTHORITIES.—Mr. J. C. H. Booth, who is prominent in North-East Coast commercial circles, in his presidential address to the Tees-side and South West Durham Chamber of Commerce, referred to a revival of the suggestion that local municipal undertakings should be merged in one authority, having the status of County Council. In 1943, members of the six Tees-side authorities were called together to discuss the matter. The authorities concerned are the town councils of Middlesbrough, Stockton, Thornaby and Redcar, and the urban district councils of Eston and Billingham. When it was discussed nine years ago, the proposal for amalgamation was received

favourably, but later the various councils individually failed to agree and the suggestion was dropped. Many Tees-side residents, however, consider its revival to be considerably overdue.

TYNESIDE EXPORT FIGURES.—Coal and coke shipments from the Tyne, during April, amounted to 743,516 tons, an increase of 9,172 tons or 1.2 per cent. on last year, but 268,699 tons or 26.5 per cent. less than in 1938. For the first four months of the present year, shipments totalled 3,229,062 tons, which was 402,096 tons or 14.2 per cent. more than 1951, but 1,051,579 tons or 24.6 per cent. below the figures for 1938. This year, 202,238 tons more coal and coke have been shipped to foreign ports than in the corresponding period of last year. Exports of general merchandise for the first three months of this year, amounted to 90,801 tons, against 97,677 tons in 1951 and 63,590 tons in 1938. The biggest items of export were 16,083 tons of oil-fuel cargo, 15,603 tons of sulphate of ammonia, and 14,683 tons of tar and pitch.

COLLIERY DE-WATERING SCHEME.—A scheme for pumping water from flooded colliery workings in South-West Durham, begun two years ago by the National Coal Board, has resulted in the water level being reduced by 120 ft. In May, 1950, electric pumps, discharging 2,500 gallons of water a minute, were installed in a disused shaft at Town End Colliery, West Auckland. There are more than 70,000,000 tons of coal in the flooded area, and coal which is now workable as a result of the reduced water level will be obtained mainly from existing pits; there will be no large-scale reopening of closed pits. It is believed that, before the de-watering scheme was put in hand, there was an underground lake about four miles in length, two and a half miles in width, and about 180 ft. in depth. In addition to obtaining access to coal which had been flooded, the de-watering plan was undertaken to deal with the possibility that flood water from the disused pits might seep into the deeper mines to the east, which are still being worked.

WEAR TRAFFIC STATISTICS.—Shipments of coal and coke from the River Wear during March amounted to 298,419 tons, an increase of 55,161 tons over March last year but 101,205 tons less than the 1938 figures. For the first quarter of the year, shipments amounted to 800,409 tons, an increase of 42,282 tons on 1951, but 362,937 tons below the 1938 figures. This year's shipments comprised 631,554 tons sent coastwise, and 468,855 tons dispatched to foreign ports. Imports of general merchandise included 18,956 tons of iron ore (25,401 tons last year), and 49,010 tons of petroleum (42,220 tons). For the first three months of this year there were no imports of chromium ore, iron and steel and iron and steel scrap. Exports included 1,887 tons of engines in new ships (2,045 tons last year), and 21,018 tons of petroleum (19,592 tons).

DEVELOPMENT OF WOOLINGTON AIRPORT.—The Newcastle-on-Tyne City Council are considering developments at Woolington Airport, which is owned by the Council, to make it a terminal for European air services. The City Council will call a conference of local authorities to discuss the matter. The Council contend that, as the airport serves the surrounding areas, as well as Newcastle itself, the Newcastle Council should not bear the total cost of the proposed developments, but that other councils should contribute. South Shields and Sunderland Councils have decided to take no action in the matter, but Gateshead is to send a representative to the proposed conference.

LANCASHIRE AND SOUTH YORKSHIRE.

THE LATE MR. H. A. LIEBERT.—We regret to report the death, on May 9, at the advanced age of 91, of Mr. Harry Anton Liebert, who was one of the managing directors of John Holroyd & Co. Ltd., Milnrow, Lancashire, from 1888 until his retirement in 1936. Mr. Liebert was born in Manchester in 1861, and served his apprenticeship with Beyer, Peacock & Co. Ltd., Gorton, Manchester. Shortly afterwards he joined John Holroyd & Co. Ltd., whose works were then in Hulme, Manchester. In 1896, they were transferred to Milnrow, near Rochdale, where the headquarters are still situated. Mr. Liebert's greatest interest was always in special machine tools, and he was responsible for the design and manufacture of numerous different types for many industries. He was the pioneer in the design of long thread milling machines, which design he patented over 50 years ago. One of these machines received a medal at the International Exhibition in Paris in 1900 and is now in the South Kensington Museum in the section devoted to historic machine tools. Mr. Liebert was elected a member of the Institution of Mechanical Engineers in 1894. He served for many years on the Council of the Machine Tool Trades' Association. During the 1914-18 war, he initiated, along with others, a Government shell factory in Rochdale and served on its managing committee. He designed some ingenious

work-handling and conveying equipment for this factory which enabled women to deal with heavy shells.

SMOKE PREVENTION RESEARCH.—Research investigators from the University of Sheffield have recently visited between 50 and 60 steelworks to investigate the possibility of reducing the amount of smoke emitted from steelworks. The head of the Department of Fuel Technology, Professor R. J. Sarjant, has expressed the opinion that the team have a solution, but perhaps not the immediate solution. Experimental work is being carried on in a workshop laboratory at the University.

EQUAL INCREASES IN WAGES.—For the first time, increases in pay granted to Sheffield operatives have been the same for women as for men. The new Cutlery Wages Council have awarded increases of 2d. an hour to adult male and female employees, who number about 8,000 in Sheffield. For men and women under 21, the increases range from 1½d. an hour to ¼d. an hour for those aged between 15 and 16. There are proportionate increases in the piecework time rates which are 15 per cent. higher than the datal rates.

LOW RECORD OF UNEMPLOYED.—The latest returns show that, in the East and West Ridings of Yorkshire, the percentage of unemployed in April was 2.4. Nationally, it was 2.2 per cent., while in Sheffield it was only 0.7 per cent., being slightly higher than in the previous month. Men out of work in Sheffield totalled 805 and, in addition, there were 121 temporarily suspended.

DEVELOPMENT OF CHARACTER.—The Sheffield firm of Brown Bayley's Steels Ltd. are paying nearly all the expenses as well as continuing the basic wages of six young employees who are attending a month's course at the Outward Bound Mountain School at Eskdale, Cumberland, to develop their characters by mountaineering, athletics and the accompanying mental training. On their return to the works, another six boys will take their place at Eskdale, making a total of 36 from the firm to attend the school in three years.

THE MIDLANDS.

BRITISH INDUSTRIES FAIR.—The general impression at the Birmingham section of the British Industries Fair is that, though the number of overseas buyers was smaller (it is officially stated to be 30 per cent. less than last year), the Fair was more realistic, and the inquiries which were made were mostly genuine. The number of home buyers at Castle Bromwich was also down, in this case by 10 per cent., which was not unexpected. Among the overseas visitors, the greatest number came from Australia.

IMPROVEMENTS AT NEW STREET RAILWAY STATION, BIRMINGHAM.—New Street (London Midland Region) railway station at Birmingham is to have a certain amount of work done to it to improve facilities for both passengers and train working. The station buildings, which are temporary, are to be repainted, and new station name boards and direction signs are to be erected. Rumours which have been circulating in the district that the complete rebuilding of the station is to be commenced soon are without foundation. On the train operation side, the second stage of a re-signalling programme is now nearly complete. Colour-light signalling was introduced on the western side of the station five years ago, and the other side (formerly the Midland Railway section) is now receiving attention.

FACTORY CIVIL DEFENCE.—Some of the larger engineering firms in the Midlands have been active in preparing their own civil-defence schemes. Round Oak Steelworks Ltd., Brierley Hill, Staffordshire, have appointed Mr. J. Regan to take charge of planning and training for civil defence in their works. Mr. Regan, who qualified at the Home-Office Civil-Defence School, will complete the training of the first group of volunteers in the next few weeks. Those who complete the training course successfully will then train other volunteers.

A SUCCESSFUL EXPERIMENT.—The firm of L. G. Harris Ltd., Stoke Prior, near Bromsgrove have now concluded an experiment which was designed to meet a temporary recession in trade. Eight weeks ago, the whole of the employees voluntarily accepted a pay cut of 10 per cent., the firm hoping thereby to avoid having to discharge a proportion of their workpeople. Conditions having improved, the cut has been restored, and the employees are continuing on the old terms.

MEMORIAL TO MR. S. J. ELLIS.—To commemorate the services to Birmingham University of Mr. S. J. Ellis, who died on March 1, 1951, after serving for 30 years as lecturer in charge of the heat-engines laboratory, an "S. J. Ellis Memorial Lectureship" is to be established in the University to provide for the delivery of an annual

lecture to engineering students by some prominent engineer. Former students and others who may wish to contribute to the endowment fund are asked to forward their donations to Mr. W. A. Linning, Department of Mechanical Engineering, The University, Edgbaston, Birmingham, 15. Cheques (which should be crossed) should be made payable to "S. J. Ellis Memorial Lectureship Fund."

SOUTH-WEST ENGLAND AND SOUTH WALES.

FACTORY EXTENSION AT RESOLVEN.—A new hardening shop and factory extensions have been opened by George Kent, Ltd., at Resolven. To meet the needs of a heat-treatment department, a new gas main had to be laid from Neath. Operations on the gas main began in February, 1951, and the intervening 15 months had been marked by an acute steel shortage, which added to the difficulties. The firm started in Resolven in 1946 and the factory has now been extended by 39,000 sq. ft. More than 600 people are employed in manufacturing steering gear for cars, and components for domestic water heaters which are made at the firm's Luton works.

ELECTRICITY BOARD ACTIVITIES.—The South Wales Electricity Board have planned a capital expenditure, for the next financial year, of 2,250,000l. Rural developments will account for 204,000l. and will enable the Board to complete, by next March, three stages of its first programme of a ten-year rural-development scheme.

END OF ABERDARE VALLEY COAL STRIKE.—The miners who had been on strike in the Aberdare Valley returned to work this week. At one time, eight collieries were involved, with nearly 5,000 men idle, and altogether there was a loss of output of between 45,000 to 50,000 tons of coal.

NORTH WALES HYDRO-ELECTRIC BILL.—The British Electricity Authority state that they have decided not to proceed, in the North Wales Hydro-Electric Power Bill 1951/52, now before Parliament, with the promotion of those provisions which relate to the Ffestiniog scheme. As the result of discussions with other interested parties, the Authority's advisers have considered further facts recently brought to their notice, regarding geological and other conditions affecting the proposed reservoir at Llyn Cwmorthin and the measures to be taken to safeguard the adjoining quarry workings. In consequence, they are of opinion that further action on this scheme should be deferred to allow for a review and possible modification of these works.

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.

INCORPORATED PLANT ENGINEERS.—*West and East Yorkshire Branch:* Monday, May 26, 7.30 p.m., The University, Leeds. "Plant Reorganisation," by Mr. A. G. Dewhurst. *South Yorkshire Branch:* Thursday, May 29, 7.30 p.m., The Grand Hotel, Sheffield. "Foundry Mechanisation," by Mr. P. McA. Martin. *Birmingham Branch:* Friday, May 30, 7.30 p.m., The Imperial Hotel, Birmingham. "Refrigeration," by Mr. A. C. Curgiven.

SOCIETY OF INSTRUMENT TECHNOLOGY.—Tuesday, May 27, 7 p.m., Royal Society of Tropical Medicine and Hygiene, Manson House, 26, Portland-place, W.1. "Recent Advances in the Industrial Use of the Microscope," by Mr. E. W. Taylor.

ROYAL STATISTICAL SOCIETY.—Wednesday, May 28, 5.15 p.m., London School of Hygiene and Tropical Medicine, Keppel-street, W.C.1. "Statistics of Tins and Cans," by Mr. J. Ryan.

INSTITUTION OF ELECTRICAL ENGINEERS.—*Radio Section:* Wednesday, May 28, 5.30 p.m., Savoy-place, Victoria-embankment, W.C.2. Lecture on "Recent Progress in Colour Television Technique in the United States," by Mr. A. G. Jensen.

INSTITUTION OF PRODUCTION ENGINEERS.—*Shrewsbury Section:* Wednesday, May 28, 7.30 p.m., The Technical College, Shrewsbury. "Designs for Fabrication to Replace Castings," by Mr. S. M. Reisser. *Eastern Counties Section:* Friday, June 13, 7.30 p.m., Garrett Memorial Hall, Ipswich. "Oil for Britain" Exhibition, arranged by the Esso Petroleum Co., Ltd., and lecture on "Machine Lubrication," by Mr. C. J. Taylor.

ROYAL INSTITUTION.—Friday, May 30, 9 p.m., 21, Albemarle-street, W.1. "Sir Christopher Wren Through His Drawings," by Mr. John Summerson. Friday, June 6, 9 p.m., "Man at High Altitudes," by Professor G. I. Finch, F.R.S.

CHEMICAL SOCIETY.—Thursday, June 5, 7.30 p.m., Chemical Society's Apartments, Burlington House, Piccadilly, W.1. Various short papers for discussion.

APPRENTICE TRAINING SCHOOL.

To overcome the shortage of skilled men capable in due course of filling the more responsible positions, such as charge hands, foremen and, eventually, departmental managers, the General Rubber Goods Division of the Dunlop Rubber Company, Limited, Cambridge-street, Manchester, have opened a technical training school where all boys reaching the age of 16 attend for one day a week until they are 18. During these two years they receive instruction in nine different subjects, the course being designed to give a sound background of rubber technology and the various trades allied to its production. The subjects covered include machine drawing, practical engineering, time and motion study, simple costing, safety regulations, textiles and factory welfare. In every case, the subject is treated in the manner most likely to interest the student and, where possible, practical instruction is included. When receiving instruction in textiles, for example, the students weave scarves on hand looms, and in the engineering shops are permitted to make such items as ash trays, candlesticks, etc., which they are allowed to take home so as to encourage the interest of their parents. The course is not intended to make the boys into skilled tradesmen, but to give them a sufficient background of knowledge to appreciate the many facets of rubber production. In the engineering shop, for instance, the aim is not to make the boys into engineers, but to impress on them the functions of the different machines and their limitations and how they are used to make the plant needed by the rubber industry. There are no examinations and the teaching is carried out by men in the company's employment who have shown a bent for this type of work. It has been estimated by the company that from 10 to 15 per cent. of the boys now in training will become charge hands, and that 20 to 30 per cent. will prove capable of replacing the operators of the more expensive and intricate plants and machinery.

TRAINING OF ENGINEER OFFICERS FOR THE MERCHANT NAVY.

THE Ministry of Transport has reviewed with shipping companies who have decided to adopt the new scheme for the training of engineer officers for the Merchant Navy, announced in February, the progress which is being made with recruitment under the scheme and the numbers expected to begin their training by entering technical colleges next September. The companies state that many applications are being received. The number likely to be accepted, however, is not yet known.

Meanwhile, the Ministry of Education and the Scottish Education Department have been in communication with local education authorities with a view to the establishment at technical colleges in suitable areas of the two-yearly ordinary national diploma courses which form the first part of the training under the new scheme. It is expected that final decisions about the establishment of courses will be taken at the end of June in the light of the numbers of candidates shipping companies are proposing to accept.

As previously announced, the scheme embraces, firstly, a two-year ordinary national diploma course in mechanical engineering at an approved technical college, with additional practical training during vacations, followed by a period of 18 months' service as an apprentice engineer at sea, and, finally, a period of 12 months' special training in a shipyard or marine-engine builders' or other suitable engineering works. The scheme is an alternative to the standard period of four years' suitable training in engineering works, which is required under the Ministry's regulations for the examinations for certificates of competency as engineers. The national diploma courses will begin annually in September. Candidates must have reached the age of 16 and must have had full-time education up to the age of 16, and have shown proficiency in mathematics and physics; or, alternatively, must have had full-time education up to 15, followed by at least a year's part-time education at an approved technical college, qualifying for admission to the first year of the ordinary national diploma course. The names and addresses of shipping companies who have adopted the scheme can be ascertained from any office of the Shipping Federation, the Employers' Association of the Port of Liverpool, the engineer officers' organisations, Youth Employment Offices and Ministry of Transport Mercantile Marine Offices.

CONGRESS OF INDUSTRIAL HEAT AND APPLIED THERMODYNAMICS.—Arrangements have now been made for the Fourth International Congress of Industrial Heat and Applied Thermodynamics to be held in Paris from Saturday, September 27, to Saturday, October 4, both dates inclusive. Further particulars are available from the general secretary of the Congress, 2, Rue des Tanneries, Paris, 13e.

PERSONAL.

Following the resignation of COMMANDER SIR ROBERT MICKLEM, C.B.E., from his offices in the Vickers organisation and his death on May 13, the under-mentioned appointments have been made by Vickers-Armstrongs Ltd.: SIR JAMES REID YOUNG, C.A., F.C.I.S., has been appointed chairman, MAJOR-GENERAL C. A. L. DUNPHIE, C.B., C.B.E., D.S.O., managing director, engineering works and shipyards, and MR. E. J. WADDINGTON, A.C.A., director of administration. MAJOR SIR HEW KILNER, M.C., continues as deputy chairman and managing director, aviation.

SIR EDWARD BRIDGES, G.C.B., G.C.V.O., has been elected a Fellow of the Royal Society, Burlington House, London, W.1, under the statute which provides for the election of persons who either have rendered conspicuous service to the cause of science or are such that their election would be of signal benefit to the Society.

LT.-COLONEL SIR THOMAS MOORE, C.B.E., M.P., has been elected a director, and Mr. B. H. MARRIAGE, sales director, of Eastwoods Ltd.

MR. R. B. SHEPHEARD, C.B.E., B.Sc., M.Inst.N.A., chief ship surveyor, Lloyd's Register of Shipping, 71, Fenchurch-street, London, E.C.3, is to be released by the Society to take up an appointment with the Shipbuilding Conference later in the year.

COLONEL GERALD H. VAUGHAN-LEE, O.B.E., A.M.I.C.E., R.E. (ret.), has been taken into partnership by Messrs. Coode, Vaughan-Lee, Frank and Gwyther, 9, Victoria-street, London, S.W.1. The firm is now to be known as COODE AND PARTNERS.

MR. H. MORROGH, research manager, British Cast Iron Research Association, Alvechurch, Birmingham, was awarded the William H. McFadden American Foundry Society Gold Medal for outstanding achievement in the field of grey irons, during the Society's 1952 Convention, held from May 1 to 7, at Atlantic City, New Jersey, U.S.A. Mr. Morrogh was one of eleven delegates from the United Kingdom who attended the convention as guests of the Mutual Security Agency, 1, Grosvenor-square, W.1.

MR. H. J. JONES has been re-elected chairman of the North-Western Centre, Institute of Road Transport Engineers. MR. F. SMALES has succeeded Mr. E. H. HORN as chairman of the North-Eastern Centre, and MR. W. MARTIN has succeeded Mr. G. MCINTOSH as chairman of the Scottish Centre.

MR. C. H. E. REBBECK has been appointed resident engineer for the Anglo-Iranian Oil Co., on the construction of the new 3,000,000 tons per annum refinery which that company are to build at Kwinana, near Fremantle, Western Australia.

MR. E. MEAD, B.Sc. (Eng.) (Lond), M.I.E.E., has been appointed assistant manager of the London office of the Metropolitan-Vickers Electrical Co. Ltd., Trafford Park, Manchester, 17. MR. R. ALLEN, Assoc.M.C.T., A.M.I.E.E., has been made assistant manager of the Birmingham office and MR. T. GILL, B.Sc., A.M.I.E.E., manager of the Swansea sub-office.

MR. E. J. PARSONS is succeeding Mr. H. M. LAWRENCE as London manager of Small and Parkes Ltd., Hendham Vale Works, Manchester, 9, on the latter's retirement on May 31. MR. A. K. HEBDITCH, hitherto service manager at the firm's Wimbledon address, has been made London Technical manager. Both Mr. Parsons and Mr. Hebditch will work from the new London office, at 76, Victoria street, London, S.W.1. (Telephone: VICTORIA 1845.)

MR. GORDON E. WEST, Mansard Cottage, West Farm-avenue, Ashted, Surrey, has been appointed sales manager to Whitehouse Industries Ltd. (Philidas Division), for London and the Home Counties.

MR. J. H. JUPE, A.M.I.E.E., has resigned his position as Press officer to the General Electric Co. Ltd., to take up an appointment in the technical information division of Marconi's Wireless Telegraph Co. Ltd., Chelmsford.

MR. J. S. WEBB, Press officer to Silver City Airways Ltd., 1, Great Cumberland-place, London, W.1, informs us that his home telephone number during off-duty hours is Hayes (Middlesex) 4017.

MR. STANLEY HOLME, one of the joint secretaries (American side) of the Anglo-American Council on Productivity, and assistant to the chairman of the board of the General Electric Company of the United States, has been created an honorary Commander of the Order of the British Empire.

METALOCK (BRITAIN) LTD., Grand Buildings, Trafalgar Square, London, W.C.2, have opened an office at 33, The Temple, 24, Dale-street, Liverpool. (Telephone: Liverpool Central 3820.) The area manager is Mr. A. TYNWELL.

WARSOP POWER TOOLS LTD., have opened a new depot at Hopgoods Yard, Southend-road, Basingstoke, to serve Hampshire, the Isle of Wight, West Sussex, Dorset, the Channel Islands, Wiltshire and Berkshire. Larger premises have also been taken to serve London and the South East, at Carlton-road, South Croydon. (Telephone: Croydon 8017) and North-East England, at Gelderd-road, Gildersome, Leeds. (Telephone: Leeds 39359.)

PRODUCTION OF MEDIUM-SIZE DIESEL ENGINES.

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

(For Description, see Page 647.)

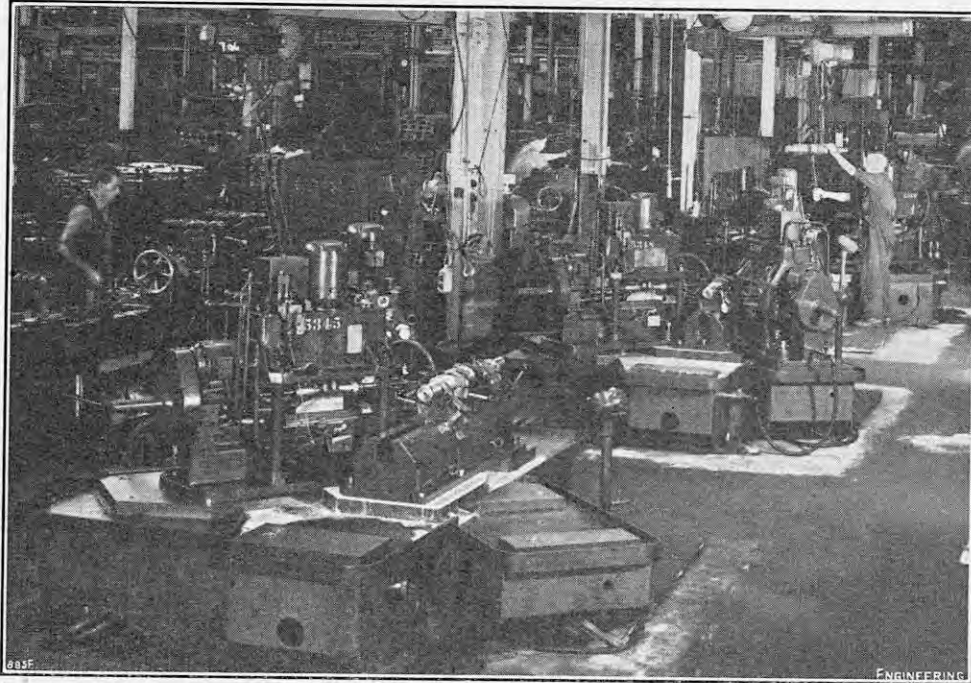


FIG. 6. DRILLING OILWAYS IN CRANKSHAFTS.

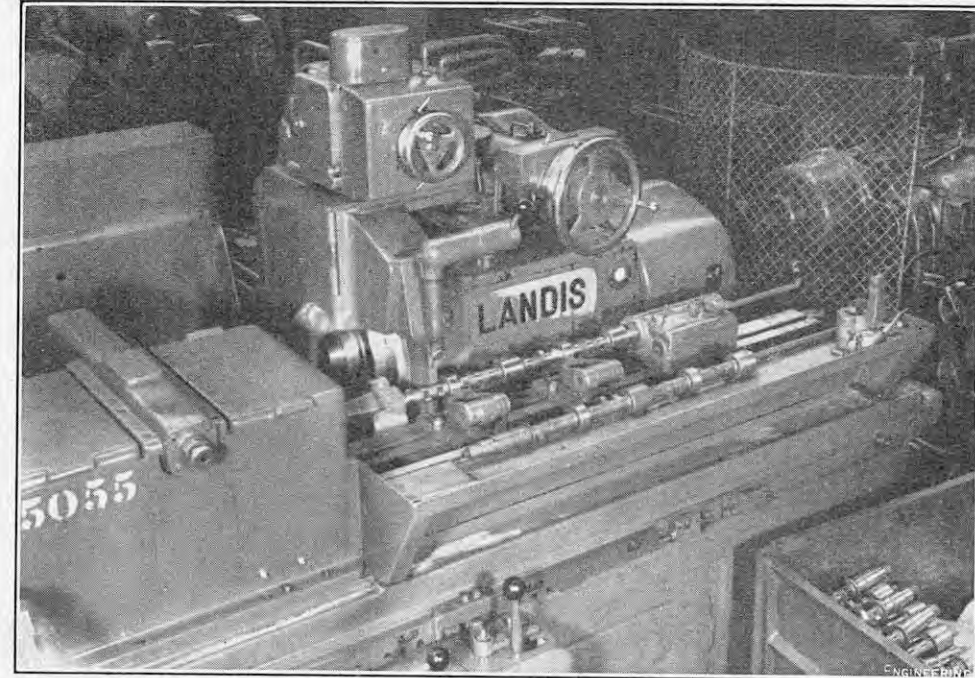


FIG. 8. AUTOMATIC CAM-PROFILE GRINDING MACHINE.

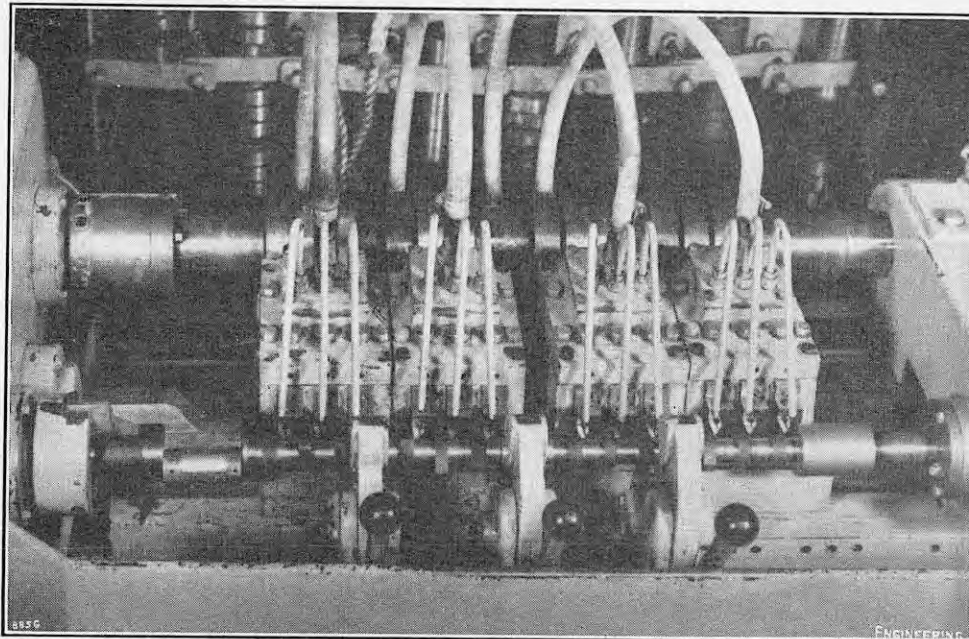


FIG. 7. CAM-PROFILE TURNING LATHE.

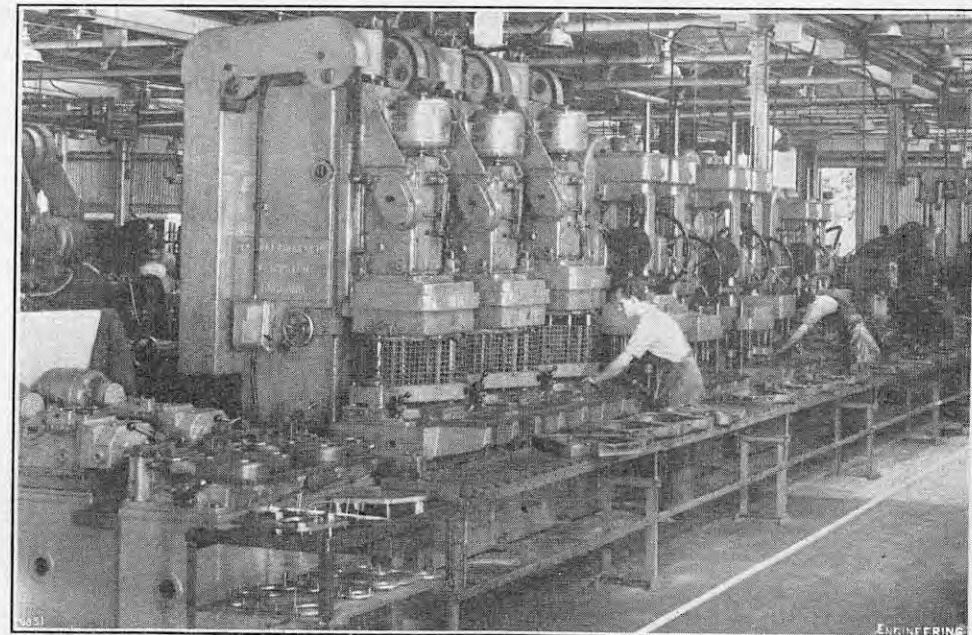


FIG. 9. MACHINES FOR BORING, DRILLING AND TAPPING GEARCASES.

ENGINEERING

35 & 36, BEDFORD STREET, STRAND,
LONDON, W.C.2.

Registered at the General Post Office as a Newspaper.

We desire to call the attention of our readers to the fact that the above is the address of our Registered Offices, and that no connection exists between this Journal and any other publication bearing a similar title.

Telegraphic Address:

ENGINEERING, LESQUARE, LONDON.

Telephone Numbers:

TEMPLE BAR 3663 and 3664.

All editorial correspondence should be addressed to the Editor and all other correspondence to the Manager.

Accounts are payable to ENGINEERING Ltd. Cheques should be crossed "The National Provincial Bank, Limited, Charing Cross Branch." Post Office Orders should be made payable at Bedford Street, Strand, W.C.2.

SUBSCRIPTIONS.

ENGINEERING may be ordered from any newsagent in town or country and from railway book-stalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months, payable in advance:—

For the United Kingdom and all places abroad, with the exception of Canada	£5 10 0
For Canada	£5 5 0

Subscriptions for periods less than twelve months are based on the price of a single copy, namely, 2s. 3d. post free.

ADVERTISEMENT RATES.

Terms for displayed advertisements on the green art paper wrapper, on the inside black and white pages and in the buff art paper two-colour supplement, as well as for insets, can be obtained on application to the Manager. The pages are 12 in. deep and 9 in. wide, divisible into four columns 2½ in. wide. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

The charge for advertisements classified under the headings of "Appointments Open," "Situations Wanted," "Tenders," etc., is 10s. for the first four lines or under, and 2s. 6d. per line up to one inch. The line averages six words and when an advertisement measures an inch or more, the charge is 30s. per inch. If use is made of a box number the extra charge is 1s. per insertion, with the exception of advertisements appearing under "Situations Wanted." Series discounts for all classified advertisements can be obtained at the following rates:—5 per cent. for six; 12½ per cent. for thirteen; 25 per cent. for twenty-six; and 33½ per cent. for fifty-two insertions.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Classified advertisements intended for insertion in the current week's issue must be received not later than first post Wednesday.

"Copy" instructions and alterations to standing advertisements for display announcements must be received at least 10 days previous to the date of publication, otherwise it may be impossible to submit proofs for approval.

The Proprietors will not hold themselves responsible for advertisers' blocks left in their possession for more than two years.

CONTENTS.

	PAGE
Hydraulics in Agricultural Engineering (<i>Illus.</i>)	637
The British Industries Fair at Birmingham—IV (<i>Illus.</i>)	639
The Institution of Naval Architects	646
Production of Medium-Size Diesel Engines by R. A. Lister and Co., Ltd., Dursley (<i>Illus.</i>)	647
Notes from the Industrial Centres	650
Notices of Meetings	651
Apprentice Training School	651
Training of Engineer Officers for the Merchant Navy	651
Personal	651
Coal Utilisation	653
Quarrying and Metal-Mining	654
Notes	655
Letter to the Editor.—Hydraulic Lock	655
The Iron and Steel Institute	656
Obituary.—Commander Sir Robert Micklem, C.B.E., R.N. (retd.) (<i>with portrait</i>)	657
The Blast Furnace in the Early Nineteenth Century	657
Machining and Heat-Treatment of Gears (<i>Illus.</i>)	659
Labour Notes	660
Explosions in Engine Crankcases (<i>Illus.</i>)	661
Annual Report of the Institution of Electrical Engineers	662
The Quantity Production of Glass Bulbs for Electrical Purposes (<i>Illus.</i>)	662
Training in Electronic Engineering	663
Tests of the Brown-Boveri Gas-Turbine Locomotive (<i>Illus.</i>)	664
Launches and Trial Trips	666
British Standard Specifications	666
Transport by Road of a Large Steel Cylinder (<i>Illus.</i>)	667
Strengthening Welded Tankers	667
Trade Publications	667
Hydraulic Selector Valve with Electric Control (<i>Illus.</i>)	668
Contracts	668
Books Received	668

Six One-Page Plates.—EXHIBITS AT THE BRITISH INDUSTRIES FAIR, BIRMINGHAM. HEAT TREATMENT SHOP OF MESSRS. BLAW KNOX, LIMITED. QUANTITY PRODUCTION OF GLASS BULBS.

ENGINEERING

FRIDAY, MAY 23, 1952.

VOL. 173.

No. 4504.

COAL UTILISATION.

IN national importance, the British Coal Utilisation Research Association occupies a position near the head of the list of the 42 research associations now in operation. Coal is not only by far the most important natural endowment in the country; its effective and efficient utilisation is also of importance to practically all manufacturing industries and to most individual citizens. The extent of the field covered by the work of the Association is indicated by its list of members, which is made up of manufacturers of appliances concerned with the utilisation of coal or its derivatives, coal producers, exporters and merchants, producers of coke and patent fuel, and consumers of coal or its derivatives. This latter group might be expected to cover almost the whole of industry, but actually the Association has only 22 members included in that class. The reason for this may well be that many, or most, commercial firms consider that the utilisation of coal can hardly be considered to come within the range of their proper activities.

This point of view receives support from the constitution of the Department of Scientific and Industrial Research. Some spheres of activity are considered to be so wide and to embrace such a variety of interests that their investigation, and research appertaining to them, cannot be regarded as the business of any specific branch of industry. As a result of this, Government laboratories concerned with roads, building and other broad subjects, have been set up. Of these, the Fuel

Research Station, although it necessarily covers a wider field, might be considered to be concerned with the same range of problems as the British Coal Utilisation Research Association. In a sense this is so, but a research association closely in touch with, and partly supported by, industry can concern itself, probably more effectively, with the practical problems of the workshop and power station than can an official laboratory which, by its constitution, is expected to devote much of its time to fundamental research. It is not to be supposed that there is any rivalry between the Fuel Research Station and the Association, and in some types of investigation they keep closely in touch, but the Association performs a service for industry which the Fuel Research Station cannot offer. This is evidently becoming more widely realised and the latest report* records that in 1951 the increase in membership was the greatest for several years past.

It would hardly be possible to consider or discuss the question of coal utilisation without paying some attention to the controversy over the relative merits of gas and electricity, particularly in the domestic field. This controversy is of many years standing but has recently flared up in an acute form. It was discussed in the first leader in our last week's issue. The British Coal Utilisation Research Association has an important part to play in the solution of the technical problems on which the resolution of the dissonance depends, but is in the fortunate position of being free from the necessity of expressing *ex parte* opinions about the merits of the rival cases. It is equally concerned with the efficient burning of coal in an electric power-station boiler or a domestic grate, as with improvement in the performance of gas producers. An Association counting among its members the National Coal Board, the British Electricity Authority and the Gas Council may be considered to have feet in both camps.

The wide range covered by the work of the Association is indicated by the report. Mention of every individual research or investigation of which some brief particulars are given could, however, be no more than a list of titles, and selection must therefore be exercised. A development of importance, which in the report is even described as an "achievement," is the working-out of a process for the utilisation of the several million tons of wet coal slurry, originating mainly from coal washeries. The process is described as "pelletizing." The slurry is first broken up to form a wet mud and is then passed to a shaker table of special surface contour and is formed into pellets ranging from ⅛ in. to ½ in. and ¼ in. to ½ in. in diameter. No binder is added, it having been found that the clay material present in the slurry is sufficient to secure adhesion. The pellets, when dry, are strong enough to withstand handling by belt or pneumatic conveyor, do not disintegrate in a producer fuel bed and have given promising results on a mechanical stoker firing a boiler. One of the claims frequently made by advocates of domestic electric space heating is that the power stations utilise small and poor-quality coal for which there is no other market. If the pelletizing process ultimately enables power stations to utilise coal slurry, arguments of this type will be strengthened although it seems likely that questions of handling and transport may impose limitations, except, possibly, for power stations situated in the neighbourhood of coal washeries. The pelleted slurry has been successfully used in gas producers and it is considered that slurry gasification may lead to the heating of coke ovens and the firing of boilers with producer gas, thereby releasing oven gas for sale to the gas industry.

The section of the report dealing with open fires and closed stoves contains the statement that "domestic appliance research has to solve problems

* Annual Report 1951. The British Coal Utilisation Research Association. Randalls-road, Leatherhead, Surrey.

that are the more formidable for the fact that they demand solutions covering more than just the technical problems alone." This may be taken to refer to the fact that, in general, domestic appliances are operated by unskilled users. In this matter both electric and gas fires, cookers and water heaters have the advantage that the user has little or no control over their operation. With solid-fuel appliances, however, an unskilled operator may not only waste coal, but may contribute to the pollution of the atmosphere. The present domestic consumption of raw bituminous coal is about 35 million tons a year and as "the substitution of any large part of this in the near future cannot be envisaged swing to the technical and financial difficulties involved," any measures which may improve the efficiency of burning and reduce smoke emission are of importance. On this latter point it has been found that with the open fire having a deep ashpit and under-floor supply of air, which was designed some years ago by the Association, "under carefully controlled conditions of operation," smoke emission may be reduced to about one-tenth of that obtained with an ordinary stool-bottom grate. Unfortunately, the method of operation defined by the words quoted is not likely to be practised by the ordinary householder. Work is now being directed to studying how far conditions of operation can be relaxed without increasing smoke emission seriously. No doubt both improved efficiency and less smoke are produced by the various types of closed or semi-closed stoves which have been introduced and, in spite of the preference for open fires in this country, are coming into increased use.

The British Coal Utilisation Research Association is not directly supported by the domestic user, for whose benefit this work on open fires and stoves is carried out, although he supports it indirectly in the form of the grant of 60,604*l.* obtained from the Department of Scientific and Industrial Research in 1951. As, however, other subscriptions and grants, largely from the National Coal Board, amounted to 164,626*l.*, industry as a whole may consider that undue attention should not be given to the domestic consumer, and study of the report shows that domestic interests do not dominate the activities of the Association. The section dealing with boiler performance records work on coal characteristics, heat transfer in smoke tubes, steam wetness and refractory furnace-tube baffles. The furnace department has been particularly concerned with research on solid-fuel firing for gas turbines. As one of the conditions for the successful operation of a coal-fired gas turbine is that the hot gases shall not contain material which will cause damage, attempts are being made to develop an improved form of cyclone-type dust collector. Although they are not related in the report, it seems possible that the work on the grindability of coal, carried out in conjunction with the National Coal Board, the British Electricity Authority and the Fuel Research Station, may prove to have a bearing on solid-fuel firing for gas turbines.

As with other bodies of the same type, the Association is finding difficulty in recruiting scientific staff, but the effect of this has been reduced by the close relations maintained with a number of universities and by participation in student vacation employment schemes. The Universities of Sheffield and Leeds are particularly associated with extramural work. At the former, a research team under the direction of Professor R. J. Sarjant is concerned with a study of heat-measurement problems relating to the work in progress in the boiler department of the Leatherhead Laboratories. It has also been assigned problems relating to work on new methods of gasification. At Leeds, under Professor A. L. Roberts, the Association is supporting investigations on the mechanism of smoke formation and on the mineral constituents of coal.

QUARRYING AND METAL-MINING.

For several years past, various Ministries, other Government departments and nationally-organised or nationally-supervised industries have been trying to overtake the arrears of reports on their various activities, resulting from the general upheaval of the war; but the war has been over for a long time now and presumably (though it is not stated) some other reason accounts for the delay in placing in the hands of the public the report of Sir Andrew Bryan, H.M. Chief Inspector of Mines and Quarries, for the year 1950. Though it is dated July 31, 1951, this report* has become available only recently, and some, at least, of the developments that it chronicles in the practice of quarrying and metalliferous mining are not only novelties no longer, but may be supposed to have been supplemented by still later improvements. Some of the comments made, however, are of sufficient interest to be worth some mention. The deep mining of coal is not covered, being dealt with in a separate report by the National Coal Board, but opencast coal-working is included, as it was made subject to the laws relating to quarrying by the operation of the Quarries (Opencast Coal) Order, 1950, which took effect on June 1, 1950. This Order laid upon the opencast contractor who undertakes to extract and deliver the coal the various duties and liabilities which were previously the responsibility of the coal owner.

The latest year for which figures of quarry output were available when the report was prepared was, of course, 1949, when the total output of numerals, excluding coal, was 119,921,000 tons. The number of persons employed was 54,900. During that year, the production of saleable opencast coal was, in round figures, 12,185,000 tons, and at the end of the year some 9,000 persons were employed on that work. How long opencast coal-working will continue to be economically justifiable is problematical, but it may be noted that the ratio of earth moved to coal won may be as high as 12 to 1, providing ample occupation for the 937 excavators, 533 scrapers, 384 bulldozers and 231 Euclid dumpers recorded as being in use for this purpose at the beginning of the year under review. It is observed that "the general increase in the mechanisation of loading operations and of the excavation of the softer rocks continued," mainly by the wider employment of mechanical shovels in conjunction with dumper vehicles. The total number of quarries listed at the end of 1950 was 5,145, of which 1,882 were in the West Midland and Southern Divisions. The distribution among the other six Divisions was as follows: Scottish 674; Northern, 492; North Eastern, 440; North Western, 533; East Midland, 624; and South Western, 500.

The section of the report dealing with metalliferous mining in the United Kingdom must be disappointing to those who still have visions of a revival of the mining of lead and tin in these islands. Zinc production had ceased before the war, and that of lead and tin had been declining steadily; moreover, the report states, "at the present time, geological and mining information on fresh reserves does not hold out much promise of a revival." During 1950, the production of tin ore was confined to the three Cornish mines of Geevor, South Crofty and New Consols, and, at the close of the year, South Crofty was put out of action by the breaking of the cast-iron beam of the pumping engine at Cook's Kitchen. This breakdown was described and illustrated in *ENGINEERING* of January 12, 1951 (vol. 171, page 53). The largest producer of tin was the Geevor mine; New Consols—an old

mine re-opened—was not fully developed. Wolfram was being produced at only one mine, also in Cornwall; fluorspar continued to be obtained from the dumps of old lead mines, but the more profitable of these were being worked out and two fluorspar mines in the North Eastern Division were abandoned; and shortage of labour seriously affected the production of hematite iron ore in Cumberland, where are situated six of the seven mines of that ore. The remaining hematite mine is in South Wales.

As some offset to the decline in non-ferrous metal mining, it is noted that the output of ball clay for use in pottery, of gypsum for the cement and plasterboard industries, and of anhydrite, used in the production of sulphuric acid, continued at a satisfactory level; but here again the need to economise in manpower is evidently somewhat acute—sufficiently so for the large anhydrite mine at Billingham, Co. Durham, to supersede its fairly modern underground haulage system, using rail locomotives, by Diesel trucks, on pneumatic tyres. These, however, provide a good instance of the incidental expenditure that may be involved in such schemes to reduce labour; the substitution of these large trucks, of 10 to 12 tons capacity, for the trains of mine cars previously used, has eliminated the cost of track maintenance, but it was necessary to provide two additional fans, each of 50,000 cub. ft. capacity per minute, and to spend considerable sums in addition on improving the ventilation, in order to ensure that the concentration of noxious exhaust gases did not reach a level that might be harmful. To convey the men to and from the working face, electric battery cars were introduced, also running on pneumatic tyres, and it may be supposed that these likewise involved an appreciable additional expenditure. It is open to question, too, whether their life and that of the Diesel-driven trucks, will be as long as that of the trains and rail locomotives that they have replaced.

The notes on fatal and other accidents to the men employed in quarrying and mining are of some interest, particularly as illustrating the old saying that familiarity breeds contempt, for the great majority of the accidents might have been avoided if the men concerned had exercised ordinary care and had taken proper advantage of the protective clothing, etc., generally available. It is difficult to know how to ensure the safety of men who are so thoughtless, for example, as to shelter from blasting operations by taking cover in a temporary store containing a day's supply of explosives and, apparently, to smoke while they were in it. The store blew up some time after the men had left it, presumably because someone had dropped a match or a cigarette end on some slow-burning substance, but a dumper driver some 75 yards away was injured by a flying fragment. In another case, a labourer sought to thaw a frozen acetylene generator with burning oily waste and, not surprisingly, was injured when it exploded; and—perhaps the most reprehensible accident of all those mentioned—another labourer, at a barytes mine, threw four cartridges of gelignite into a coke brazier, even though he had reason to suppose that they might contain a detonator—which they did.

Some of these men may have been too inexperienced to know the seriousness of the risks to which they exposed themselves and others so heedlessly, but there were many other cases in which men of considerable experience suffered because they did not trouble to take ordinary precautions. The total number of deaths, from all causes, and including those in quarries, metalliferous mines and opencast coal-working, was 45, of which ten occurred in the opencast coal quarries; and the corresponding totals of persons who were "reportably injured" were 157 and 32. Of these totals, 39 casualties resulted from falls of ground, 42 from accidents with explosives, 50 from haulage and transport, and 24 were "accidents with machinery."

* *Report of H.M. Inspectors of Mines and Quarries for the Year 1950.* H.M. Stationery Office, York House, Kingsway, London, W.C.2. [Price 2s.]

NOTES.

INTERNATIONAL CONFERENCE ON GALVANISING.

A SECOND International Conference on Hot Dip Galvanising will be held in Düsseldorf, from Monday, June 30, until Friday, July 4, under the auspices of the Zinc Development Association. The field covered will be wider than that dealt with at the first conference, held at Copenhagen in 1950, and it is anticipated that many more specialists in the galvanising of sheet, wire and tube will be present than was the case two years ago. The technical sessions will be held in the Landtag building, the seat of the provincial parliament of the North Rhine and Westphalia district of Germany. All the papers and the discussions will be in English. The formal opening of the conference will take place at 11 a.m. on the first day, and after an inaugural lunch in the Landtag, a technical session on the subject of "The Zinc Coating" will be held at 2 p.m., when three papers will be introduced and discussed. At 3.30 p.m., there will be visits to works. On Tuesday, July 1, the first technical session, on the "Galvanised Sheet" will be held at 9.30 a.m., and the second, on "The Galvanising Bath," at 11 a.m. One paper will be presented at the first session and three at the second. At 2.30 p.m., parties will visit local works. On Wednesday, July 2, from 9.30 a.m., until 12.30 p.m., two sessions, the first on "The Galvanising Process" and the second on "Finished-Product Galvanising," will be held, at each of which two papers will be presented. At 2.30 p.m., there will be visits to works. On Thursday, July 3, from 9.30 a.m. until 12.30 p.m., there will again be two sessions. At the first, two papers on "Residues" will be discussed and, at the second, one paper on the "Future Outlook in Galvanising" will be dealt with. At 2.30 p.m., there will be visits to local works, and, in the evening, at 6.30 for 7, a dinner will be held in the Rheingoldsaal of the Rheinterrasse Restaurant. On Friday, July 4, whole-day visits will be paid to the Eisenwerk Streuber und Lohmann, at Herford, and the Eichener Blech und Fassfabrik, in Kreuzthal. The works visited on the previous days of the conference are: the Rheinische Röhrenwerke, Mülheim; Wirtz und Co., Gelsenkirchen; Schwelmer Eisenwerk Müller und Co. G.m.b.H., Schwelm; Stolberger Zinc A.-G., Zinkhütte, Nievenheim; and the Henkel Works. An entrance fee of 5*l.* is payable by persons who participate in the conference and further particulars may be obtained from the secretary of the Zinc Development Association, Lincoln House, Turl-street, Oxford.

TRANSATLANTIC ARRANGEMENTS FOR MANUFACTURING LICENCES.

One of the activities of the Mutual Security Agency is to sponsor licensing arrangements which enable European (including British) firms to manufacture goods under licence from United States firms. Reciprocal arrangements are also made so that European firms who, for one reason or another, are not able to export their products to the United States or set up factories and sales organisations there, can, nevertheless, obtain some "export" benefits by granting licences to American firms. Such opportunities are particularly valuable to medium-size and smaller firms; the larger organisations, principally because of their greater resources, have generally been able to overcome the difficulties. The M.S.A. have recently issued a list of 33 American firms who are seeking European licensees; several of the products concerned are of engineering interest. The greater the movement of industrial techniques, patents, formulae and processes between Europe and the United States, the greater will be the possibility of many products, some of which have hitherto been confined to domestic areas, reaching new outlets. These items could then be made and sold where the need exists, without the complication of overseas transport, customs clearance, insurance, etc. Where, for example, a British firm wishes to arrange for manufacture under licence in the United States, the M.S.A. service puts it in touch with a suitable American firm. No charge is made. Thereafter, the negotiations follow ordinary business procedure,

being strictly a matter between the two companies. The M.S.A. have established an extensive network of "field counsellors" in Europe and America to help in gathering and distributing licensing proposals. Officers of the Associated British Chambers of Commerce, the Federation of British Industries, the Scottish Council (Development and Industry) and the Ministry of Commerce of Northern Ireland are acting as counsellors in the United Kingdom. A booklet entitled "Transatlantic Licensing Arrangements," which describes the operation of the scheme and the procedure for utilising it, is published by the M.S.A. In this country, copies are available from the Mutual Security Agency, 1, Grosvenor-square, London, W.1.

LEVERHULME RESEARCH FELLOWSHIPS AND GRANTS.

The announcement has been made, during the past week, of the award of ten Leverhulme Research Fellowships and 23 Research Grants for the year 1952. As usual, the range of subjects being studied by the recipients is a very extensive one, including historical, biological, sociological, theological, chemical, literary, archaeological and other categories, many of which, being completely outside the scope of this journal, need not be particularised. We note, however, that a grant has been made to Mr. J. W. Wright, M.A., an inspector of surveys under the Sudan Government, for a study of "The Hydrology of the River Sobat and its Relation with the White Nile"; and that Fellowships have been awarded to Dr. F. Smithies, M.A., lecturer in mathematics in the University of Cambridge, who will investigate "Applications of functional analysis" and to Mr. W. K. V. Gale, F.R.Hist.S., for the "Recording of traditional processes in the engineering and metal-working trades, in danger of becoming extinct." Mr. Gale, who has been for many years the honorary secretary of the Birmingham branch of the Newcomen Society and is also the editorial correspondent to *ENGINEERING* for Birmingham and district, has already carried out extensive researches into such handicrafts as hand chain-making, nailmaking, and the making of wrought iron, on which he is an accepted authority. Further information about the Leverhulme Fellowships and Grants, and forms of application, may be obtained from the secretary, Leverhulme Research Fellowships, 3-5, Salisbury-square, London, E.C.4.

PRODUCTION AND CONSUMPTION OF PETROLEUM PRODUCTS.

Statistics of the petroleum consumption (exclusive of foreign bunkers) and of the production of refineries in this country during 1951 have just been published by the Petroleum Information Bureau, 29, New Bond-street, London, W.1, on behalf of the United Kingdom Petroleum Industry Advisory Committee. These show an increase in total consumption of all products from 15,276,771 tons in 1950 to 16,887,908 tons in 1951. There was an increase in the consumption of every single petroleum product listed, from aviation and motor spirit to bitumen. The principal items and the quantities consumed in 1951 were aviation spirit 334,148 tons, motor spirit 5,454,264 tons, fuel oil 3,417,285 tons, kerosene 1,775,929 tons, gas and Diesel oil 1,711,812 tons, and Diesel fuel for road vehicles 1,125,623 tons. It is interesting to note that the consumption of oil fuels by the steel industry totalled 968,990 tons last year, against 884,577 tons in 1950. The gas industry also utilised larger quantities of oil, namely, 556,660 tons in 1951 against 539,611 tons in the previous year. Among the most interesting figures are those relating to the output of finished products from refineries in the United Kingdom. The aggregate was 16,430,025 tons last year, compared with only 9,283,752 tons in 1950. This considerable increase reflects the very great development which has taken place during the past 12 months in the refinery-expansion programme in this country. The production of motor and aviation spirit, for example, has more than doubled, namely, 2,923,181 tons in 1951, compared with 1,477,955 tons in 1950. Moreover, nearly half the total output of refined products was fuel oil, the aggregate for 1951 being 7,649,982 tons, and that for 1950, 3,805,198 tons. A welcome feature of this expansion, which, it is pointed out, is continuing, is the considerable

saving in import costs which would have been required if no large-scale refining industry existed in this country. The new refineries in the United Kingdom, it is interesting to note, are operating almost entirely on Middle-East crude oil, which is stated to have a relatively low "dollar content." A final table giving details of the United Kingdom indigenous materials made available by the petroleum industry, shows a significant drop for refined benzole from 188,842 tons in 1950 to 78,996 tons in 1951. The explanation is that exports of benzole have been quadrupled, amounting to 163,000 tons in 1951 against only 44,000 tons in 1950.

THE INSTITUTION OF ENGINEERS IN CHARGE.

The 47th annual dinner of the Institution of Engineers in Charge was held at the Holborn Restaurant, London, W.C.2, on Friday, May 9, the chair being taken by the President, Mr. Robert Chalmers, O.B.E., M.I.C.E. The principal guest was Mr. W. Robson Brown, M.P., A.M.I.Mech.E., who, in proposing the toast of "The Institution," said that the members could be proud of the pioneer work that it had done, especially among engineers holding Local Government posts. He felt, however, that there was more work still to do; for example, on every Regional Hospital Board there should be an engineer member with authority to make his presence felt directly when engineering matters were under discussion. The President, in response, drew attention to the activities of the Institution in connection with the Whitley Councils concerned with the hospital service, where it had been instrumental in securing some considerable improvements in conditions. The toast of "Our Guests and Friends," proposed by Mr. R. L. Quertier, B.Sc., was acknowledged by Dr. Andrew Topping, Dean of the London School of Hygiene and Tropical Medicine, who commented on the movement in the United States to elevate the sanitary inspector into a special grade of "sanitary engineer," for which purpose a number of American universities were providing qualifying courses of instruction.

LETTER TO THE EDITOR.

HYDRAULIC LOCK.

TO THE EDITOR OF *ENGINEERING*.

SIR,—With reference to Mr. Stringer's letter in your issue of May 16, on page 624, *ante*, we regularly manufacture valve spindles up to $\frac{3}{4}$ in. in diameter, which are selectively assembled in a valve bore having a radial clearance of 0.0001 in. I do not think that there would be much difficulty in selecting a spindle with half that clearance.

Yours faithfully,

TOWLER BROS. (PATENTS), LTD.,
A. W. INGLEBY,
Chief Inspector.

Electraulic Works,
Rodley, near Leeds.
May 19, 1952.

FIRST INTERNATIONAL INSTRUMENT CONGRESS AND EXPOSITION, 1954.—The first instrument congress and exposition with an international basis to be held in the United States will take place at the Commercial Museum and Convention Hall, Philadelphia, from September 14 to 24, 1954, both dates inclusive. The congress is being sponsored by the Instrument Society of America and will coincide with the tenth anniversary of the Society's formation. Further particulars may be obtained from Mr. Richard Rimbach, 921, Ridge-avenue, Pittsburgh 12, Pennsylvania, U.S.A.

AERONAUTICAL RESEARCH FELLOWSHIP AT CRANFIELD.—The English Electric Co. Ltd. announce that they have established a new research fellowship, valued at 500*l.* a year, at the College of Aeronautics, Cranfield. The purpose of the fellowship is to promote the study of advanced problems involved in aeronautical engineering. Holders will be concerned mainly with investigations into problems of vibration, stability and the control of aircraft, all of which are of particular interest at the very high speeds of flight now being reached. This is the second fellowship of the kind to be established recently by the English Electric Company, the first being in the University of Glasgow last December.

THE IRON AND STEEL INSTITUTE.

(Continued from page 609.)

WE continue below our report of the recent annual general meeting of the Iron and Steel Institute and have now to deal with the proceedings on the morning session of the second day, Thursday, May 1.

OPEN-HEARTH FURNACE COMBUSTION PROBLEMS.

The first matter on the agenda was the presentation of Parts V and VI of "An Experimental Furnace for the Investigation of Open-Hearth Furnace Combustion Problems." Part V was concerned with "Experiments with the Venturi Port and Modifications Thereof," and was by Mr. J. F. Allen, and Part VI was a "Summary of Results and Their Application in Practice," and was by Mr. J. R. Hall and Dr. A. H. Leckie. Mr. Allen and Dr. Leckie are on the staff of the Steel-making Division of the British Iron and Steel Research Association, and Mr. Hall is the melting-shop manager of the Shelton Iron, Steel and Coal Company, Limited. In presenting Part V, Mr. Allen said that the effect on heat transfer of the position of the gas-port nose and the steepness of the ramp roof in ports of the Venturi type had been examined in the one-fifth-scale furnace operated by the British Iron and Steel Research Association at the works of the Shelton Iron, Steel and Coal Company, Limited. The observed results for the air/gas ratio and the furnace pressure were similar to those recorded in previous papers; in other words, the use of the theoretical air quantity and of high furnace pressure was beneficial to heat transfer. Improved results had been obtained by moving the nose of the gas port back and by steepening the roof ramp. When roof temperatures were taken into account, these conclusions were modified slightly; a moderate excess of air could cool the roof and so permit a higher rate of driving and an increased heat transfer to the hearth without damage to the roof. The cost of the extra fuel was presumably more than regained in the increased output. The more efficient port designs were more sensitive to correct operating conditions than were poor designs. As the design of the furnace was improved, instrumentation and automatic control became increasingly important.

In their "Summary of Results and Their Application in Practice," Mr. Hall and Dr. Leckie stated that the greatest heat transfer to the hearth for a given heat input was attained when the theoretical air quantity was used; this was in accord with theory. It has also been found that under some conditions maximum heat transfer to the hearth, while not exceeding a given roof temperature, was attained when excess air was used, and that, with less efficient port designs, excess air could bring about more complete combustion at high fuel rates. Full application, in practice, of the conclusions reached on the air/fuel ratio from the model investigations must await advances in furnace engineering, but if it were found that a large excess of air was necessary to keep the roof cool, or to obtain efficient combustion, there was some serious fault in the design. The most effective modification in port design was probably the single-uptake furnace. Preliminary tests had shown, however, that, in practice, the single-uptake furnace was more successful with liquid-fuel firing than with gas firing. Future work would be carried out on a smaller furnace which was being built in the Association's steelmaking laboratory at Sheffield, because it was now known that useful results of the kind obtained from the Shelton furnace could be obtained on smaller models. The Shelton furnace was subject to the type of difficulties associated with large-scale practice. The use of a smaller model, operated on a site provided with full research-laboratory facilities, should permit a more rapid rate of working and quicker changes in design, so that further progress could be made on the many outstanding problems, such as the optimum slope and shape of the roof ramps.

DISCUSSION.

Mr. R. W. Evans, who opened the discussion, said that, on the question of aerodynamic flow in open-

hearth furnaces, British technicians were leading the world. While it was necessary to have good mixing in the furnace port, it was also necessary for the best flame development to have high air pre-heats, and the one instrument which furnace operators must have very shortly was a recording suction pyrometer, which would enable them to see whether actually they were getting the highest possible pre-heating of the air. It was true that a number of single-uptake furnaces were working quite satisfactorily, but perhaps a word of caution was necessary before the industry went too wholeheartedly in this direction. At the Steel Company of Wales there were 200-ton furnaces which Dr. Leckie would refer to as being of good old-fashioned design; they had two very large uptakes and were worked on fuel oil. The furnaces were sealed off to a very great extent and they worked at extremely low fuel consumptions, even compared with American practice, in spite of the fact that they were operated with a very high metallurgical load.

Dr. J. H. Chesters said that some of the best furnaces working to-day looked extraordinarily like those of 50 years ago at least. Even when all the changes advocated by Dr. Leckie and his colleagues were made, steel men would still essentially be building the furnace which Siemens built. On the other hand, furnace engineers had an enormous advantage over Siemens, or over anybody in the last 20 years, in that they had a great deal of fundamental information available. They were in the unique position of having three or four laboratories capable of investigating any problem put to them. Moreover, with the co-operation which was now available, if any of these ideas showed real promise there was not much difficulty in convincing practical men that they should try it out. What was desperately important, at that stage, was to define what it was that they were striving for and how they might possibly obtain it. The main object was increased output with a lower fuel figure and a lower refractories figure. There were three ways in which this could be done. The first was by more intense combustion; the second was by improving heat transfer; and the third was to control the flow pattern in a manner which would allow intense combustion, give good heat transfer, and still save the refractories.

Mr. M. W. Thring stated that there were, in fact, probably three fundamental properties of flames which entered the problem under discussion. The first concerned the question of flame length, namely, where it commenced and where it ended. In the second place, there was the question of vertical flame position; the angle downwards; how high up it was over the bath and how well it was kept down on the bath. The third question concerned the heat transfer factors of emissivity and convection. Dr. Chesters and he, some years ago, had drawn the main conclusion that the producer-gas flames at that time were too long, and he believed, on the whole, that this generally applied. It was possible to make the flame too short in an open-hearth furnace, but there was an optimum flame length, and he believed that, in general, flames were too long. It was high time, as a result of Dr. Leckie's work, that somebody, for the first time, did a proper experiment on an open-hearth furnace. Research workers were now building up knowledge on how to adjust the flame length and the flame angle, and control all the flame properties, but they had never done an experiment, as a result of which they could say that, when they changed the flame length, the effect on output, refractories consumption and fuel economy would be exactly so much.

Mr. M. P. Newby said that the present papers dealt with work done on models of furnaces at high temperatures, and his own field of work also concerned models of furnaces, but these were operated at low temperatures. Cold models were very good for showing easily where the heat should be coming from. In particular, a cold model gave a very quick and easy method of predicting where a flame should be inside the furnace, and giving an idea of the size of it and some conception of the rate of combustion which was going on. Flame length depended on the rate of combustion along the flame, and the quicker the combustion the shorter the flame. A cold model could show that very clearly.

Perhaps there had been not enough collaboration between those who built cold models, and Dr. Leckie and his collaborators who built hot models, but the connection between the two types was still largely inferential. There were no exact measurements between the two. The work now being done at Ijmuiden on flames, which was being followed up by cold-model work at Battersea, might be a pattern for future work of this type. There were good hopes of being able to predict the flame position and rate of combustion from a model, as was being found from the comparisons made with the Ijmuiden furnace.

Dr. D. F. Marshall, speaking on the subject of central uptakes, asked the authors whether they had considered, in the application of them, what was the effect of the size of the furnace. The Americans had tried central uptakes, in a somewhat perverted form, on very large furnaces of 150 to 200 tons, and, in many instances, the result had been exactly the reverse of what they had expected; the fuel consumption had increased and the rate of output had decreased. In the United Kingdom, where tests had been carried out on furnaces of 50 to 100 tons capacity, the results were the opposite, and were, in fact, most promising. He would like, therefore, to ask Dr. Leckie whether the furnace size had a great effect on the benefits of using a central uptake. On the subject of air infiltration, the whole question constituted a challenge to furnace designers. In modern American plants, and in the South Wales plants, all the vulnerable parts of the furnace were accessible. In many other plants in this country, on the other hand, it was not possible to reach the vital parts of the furnace. One of the first steps which should be taken in designing new plant should be to make the furnace accessible, so as to keep air infiltration down to a minimum.

Mr. J. E. Pluck, who closed the discussion, considered that the work of Mr. Allen and Dr. Leckie was absolutely invaluable to build on for the future, but their model showed a furnace with a flat hearth, and he was wondering whether it would be possible to simulate an actual furnace by putting in water tanks with a hump in the middle, which would represent the average shape of scrap when partly melted. Such a condition, Mr. Pluck added, was a very important part of the furnace programme. Half the furnace time was occupied in melting and the other half in refining. The melting condition was important, and was the point where the maximum quantity of heat must be put into the bath. Moreover, the scrap would materially change the flow patterns, and heat transfer would be very different from that shown in the paper. On most furnaces the doors did not really shut, and to get high pressure, in order to obtain improved heat transfer, this matter would have to be investigated by furnace designers. The doorways, expansion joints and places underneath the roof and skew-back were all generally very open positions on plant that he had seen, and more attention to them should pay big dividends. A single-uptake furnace, heated with producer-gas fuel, built in the Steel, Peech and Tozer melting shop, had worked exceedingly well. The roof life had been nothing short of remarkable. The previous two-uptake designs on that furnace had given a good deal of trouble, but the design of the furnace was very limited at the ends, where there was not much room. A difficulty peculiar to the furnace, however, was that the bottom edge of the flame caught the end bank of the hearth, and this tended to be burned away, once even causing a breakout. In spite of this, the output went up, the roof life was improved and in every other way the furnace was a complete success. The difficulties encountered, however, were perhaps the reason why the single-uptake design had not been proceeded with with gas firing. With oil firing, on the other hand, the single uptake was being tried, and it was thought that it would prove successful.

Mr. J. F. Allen, in reply, said that they entirely agreed with Mr. Thring that the model on which they had worked at Shelton had indicated the effect and not the cause; so much so that the new model in Sheffield had been built with a higher temperature range, purposely to examine the three fundamental qualities which he had mentioned, namely, flame

shape and size, emissivity, and temperature. In answer to Mr. Pluck's question concerning the flat bottom, as distinct from a hump in the middle: presumably the hump in the furnace occurred while the furnace was being charged, and it was felt that that was not the period when the damage was done. It was relatively easy to get heat transfer during the charging period, on account of the difference in temperature between the flame and the charge. Difficulties arose once the bath was flat. As far as the furnace pressure was concerned, they entirely agreed with Mr. Pluck. It was for the engineer to make the structure air-tight; the higher the furnace pressure, the better.

Dr. A. H. Leckie, who also replied to the discussion, said that both Dr. Chesters and Mr. Evans had pointed out that, with a high-velocity oil jet, the jet would draw to itself sufficient air for combustion under almost any conditions, and the advantage of a single uptake in getting rapid combustion was not so marked; but it was important to note that the single uptake had advantages from the point of view of economy in brickwork and general simplicity. Mr. Evans had drawn attention to the excellent results at the New Abbey plant with rather old-fashioned furnace design, but might he not have obtained equally good results with a simpler design, involving the use of fewer bricks and also a little cheaper to build? He hoped that Dr. Chesters was not being too optimistic. It must be remembered, and no doubt he had considered it, that there was a limit to the efficiency of an open-hearth furnace. The trouble was that iron would burn almost more readily than carbon monoxide. In the open-hearth furnace, everything became covered with slag and was protected fairly quickly; but in a radically different furnace, with intense combustion within the scrap, there might be too much burning of the iron. This did not arise in an electric furnace because air was not needed for combustion.

Dr. Marshall had drawn attention to the question of the size of the single uptake and this was most important. As far as he knew, all the single-uptake furnaces, particularly in America, and a few in this country, which had been disappointing, had had the single uptake built too large. In those circumstances, combustion might take place too soon, and the incoming end of the furnace might be too hot and the outgoing end too cold. In America, where a large single uptake had failed, it had been cured, in many cases, by narrowing it down and making it smaller. There was no need to make the uptake any larger than was necessary to carry the amount of gases at the pressures or draughts available. In so far as furnace design was concerned, British practice still tended too much to copy America, admirable though their ideas were in many ways. Let us, he said, use some of the ideas developed in this country; we had different problems in the United Kingdom. In conclusion, he emphasised Mr. Pluck's remarks that the troubles with the only producer-gas furnace built as a single-uptake furnace in his works had been local to that furnace. The builders had been well aware of the alterations which might be made to overcome that difficulty, but it had not been possible to make them because of structural limitations. He again pleaded for someone possessing a producer-gas-fired furnace, but without the same structural limitations, to try a single uptake and embody the modifications which would get over the trouble to which Mr. Pluck had referred.

(To be continued.)

FILM ON "COMBUSTION."—Messrs. International Combustion, Limited, Derby, have produced a film, with spoken commentary, to expound the subject of combustion (which word is its title) in terms designed to interest and inform the young technical student. The film has been made for them by Gaumont-British Instructional, Limited, with the assistance of Dr. A. Parker, C.B.E., F.R.I.C., Director of the Fuel Research Station, East Greenwich, as chief technical adviser, and deals in turn with the formation, structure and composition of coal, and the evolution of improved methods of utilising its combustion, more especially in large boilers, by the use of mechanical stoking, and pulverised coal. It runs for 25 minutes. Applications for the loan of the film should be addressed to International Combustion, Ltd., 19, Woburn-place, London, W.C.1.

OBITUARY.

COMMANDER SIR ROBERT MICKLEM, C.B.E., R.N.(RETD.).

WE recorded last week, on page 625, *ante*, the death on May 13 of Commander Sir Robert Micklem, who was, until very recently, joint managing director of Vickers Limited, chairman of Vickers-Armstrongs Limited, and a director of various other companies in that group, but there was then no opportunity to include biographical details. These are now given below.

Edward Robert Micklem was born on June 5, 1891, and was educated at the Royal Naval Colleges at Osborne and Dartmouth, entering the Navy in 1903. He served in the 1914-18 war as a lieutenant, this service including two years in submarines. In 1919, he retired from the Navy with the rank of commander and joined Vickers Limited, his principal interest for a number of years being their subsidiary, the Variable Speed Gear Company. During his association with them, several important modifications were made in the design of the gears



THE LATE SIR ROBERT MICKLEM.

and in this work, as we recall very clearly, he displayed the mastery of technical detail that remained one of his prominent characteristics even when, in later years, his time was mainly occupied with administration and direction. In 1928, he left Westminster for Elswick, to take up the position of general manager at that works, and eventually, became general manager also of the works at Scotswood and Chertsey. In 1944, on the death of Sir Charles Craven, he was appointed deputy chairman of Vickers-Armstrongs Limited and, in 1946, chairman, continuing to hold the latter position until a few weeks ago, when increasing ill-health obliged him to relinquish all his offices. He was also a director of the English Steel Corporation, Limited, Barclays Bank, and the Sun Insurance Office. During the recent war, Commander Micklem was chairman of the Ministry of Production's Regional Board for the Northern Area, to which he was appointed in 1942; but in the same year he became temporarily associated with the Ministry of Supply, serving as chairman of the Armoured Fighting Vehicle Division of that Ministry and as chairman of the Tank Board. For these services, he received a C.B.E. in 1942, and a knighthood four years later.

Sir Robert was a member of the Institution of Naval Architects, a member and former member of Council of the Institution of Mechanical Engineers and the North-East Coast Institution of Engineers and Shipbuilders, and a past-President of the Institute of Marine Engineers. He had served also on the Executive Board of the Shipbuilding Conference, and was a past-President of the Engineering and Allied Employers' National Federation.

THE BLAST FURNACE IN THE EARLY NINETEENTH CENTURY.

By ALAN BIRCH, M.A.

THE salient feature of technological progress in the iron industry of the Nineteenth Century was indubitably the phenomenal expansion of output. In 1806, there was a production of approximately 250,000 tons; by 1867, the annual output had reached the impressive figure of 4,761,023 tons. By the end of the century, it was well over 8 million tons. It will be apparent, from the fact that there was less than a fivefold increase in the total number of blast furnaces (from 216 in 1806 to 913 in 1867), that there was an outstanding development of blast-furnace technique during this period.

The major inventions of the Eighteenth Century had provided the motive forces which were to determine the pattern of future development. Although water power persisted in some works, the waterwheel still driving the blast bellows and the hammers of the forge, steam power and coke were to be the chief weapons of the Nineteenth Century ironmaster. The technical innovations of the later period, it is true to say, did not introduce any new elemental force to the furnace until the introduction of the electric-arc furnace by Siemens in the 1870's; the industry was still dependent upon the inventions of Abraham Darby and James Watt. Indeed, the outstanding invention of the first half of the century, the hot blast of James Beaumont Neilson (1828), was but an extension of the steam-blast coke-fired furnace; nevertheless, its consequences were revolutionary. Before examining these, however, it is necessary to outline the development of the blast furnace at that time.

A modern furnace is a complex piece of engineering, giving the technicians control over the processes in accordance with the highly developed science of metallurgy and the inherited practical skill of the smelter. At the beginning of the Nineteenth Century, however, the blast furnace had not evolved far beyond its original Tudor prototype. (*Vide* the article by Dr. H. R. Schubert on the first English furnace in the *Journal of the Iron and Steel Institute*, February, 1952.) The oldest type of furnace in use during the Napoleonic wars was a crude structure, a square stone tower, slightly tapering, with a cylinder on top. These were often built into the hillside so as to provide a natural platform for feeding the furnace from the top. In 1815, it is true, the height of the furnace had been increased to between 35 and 50 ft. Outputs varied between 25 and 60 tons a week. In the country backwaters, low outputs continued to be usual, but in South Wales, which concentrated on the manufacture of bar iron, the ironmasters were anxious to expand the output of their furnaces by increasing the burden. Later, when hot blast had given an immense impetus to the exploitation of the West Scottish coalfield, it was there that the "gigantic crucibles" (as they were called) were built to give the largest outputs.

The first, and the most obvious, source of great output was, of course, by increasing the size, and particularly the height, of the blast furnace. Where the nature of the raw materials would allow it (depending upon the strength of the coke, to support the increased burden), the ironmaster, when rebuilding his furnaces or erecting new ones, added several feet to their height; also, improvements were made in the shape of the interior, to secure the speediest and most efficient firing of the charge. As a result, there was an extreme diversity in the size and shape of blast furnaces.

In 1827, when Dufrenoy and Beaumont reported on the manufacture of iron in this country (*Annales des Mines*, 1827, II^e Série, vol. II), the average size of furnaces was 45 ft. to 50 ft. in height, though at Dowlais and the Plymouth works, in South Wales, the furnaces were 60 ft. high and producing 80 tons of pig iron a week. In South Staffordshire, where there was more concentration on quality than quantity, this growth in the furnace capacity was less marked; but even here, among the larger owners, there was this same drive towards large-scale production. A furnace erected for

J. Gibbons of Pensnet, in 1832, 60 ft. high, with many improvements in contour and with a round hearth, was capable of producing the unprecedented output of 115 tons a week. (*Practical Remarks on Staffordshire Blast Furnaces*, by J. Gibbons, 1844.) By 1848, some of the largest Scottish furnaces were yielding 150 and even 200 tons a week, according to a paper by J. P. Budd, in the *Report of the British Association* for 1848.

Nevertheless, there was a limit to this means of expansion. F. Kohn reported, in his *Iron and Steel Manufacture*, that there had been a trial at Garsherrie of furnaces which were 60 ft. high, but that the furnace charge failed to support itself above the tuyeres. It was in the Cleveland district, however, where considerations of economy of fuel and the relatively low yield of the ore compelled its adoption, that the construction of the blast furnace was most advanced. From 1864 onwards, furnaces were being erected 100 ft. high, though, at the same time, opinion was not unanimous upon the economies resulting from increased heights. Certainly, by 1871 it was thought that the maximum manageable height had been reached; though, by then, there were other considerations to be taken into account, such as the closed top. At this time, the most efficient furnace made 350 tons a week. The output of a large modern furnace is about 4,600 tons a week.

This first way of increasing outputs, then, was implicit in the competitive nature of the industry; taller furnaces were built by ironmasters when firms expanded to outvie their neighbours, and this development was not in accordance with any principle or patent. With the Neilson process, however, it was another matter. This, undoubtedly, was the most important single innovation in the industry in the age of iron.

James Beaumont Neilson (1792-1865), the son of a colliery engine-wright, after a few years at Govan colliery, had been apprenticed in his brother's foundry at Glasgow. His first job as colliery engineer was of short duration, and in 1817, without qualifications, he was appointed superintendent and foreman of the Glasgow gasworks. It is interesting to note that, on being appointed, he attended evening classes at the University to acquire the necessary knowledge of the sciences for his job. Thus he made a success of it; and, in fact, being promoted to the post of manager and engineer, he stayed with the company until his retirement in 1847. Although, therefore, he had received his training in an iron foundry, it was only indirectly that Neilson became connected with the iron industry.

Having gained experience of purifying coal gas, he was approached in 1824 by an ironmaster, who asked him if a similar process could be used to free from sulphur the air which was to enter the blast furnace. As Neilson explained later, "I perceived that he imagined the presence of sulphur in the air to be the cause of blast furnaces working irregularly and making bad iron in the summer months" (*Trans. Inst. C.E.*, vol. 1 (1842)). In 1825, before the Glasgow Philosophical Society, he read a paper on the problem, in which he came to the conclusion that this defect was due to a lack of oxygen (the air being rarified by the heat of summer) and, equally important, the absorption of moisture by the air in its passage through the pressure-equalising water vaults. However, his first remedy, to use calcined lime as a drying agent, was not put to trial, for just then another problem arose, which was to set him upon the road towards his great invention. This was an inquiry from the Muirkirk Ironworks about the weakness in the blast arising from the distance of the blast engine from the furnace. Then it occurred to Neilson that, simply by heating the air to increase its volume, the force of the blast would be improved. Experiments with gas at the Glasgow works, and with a blacksmith's fire, confirmed this idea. This was the principle of his hot blast system.

Naturally, Neilson wished to apply his theory to the blast furnace, but here he met frustration for some time as a result of the intense conservatism of the ironmasters, who feared to meddle with the furnaces. Eventually, however, he was allowed to conduct further experiments at the Clyde Ironworks of Colin Dunlop, who, with Charles McIntosh and

others, owned shares in the patent (No. 5701) which Neilson took out in September, 1828, for "Application of air to produce heat in fires, forges, or furnaces where bellows or other blowing apparatus are required." These experiments were made in a founder's cupola, when the temperature was only raised by 50 deg. F., but in the next year, when the heated blast was applied to the furnace for the first time by means of wrought-iron chambers (with a fire below) at each of the tuyeres, the temperature was raised to about 200 deg. F. The complete specification was patented on February 28, 1829, though it was not until 1832 that a really satisfactory form of blast stove was evolved, and all the difficulties about leakages and tuyeres melting under the great heat were overcome. This last improvement came, not from Neilson, but from James Condie of the Blair Ironworks, who, in 1834, adopted an old idea, a spiral tuyere with a cast-iron water jacket to enable cooling by a continuous flow of water. (It may be noted that William Jessop, of the Butterley Ironworks, at the trial *J. B. Neilson v. W. Baird* (1843), stated that the water-cooled tuyere was known long before 1800.)

The immediate consequences of the adoption of the invention at the Clyde and Calder Ironworks showed its great importance to the Scottish industry. The consumption of coal, which previously had been very high—about 8 tons of coal per ton of pig iron—was reduced by about two-thirds. This was with the blast heated to a temperature of 600 deg. F., which became the heat usually adopted; when the temperature was only 300 deg. F., as at the Clyde works, where the process was tried out, the saving was only 2½ tons of coal per ton (*Proc. Roy. Soc. of Edin.*, 1836). Moreover, furnaces gave greater yields because they could be tapped more often than the previous once a day. Nor were Scottish claims unfounded, for they received confirmation on many points in the report of M. Dufrenoy, a representative of the French Department of Mines, whose country's iron industry was then so far behind that of Britain (*Annales des Mines*, 1833, vol. IV, 3me Serie). The evidence there given from the trials at the Calder furnace, showed that the daily production with cold air and coke, in 1828, had been 5 tons 12 cwt.; in 1831, with heated air (200 deg. F.) and coke, the output was 6 tons 13 cwt.; and in 1833, using coal and a temperature of 612 deg. F., the daily output had increased by 50 per cent., from 6 tons to 9 tons. Further, Dufrenoy reported that there had been a reduction in the consumption of flux, and a saving in labour and in steam-power for the blast; also, the method produced iron of better quality—a point on which there was to be much subsequent discussion. This report, it is interesting to note, was translated by Lady Charlotte Guest, the wife of the prominent Welsh ironmaster, and its contents were widely publicised; possibly because of this, the process was widely adopted from the first.

As early as 1833, Dufrenoy listed 67 blast furnaces working on hot blast; though he regretted that the new process had not only to overcome the conservatism of ironmasters, but also a widespread prejudice that it was not practicable to use raw coal in the furnace because of its content of sulphur. Dr. Thomas Clark* forecast that the use of raw coal (which Neilson's hot blast had made possible for the first time) would be given up, because trials at Wilson Town had shown that the furnace became "gobbed" and produced iron of inferior quality. This proved to be wrong, however, and the practice of using raw coal soon spread. In passing, it may be noted also that the famous Black Band, which had lain neglected since 1802, when David Mushet had discovered this doubly rich ore, could now be exploited. As a result, the output of Scotland rose from a mere 37,700 tons in 1828 to 241,000 tons in 1840.

In Scotland, the chief among the exponents of the new process was the largest ironmaster, William Baird, who entered into an agreement to pay the patentee 1s. per ton royalty in 1832. However, he soon came to regard this as an exaction, and combined with other Scottish ironmasters in an attempt to invalidate the patent, meeting the

cost by a levy on output; then he entered into a lawsuit to upset the patent. This revealed many significant details about the effects of the invention. In the course of the proceedings, it was shown that Baird's output had increased in five years from approximately 1,000 tons a month to nearly 16 times as much, and that, in the period 1833-40, the firm had made profits amounting to 269,655l. The trial also gave information about the spread of hot blast, from ironmaster-witnesses from many parts of the country. Hot blast had been adopted in Derbyshire between 1832 and 1835, but in Shropshire it was viewed with disfavour; in Staffordshire, too, there was a strong prejudice against it, though the first works to adopt it, Lloyds, Foster and Company, of Wednesbury, had done so as early as 1834. One ironmaster in this district had adopted the hot blast in 1835 and then reverted to cold blast in 1839.

Staffordshire, indeed, eventually specialised in cold-blast iron. South Wales, too, at this time, was another district where the hot blast was not taken up at first. The different qualities of coal available in each district, of course, determined the local attractiveness of Neilson's invention. In South Wales, so low was the consumption of fuel that the very small saving of coal through the use of hot blast (11 cwt. to a ton of pig iron) was almost all absorbed by the payment for the royalty. However, Harfords, of Ebbw Vale, had attempted, in 1841, to overthrow the patent rights, claiming that Thomas Botfield, the Shropshire ironmaster, had preceded Neilson with the same idea. In fact, the Shropshire patent was not the same; moreover, Botfield's process was never exploited on a large scale. In passing, the tradition may be noted that John Wilkinson, the famous ironmaster of the Eighteenth Century, had invented the hot blast; but the evidence brought forward in the above case (*Neilson v. Baird*) was inconclusive on that point.

Referring again to Staffordshire, the local ironmasters, prejudiced in favour of the cold-blast iron (doubtless because of its superior price), complained that, "Hot blast has seriously injured us in foreign markets" (*Midlands Mining Commission*, 1843). Some ironmasters used a mixture of hot and cold blast, since it was thought that this compromise would give the quantity and quality of both systems. In 1843, 42 furnaces operated on hot air and 38 on cold blast, thus it is evident that the patent was strongly established by that time. Indeed, an estimate for the whole country computed that about half a million tons of hot-blast iron were produced two years earlier, as against 800,000 tons of cold-blast iron. It says much for the productivity of Neilson's system that only 162 furnaces, out of a total of approximately 400, operated with hot blast.

On the technical advantages of the process, nevertheless, there still remained a sharp division of opinion. It is understandable, perhaps, that, in 1842, a Yorkshire ironmaster, Henry Hartop, should have been denying its advantages; yet, as late as 1855, S. Truran was demonstrating that "the saving in fuel, and the increase in make due to it, is not in general one fourth of that which has been asserted to have been effected" (*The Iron Manufacture of Great Britain*). It was true, of course, as he said, that economies arising from improvements in the preparation of the fuel and ironstone, as well as in the furnaces and blowing engines, had to be taken into account. However, the course of events was against Truran, for, in the Cleveland district, when the waste gases of the furnace were utilised in the blast stoves of Edward Cowper and Thomas Whitwell, temperatures double that finally advocated by Neilson were being used in the 1860's.

The field of fuel economy in the iron and steel industry, perhaps the most important aspect of practical metallurgy to-day, has, of course, developed greatly since the foregoing inventions. As W. A. Bone remarked, in his well-known book, *Coal: Its Constitution and Uses*, "As a result of a century's effort, a blast furnace has now produced as much iron in an hour as one did in a week in 1829, and at about one-fifth the cost in fuel." This was a German furnace, which achieved the remarkable output of 7,520 tons in one week in 1928-31. "And the germ of all this," Bone continued, "lay in Neilson's invention."

* *Trans. Roy. Soc. Edin.*, Vol. XIII, page 373 (1836.)

GEAR-CUTTING SHOP: BLAW KNOX, LIMITED.



FIG. 1. GENERAL VIEW OF GEAR-CUTTING SHOP.

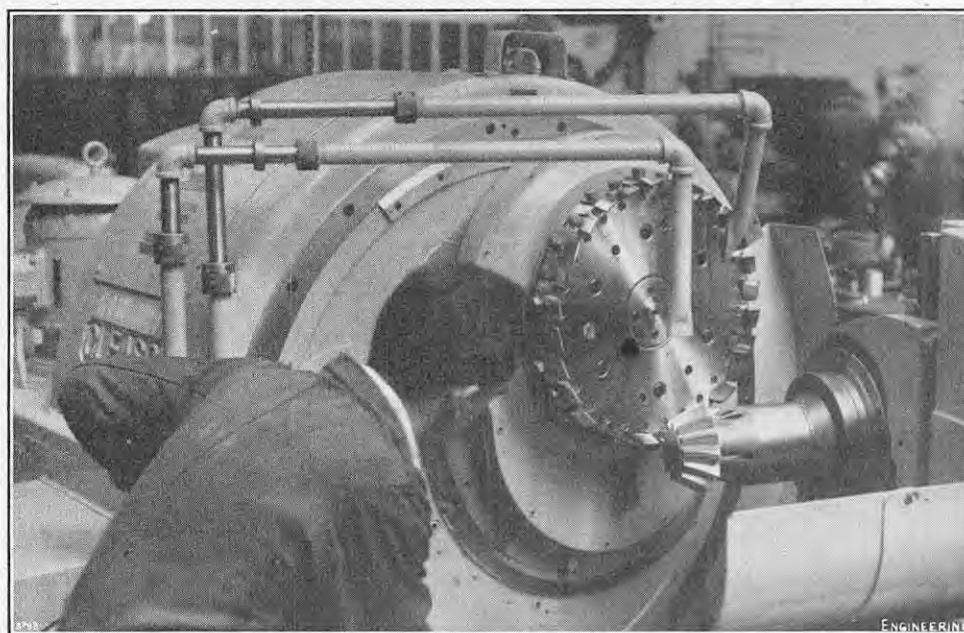


FIG. 2. GLEASON CURVED-BEVEL HYPOID GENERATOR.

MACHINING AND HEAT-TREATMENT OF GEARS.

In the issue of *ENGINEERING* for November 4, 1949 (vol. 168, page 484), a description of a 94-h.p. land grader—a self-propelled machine able to perform a variety of land work, including ditching and road-making—which had been developed shortly before by the well-known firm of Blaw Knox, Limited, 90-94, Brompton-road, London, S.W.3, was included. When production of the new machine started, delays occurred owing to the difficulty of obtaining regular supplies of the gears needed for the various mechanisms on the grader. In the interests of efficient production, therefore, and to meet expanding demands for this and others of their products, Messrs. Blaw Knox installed a number of modern machine tools in their works at Rochester for the manufacture of gears, and added an up-to-date heat-treatment plant, thus enabling them to meet their requirements. Some details of the equipment are given below and in the accompanying illustrations.

The gear-cutting shop, illustrated in Fig. 1, herewith, contains all the machine tools required to produce every type of gear used in the firm's products. The variety of gears is considerable and includes both internal and external spur gears, helical gears, worms and worm wheels, and straight and curved bevel-gears. In addition to gears with plain bores, either uniform or tapered, there are many with straight-splined bores—10 splines being common—and others which have

tapered serrated bores. The manufacture of the various types of gears proceeds according to an ordered sequence of operations which is normally as indicated in the following.

The first operation consists in turning, facing and boring the blank to the approximate dimensions required, an overall excess of $\frac{1}{16}$ in. thickness of material being left for subsequent removal. Herbert No. 5 automatic and No. 7 combination lathes are used for the purpose. Any internal stresses in the material are then relieved by heat-treatment. The next operation, when it is necessary, consists in broaching the bore on a Lapointe H.P.40 horizontal broaching machine. After this, the partly-machined blank is transferred to a Swift-Sentinel centre lathe, located from the bore and turned to its final outside diameter, being subsequently faced to the correct length. The gear teeth are then cut on whichever machine is appropriate. For external spur-gears, a Sykes 3C generator is employed, internal spur-gears being cut on a V.10A generator of the same manufacture. Gleason generators, types No. 14 and No. 26, are used for straight and curved bevel-gears, respectively. A No. 26 model, installed in the gear-cutting shop at Rochester, is illustrated in Fig. 2, herewith. The built-up face-mill on the machine is fitted with inside and outside cutters arranged alternately, so that both sides of each gear-tooth space are cut in one operation. The tooth profile is generated by a rolling motion of the mill relative to the gear, the spindle of the mill being carried in a cradle which rocks in a predetermined

manner. The angle and hand of the spiral, and the size of tooth cut, can be varied as desired.

When necessary, the gear teeth are rounded in a Hey tooth-rounder, after which the product is inspected for accuracy. A Gleason No. 13 universal tester, which suffices for all types of gears manufactured, is used in this operation and can be seen in Fig. 1, to the left of the David Brown universal hobbing-machine in the foreground. The subsequent operations include degreasing and heat treatment, followed by shot blasting for cleaning purposes. The heat treatment is described in detail below; the shot-blasting plant was supplied by St. George's Engineers, Limited, Trafford Bridge, Salford. The gears are then placed in a Heald 72A internal grinder, where they are located in position from the pitch line of the teeth, after which the bores and faces are ground to their final dimensions. A final inspection and test for accuracy concludes the series of operations. Another machine tool of interest in the gear shop is a Werner spline grinder which is used for grinding splined shafts to close limits after heat treatment. Either a single grinding wheel or three wheels running simultaneously on one spindle may be used. In the latter case, the central wheel grinds the base of the groove, and the two side wheels, which are bevelled, grind opposite faces of the two adjacent splines.

The heat-treatment shop is illustrated in Figs. 3 and 4, on Plate XXXVI. The building was constructed specially for the purpose and is well equipped with modern plant, most of which was supplied by Wild-Barfield Electric Furnaces, Limited, Elecfurn Works, Watford, who also advised on the layout. The necessary processes can be carried out conveniently and quickly on a wide range of parts which are components in earth-moving, concrete-mixing, pumping, and other equipment manufactured by Messrs. Blaw Knox. Although the main work is the gas carburising of steels, various other processes, such as tempering, refining, normalising and hardening, are also carried out.

The furnaces, cooling pits, and quenching tanks are arranged in a line parallel to the longer sides of the building, with the gas-treatment plant and main switchboard on one side, and a gas-burning plant and its associated horizontal furnace on the other. The latter equipment is partly visible in Fig. 3, and the furnace, with its loading trolley, is illustrated in Fig. 5, on Plate XXXVI. An overhead crane is installed for handling the heavy loads. The gas employed for carburising is prepared from town's gas. The methane and carbon monoxide in the latter are very suitable for the purpose since they do not leave a hard scale on the surface of steel at a high temperature. On the other hand, the carbon dioxide, oxygen, water vapour, and organic sulphur compounds, which are also present, are deleterious and have to be removed. To effect their removal, the gas is first passed through a catalytic sulphur-removal plant, where most of the organic-sulphur compounds are reduced to hydrogen sulphide and removed by activated bog ore. This plant was supplied by Messrs. W. C. Holmes and Company, Limited, Turnbridge, Huddersfield.

The gas then passes into a Wild-Barfield gas-preparation unit which it leaves under pressure to enter a furnace containing a catalyst heated to 900 deg. C. This effects the removal of the carbon dioxide and oxygen, and the gas then returns to the preparation unit where it is cooled in a condenser and passed through driers containing silica-gel. There are two driers, which are used alternately, each charge, when exhausted, being regenerated by heating it in a small vertical low-temperature furnace having a forced air circulation while the other charge is in use. The plant, therefore, can operate continuously. The small furnace, which is visible in Fig. 3, Plate XXXVI, beside a degreasing tank against the end wall, is also used for tempering parts within its capacity. The prepared gas is supplied to the furnaces from gas-distribution panels. As finally constituted, it is highly satisfactory for gas-carburising, since it causes little or no sooting of the parts being treated and can carburise at any appropriate temperature and at almost the maximum theoretical rate.

A typical carburising operation proceeds as follows. The components to be treated are placed on a jig, as shown in Fig. 6, on Plate XXXVI, and the whole assembly is then loaded into a retort. The latter is one of three associated with the Wild-Barfield electrically-heated gas-carburising furnace, which is installed at Rochester. It is of the vertical type and has a cylindrical working chamber 48 in. deep and 24 in. in diameter. The heating elements are of heavy "hairpin" type and are constructed of nickel-chromium alloy. The electrical rating is 100 kW and the maximum operating temperature 1,000 deg. C. There are two cylindrical cooling pits adjacent to the furnace.

After the jig has been placed in the retort, the latter is purged free from air by filling it with prepared town's gas. The gas-carburising furnace having been brought to a temperature of 925 deg. C., its insulated plug-type door is removed and the retort lowered into the furnace. A normal load of 15 to 22 cwt. takes

from $1\frac{1}{2}$ to $1\frac{3}{4}$ hours to reach the carburising temperature of 925 deg. C. During this period, gas is allowed to flow only very slowly through the retort but, once the correct temperature has been reached, the gas rate is increased to 200 to 250 cu. ft. per hour. This process continues without interruption until the end of the active carburising period, after which the gas-exit valve on the retort is closed and the gas compressor switched off. The retort is then left in the furnace for a further period, known as the diffusion-time, during which the ambient gas is static and the carbon which was absorbed during the active period diffuses into the steel. The extent to which this is permitted depends on the type and depth of case-hardening desired. At the end of this second period, the retort is removed from the furnace to a cooling pit and another is loaded into the furnace.

Subsequent heat-treatment depends on the steel, and the plant is capable of treating practically the whole range of carburising steels ranging from En. 32 to En. 39. After final machining, the parts are subjected to heat treatment involving, first, their being heated to a temperature in the neighbourhood of 800 deg. C. in a controlled atmosphere, in the horizontal furnace referred to previously, and then quenched in oil. The furnace, which is illustrated in Fig. 5, Plate XXXVI, has a chamber lined with grooved refractory bricks enclosing a working space 40 in. wide $\times$ 18 in. high $\times$ 56 in. deep from front to rear. The heating elements are nickel-chromium alloy rods of hairpin shape, so that they are easily removable, and a hearth tray of heat-resisting material protects those which cover the floor, as well as the brickwork. The maximum operating temperature is 1,050 deg. C. A two-fold heat-treatment for refining and hardening, followed in each case by quenching of the components in oil, is also given in the horizontal furnace, and the normalising of rough forgings before machining and the hardening of carbon and alloy steels are also undertaken there. The components to be treated are fed into the chamber from a trolley which has a roller table so that the worktrays can easily be moved into or out of the furnace.

The controlled atmosphere for the furnace, which is necessary to prevent decarburisation and scaling of the components, is supplied by a plant in which town's gas is partly burnt for the purpose. This plant, which has a capacity of 500 cu. ft. per hour, is equipped with silica-gel driers and was supplied by G.W.B. Electric Furnaces, Limited, Dibdale Works, Dudley. There are two quenching tanks in the building. One of these is water-filled, and the other contains Shell-Wild-Barfield quenching oil which is cooled by means of a Serck oil-cooler.

Tempering of the products is accomplished in a Wild-Barfield vertical tempering furnace, the maximum operating temperature of which is 700 deg. C. The furnace has a removable work basket 32 in. deep and 32 in. in diameter. A fan, located at the bottom of the furnace chamber, circulates the heated air around and through the components in the basket. A small laboratory adjoins the heat-treatment shop. The testing equipment includes a Vickers diamond-pyramid hardness tester and an optical projection-microscope.

THE STEPHENSON LOCOMOTIVE SOCIETY.—Membership of the Stephenson Locomotive Society was 1,635 at the time of the annual general meeting on April 5; this figure compared with 1,499 at the same time last year. During the year, 60l. was raised by subscription from members towards the cost (88l.) of repainting the locomotive Gladstone, at York. The headquarters and library of the Society, which was founded in 1909, are at 32, Russell-road, Kensington, London, W.14.

AUXILIARY RELAY FOR PHOTO-ELECTRIC AMPLIFIERS.—A new unit, for use with their type MD photocell amplifier, to obviate incorrect indications which would otherwise result from a failure of the photocell lamp or a brief interruption of the electricity supply, is announced by the General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2. Failure of the lamp is equivalent to an interruption of the beam of light to the cell and, in the case of systems designed for protection, results in a false alarm. The same result, however, is produced if the electricity supply is cut off and restored within eight seconds, because the amplifying valve cathode remains sufficiently hot during this period for the anode current to flow as soon as the supply is restored and, therefore, before the photocell lamp is fully alight; this causes the valve relay to operate the alarm. The new unit is a current-operated relay which is closed so long as the lamp is intact. If either of the above-mentioned events occurs, however, the relay opens, cutting off the amplifier supply and bringing a pilot lamp into circuit. The relay has a lock-out contact and must be reset manually by means of a push button before the equipment can operate again. In the meantime, the pilot lamp indicates that it is out of action. The auxiliary relay has wider applications also, when it is desired to safeguard electrical equipment against failures.

LABOUR NOTES.

A CLOSED-SHOP policy for the Post Office was rejected by an overwhelming majority when this subject was discussed at the annual conference of the Union of Post Office Workers at Blackpool on Friday last. The delegates had before them a resolution demanding that all employees in the postal services should be members of a recognised trade union or association as a condition of their employment. It was estimated by the seconder of the resolution that some fifty thousand employees in the Department did not belong to the union. Mr. C. Geddes, the general secretary of the union, warned the delegates that they were dealing with a fundamental principle and stated that he was fully behind the union's executive council in believing that the closed-shop policy might well lead to trade-union tyranny. He was, he said, strongly against tyranny, wherever it might raise its head, whether it be in the trade-union movement or elsewhere.

Delegates were reminded by Mr. Geddes that for two days they had been trying to discuss the tyranny of the anti-trade union closed shop. In his view, the trade-union closed shop was no different. If delegates denied the right of employers to have a closed shop, how could they demand such a right for themselves? Trade unions could try to organise only on the basis of service and if they tried to do it on any other basis, they were imperilling democracy. By the terms of the resolution delegates were being asked to say that any persons who did not belong to a particular union should not be allowed to work for the Post Office. Such conduct constituted dictatorship and tyranny.

To have a democratic trade union, which could say to its members that if they did not agree with the union policy they would be expelled from the union and denied the right to live, was just an impossibility, in the opinion of Mr. Geddes. In his view, it was an attempt at tyranny in its worst form. People who accepted the benefits of trade unionism without taking up membership were not possessed of consciences, but it was impossible to supply this deficiency by forcing them into an organisation. In spite of undertakings by the general secretary to carry out a thorough investigation into the working of late postal services, the conference rejected proposals of the executive council and requested that the 8.15 to 9.15 p.m. collections introduced last year in some districts should be abolished. It was suggested that such collections were a waste of time and money, and the cause of an excessive amount of overtime being worked.

At earlier sessions of the conference, proposals to set up a strike fund in the union were rejected by a large majority, but the delegates approved of a request being made to the Treasury for a grant towards the fares of all Post Office employees residing more than three miles from their offices. The executive council was asked to obtain the agreement of the Department to the principle of a 40-hour week and, pending the implementation of that agreement, to press for a 44-hour week to be put into force. It was stated that negotiations were to be commenced at an early date for the institution of three weeks annual holiday with pay for all persons employed by the Department.

Further measures against the Durham County Council in respect of the closed-shop controversy between that body and the professional associations representing engineers, teachers, doctors, dentists, midwives and nurses, have been recommended by the joint emergency committee of representatives of the six associations. A statement issued on behalf of the joint committee on May 15 reported that the committee decided on April 30 to enforce certain preliminary measures against the Durham County Council, after that body had failed to give a satisfactory undertaking that its professional employees should not be subjected, directly or indirectly, to the compulsory membership of a trade union or professional organisation. The joint committee also decided that professional journals should be asked to refuse to publish advertisements of any appointments under the county council.

The joint committee had now agreed, the statement continued, to recommend to its constituent organisations that they should apply such other measures against the Durham County Council as might seem appropriate to the circumstances of each of the associations, and that such measures should be applied at such a time and in such a manner as the associations might consider most effective. It was reported on May 17 that the executive committee of the National Union of Teachers had decided, after a meeting in London on that day, that the county council should be informed of the union's intention of calling upon its members, serving under the county council, to place their resignations from the council's service in the hands of the union. Unless proposals for the satisfactory settlement of the dispute were received from

the Durham County Council by May 30, it was the intention of the union's executive committee, the report stated, to tender to the council such resignations as might be deemed necessary.

Some of the final sessions at the fortnight-long conference of the national committee of the Amalgamated Engineering Union at Blackpool were devoted to the question of dilutees in the engineering industry. After long discussions on May 14 and 15, the committee decided to tighten its policy, action which might have the effect of slowing down the transfer of unemployed persons from the textile and other industries to work connected with rearmament. The committee decided that the employers should be asked to agree that every application for the admission of dilutees into the engineering industry should require the approval of the national executive bodies of both the A.E.U. and the Engineering and Allied Employers' National Federation, before becoming effective. With the commencement of the recent war, it was agreed between the two organisations that unskilled persons might be admitted to employment, subject to the approval of the national executives. At a later date, this power was delegated to local committees, and, subsequently, to shop stewards, but complaints of growing laxity in the administration of the scheme, by both sides, appear to have been increasing.

Members of the committee expressed their dissatisfaction that some firms had interpreted the relaxation of the provisions for the acceptance of dilutees as meaning that they were free to employ other than apprentice-trained engineers, even when such were available, for skilled work. A proposal that the union's national executive council should inquire into the numbers of dilutees in the various branches of the industry, and that consideration of the matter should be deferred to a later meeting of the national committee, was rejected. Another resolution, that semi-skilled persons without apprenticeship training, who had been engaged in the industry and had been members of the A.E.U., for five years or longer, should be admitted to full membership of the union, was defeated by a large majority. The delegates agreed unanimously that the national executive council should press, through the Confederation of Shipbuilding and Engineering Unions, for the introduction of a 40-hour week in the engineering industry, without any loss of pay. The executive council was also instructed to present a claim for increased wages to the Railway Shopmen's National Council in respect of union members employed in railway workshops.

The working population of Great Britain, comprising all persons aged 15 and over who work for pay or gain, or who register themselves as available for such employment, numbered 23,443,000 at the end of March last. The Armed Forces, ex-Service men and women on release leave seeking employment, registered unemployed, and all persons in civilian employment (including private indoor domestic servants and persons over pensionable age in gainful employment) are included in the description working population. Part-time employees are counted as full units. The total at the end of March last represented an addition of 13,000 persons since the end of February.

Of the total working population of 23,443,000 at the end of March, 16,030,000 were men and 7,413,000 were women, according to statistics issued last week by the Ministry of Labour. It is estimated by the Ministry that some 450,000 persons were registered as unemployed at the end of March, and that there were 840,000 men and 23,000 women then serving in the Armed Forces. There were also 8,000 ex-Service men and women on release leave seeking work, compared with 9,000 at the end of February and 3,000 at the end of December, 1951. The balance of the country's working population at the end of March, 22,122,000 persons, were all in civil employment, that is, engaged in industry, commerce, or services of various kinds. This total comprised 14,946,000 men and 7,176,000 women, and compared with a total of 22,221,000 persons at the end of December, 1951, of whom 14,975,000 were men and 7,246,000 were women.

Persons registered as unemployed on April 21 totalled 467,900 in all, of whom 142,800 were only temporarily disengaged. This represented an increase of 34,900 as compared with the total for March 17. Of the total, 138,400 had been unemployed for more than eight weeks. In the textile industry, unemployment increased by 38,000. Total unemployment on April 21 represented 2.2 per cent. of the estimated total number of employees, compared with 2.1 per cent. on March 17 and with 1.2 per cent. in mid-April, 1951. The number of persons reported as working short time in manufacturing establishments during the last pay week in March was 276,000, compared with 216,000 at the end of January.

HEAT-TREATMENT SHOP OF MESSRS. BLAW KNOX, LIMITED.

(For Description, see Page 659.)

FIG. 3. GENERAL VIEW OF HEAT-TREATMENT SHOP AND EQUIPMENT.

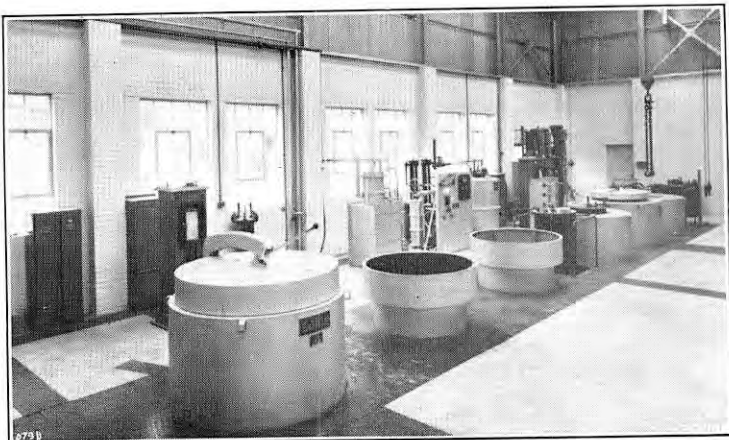


FIG. 4. CARBURISING AND TEMPERING PLANT.



FIG. 5. HORIZONTAL FURNACE AND LOADING TROLLEY.



FIG. 6. LOADED JIG AND RETORT.

QUANTITY PRODUCTION OF GLASS BULBS.

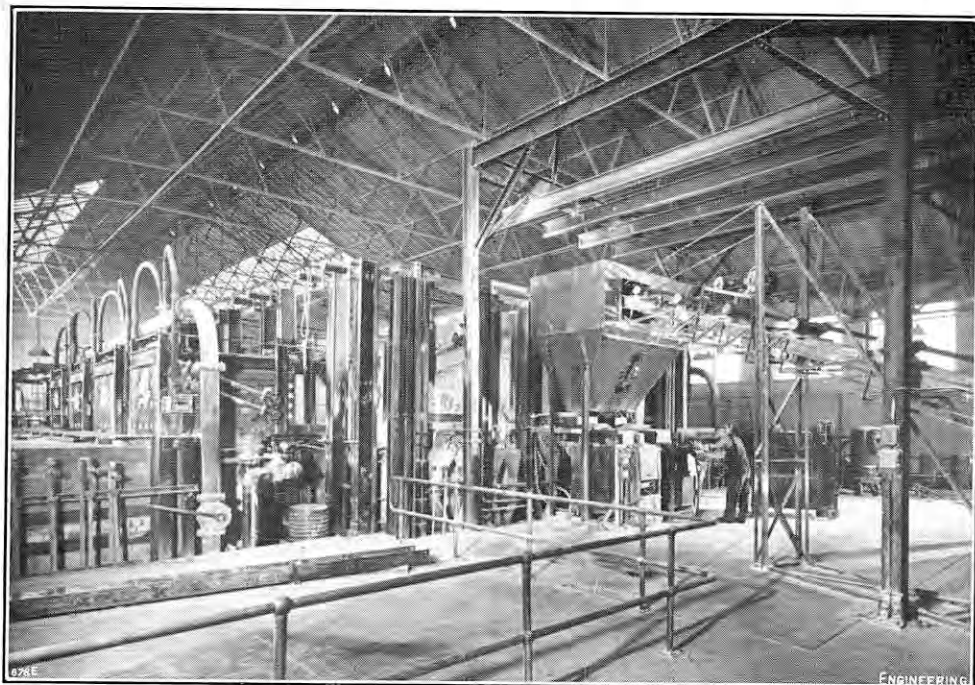
(For Description, see Page 662.)

FIG. 5. SCREW FEEDERS AND GLASS FURNACE.

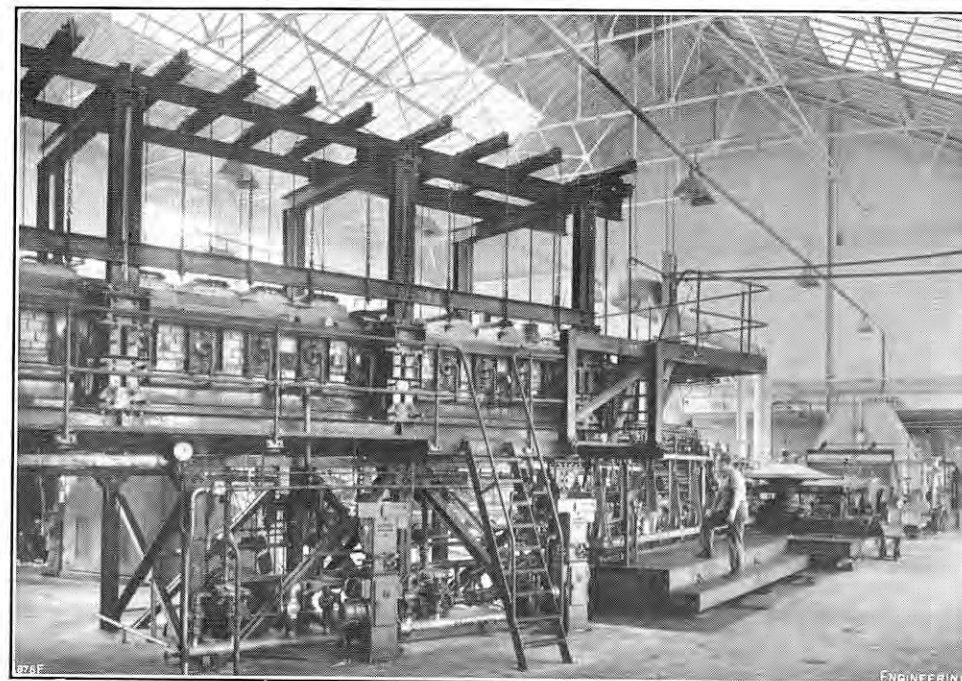


FIG. 6. FOREHEARTH AND RIBBON MACHINE.

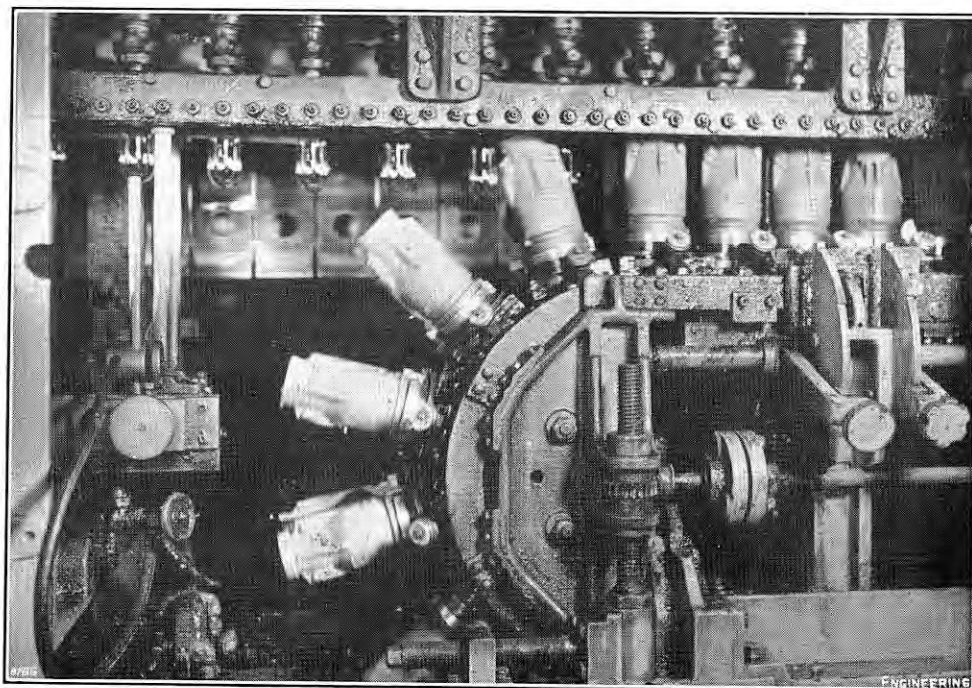


FIG. 7. GLASS BLANKS ENTERING MOULDS.

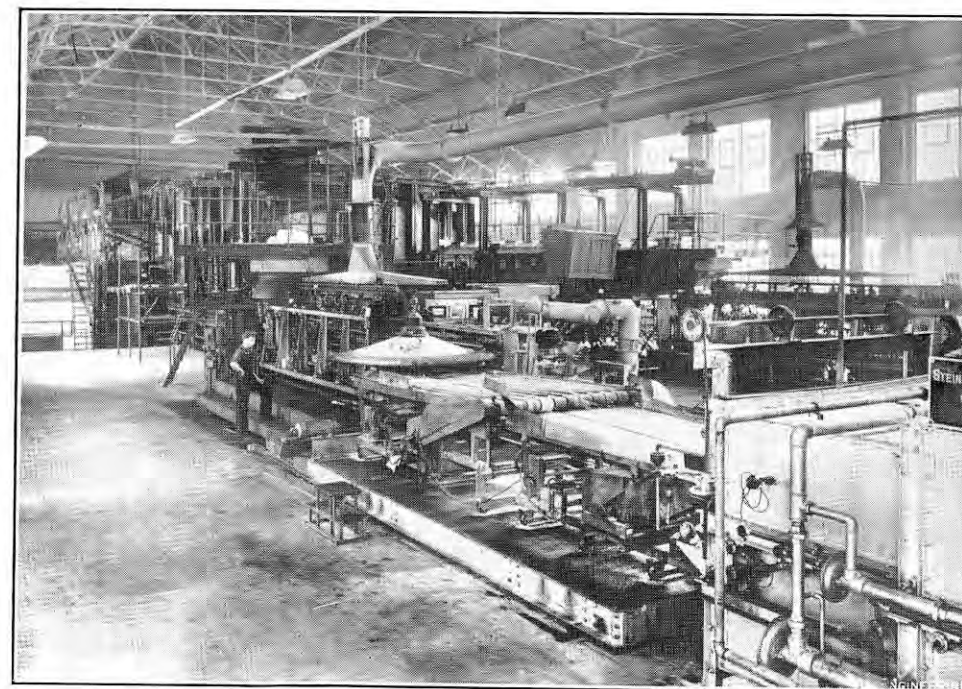
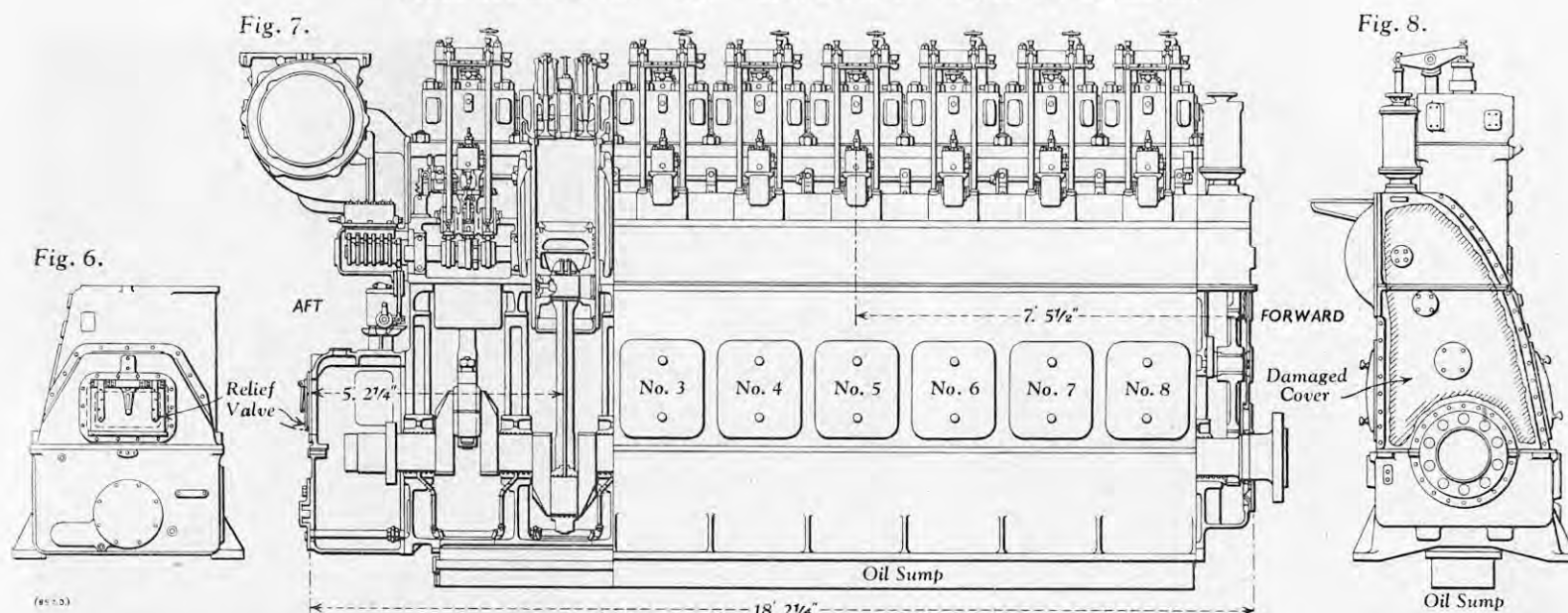


FIG. 8. FURNACE, RIBBON MACHINE AND ENTRY TO ANNEALING OVEN.

EXPLOSIONS IN ENGINE CRANKCASES.



EXPLOSIONS IN ENGINE CRANKCASES.*

By JOHN LAMB, O.B.E., M.I.Mech.E.

(Continued from page 633.)

It would be a simple matter to provide the crankshaft and stationary bearings with remote recording thermometers, the dials being situated in a position where they would be under constant observation. With crankpin bearings this is not possible owing to their rapid gyratory motion. This form of motion, however, causes the oil leaving the ends of the bearing to be forcibly projected on to the crankcase doors. When such doors are made of aluminium alloy, overheating of crankpin bearings can be easily detected. Copper would cause a change of temperature to be detected even more readily.

A method of detecting temperature rise in crankpin bearings, which is not dependent upon the oil, is to insert, and firmly secure, in the position shown in Fig. 3, on page 663, *ante*, rods made of pure aluminium or copper, which readily absorb and conduct heat. The inner end of the rod should extend to within about half an inch of the bearing flange, and, if necessary, it can be bored to take a thermometer. It will be found possible, however, to detect a 20 deg. F. rise in temperature by touching the projecting end with the hand. Early detection of temperature rise in crosshead bearings is not easy unless small doors are provided near the top of the crankcase. It is even more difficult with gudgeon bearings and, unfortunately, such bearings are not infrequently responsible for pistons becoming hot. The author cannot at present suggest a practical method of detecting overheating of such bearings.

Most crankcase explosions that have occurred in trunk-piston engines were due to hot pistons, which are totally inaccessible while the engine is running. Generally, the cylinder liner, which is subsequently affected, is also inaccessible, so that an aid is particularly necessary to indicate a temperature rise in pistons. Any aid, such as remote-recording thermometers, would of necessity have to be connected to that part of the stationary liner which usually protrudes from the lower end of the water-jacket. With the present known types of remote-recording thermometer, it would be difficult to decide at which points they should be fitted, as a piston is liable to overheat at any part of its circumference. In view of this, the only satisfactory aid would be one that would monitor the temperature at all points on the liner circumference.

The layout of such a device fitted to one of the trunk-piston engines in the *Auris* is shown in Figs. 4 and 5, on page 663, *ante*. The detecting elements consist of lengths of single-core mineral-oxide-insulated cable which encircle each cylinder liner. At normal engine temperatures the insulation resistance of the mineral-oxide filling is high and the leakage current from core to sheath is low. Should, however, only a few inches of an element be raised in temperature due to the development of a hot spot on the liner, the insulation of that short length would so decrease as to allow a much increased leakage current to flow. The leakage current is continuously

Fig. 9. SPRING-LOADED HINGED-VALVE.

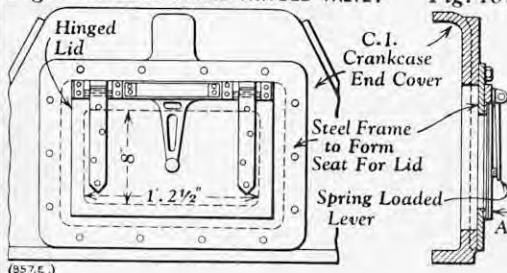
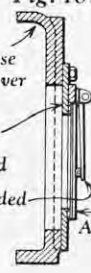


Fig. 10.



passed through a sensitive relay which operates to give an alarm, should the leakage current exceed a certain value. Because of the logarithmic relation between the resistance of the mineral oxide and its temperature, the device can be made sensitive to quite small and local temperature rises above normal. A control indicator box which contains the relay and the electrical alarm circuits is also provided with selector switches, by means of which the particular cylinder element giving rise to an alarm may be quickly ascertained.

PREVENTION OF INJURY DUE TO EXPLOSION.

In the prevention of injury to personnel and damage to property as a result of crankcase explosions, two problems are involved. The first is to obviate pressure build-up inside the crankcase by provision of an adequate escape for the rapidly expanding gases; and the second is to prevent personnel in the vicinity from being burnt, or a fire being started, either by diverting the hot gases to a point where they will do no harm, or by reducing their temperature. Gases released in this way are in process of burning, and flames of great length have been observed on such occasions. To prevent damage, the requirements are that the gases be released at a rate which will ensure that the pressure is kept within the safe working pressure of any part of the crankcase, and that, immediately the excess pressure has been released, the escape opening be instantly closed to prevent entry of air, and a second explosion.

A great deal of thought has been given by various authorities in Britain and abroad to the ratio of the cubic measurement of crankcases to the area of the device provided for the free escape of excess pressure. Lloyd's Register of Shipping recommends that the minimum size of such devices should be determined on a basis of 1 sq. in. per 5 cub. ft. of crankcase volume for engines with a crankcase volume per cylinder of 100 cub. ft. and over. For smaller engines, the allowance is to be 1 sq. in. per 10 cub. ft. plus 10 sq. in. At least one device, of diameter not less than 3 in. or equivalent area, must be fitted on each cylinder crankcase. No relief device is required for engines having a cylinder bore of less than 6 in. The American Navy Department's *General Specification for Machinery* calls for access and inspection covers to be designed to withstand a minimum explosion pressure of 20 lb. per square inch, based on a ratio of 1.5 sq. in. of relief valve area per cubic foot of crankcase volume.

The divergence in the views of these two high authorities confirms the general opinion that reliable data upon which definite conclusions can be drawn are not yet available, and that, until more information is

obtained, the wisest course is to make generous allowance in relief-valve area. Lloyd's view may be, and rightly, that it is not desirable to construct crankcases to withstand an internal pressure of 20 lb. per square inch, at any rate until it is certain that large volumes of burning gas at such a pressure will not, in any circumstances, be released into a ship's engine-room. On occasions, an explosion has been immediately followed by another, sometimes of greater violence. This is attributed to the partial vacuum created by the momentum of the released gases causing air to rush into the crankcase and mix with the remaining oil mist.

The author's most recent experience of a crankcase explosion occurred in an engine crankcase, the construction of which is shown in Figs. 6, 7 and 8, herewith. This follows normal practice. The only communication with the atmosphere was through a vent pipe of 2 in. diameter at the forward end of the engine. The first explosion was caused by the overheating of No. 2 piston. The cover at the opposite end of the engine was broken into several pieces and projected with great force about the engine room. The camshaft-drive gearwheels situated immediately inside the broken cover were unaffected, and the engine continued running until the fuel was shut off. The engine had been running continuously for several days when the explosion occurred. An interesting feature of this explosion is that other parts of the crankcase, nearer to No. 2 piston, showed no sign of strain. This supports the theory that the pressure produced at the seat of the explosion is relatively small, and that the farther the pressure-waves travel through oily mist, the greater will be the accumulated pressure.

The steps taken to prevent a repetition of this damage included the fitting of a spring-loaded hinged valve in the position indicated in Figs. 6 and 7. This position is not at the end where the cover was broken, because release of burning gases at the opposite end would have severely damaged a vital part of the propelling installation.

About two years later a second explosion occurred. This was caused by the running hot of No. 5 piston, which is situated about mid-length. Both ends of the crankcase would, therefore, have been subjected to approximately the same pressure. It is possible, however, that, as the pressure waves did not travel quite so far during the second explosion, the cover at the after end of the crankcase was not subjected to as high a pressure as on the first occasion, when the seat of the explosion was at No. 2 piston; or that the presence of the excess pressure escape on the forward end reduced the pressure on the opposite end. As the engine had been running continuously for about the same length of time as on the previous occasion, the density of the oil mist would have been the same.

This eight-cylinder engine has a total crankcase volume of 220 cub. ft. and a crankcase volume per cylinder of approximately 28 cub. ft. The area of the pressure release opening is 118 sq. in., so that the ratio of release area to total crankcase volume is 1 sq. in. per 1.8 cub. ft., which, in this particular instance, proved sufficient to prevent damage to the engine under the conditions resulting from an explosion starting from No. 5 piston.

The advantages of the form of relief valve shown in Figs. 9 and 10, herewith, are that it is simple in construction, and that, when fully open, it offers minimum

* Paper presented at a meeting of the Institution of Mechanical Engineers, held in London on Friday, April 25, 1952. Abridged.

QUANTITY PRODUCTION OF GLASS BULBS.



FIG. 1. MIXING TOWER WITH SUCTION PIPES.

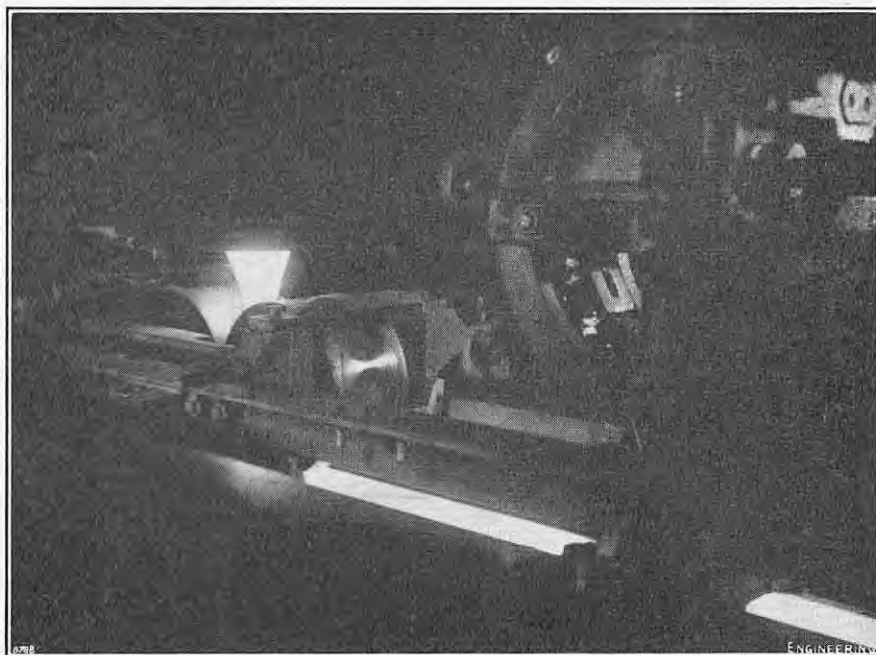


FIG. 2. RIBBON-FORMING ROLLERS.

resistance to the flow of excess gases. The disadvantages are that, if the spring load is sufficient to ensure the closing of the door with the speed necessary to prevent air entering the crankcase, the load may be too great to ensure its opening with the speed necessary to prevent a serious build-up of pressure. In the case just quoted, the spring load holding the relief valve in closed position was just sufficient to avoid movement and leakages of mist resulting from the pulsation of the eight trunk pistons. When it was tested by means of a sensitive spring-balance, a pressure of 4 lb., applied at the point indicated by A (Fig. 10), was found to be required to "crack" the valve, and 13½ lb. to hold it fully open.

When this relief valve was called upon to function, the pressure produced in the crankcase was such that the burning gases issuing from the aperture spread fan-wise. The position occupied by men who were injured, and the scorched paint, showed that the flame must have spread to an angle of nearly 180 deg. and extended for a distance of 15 ft. A rough estimate may be made of the minimum pressure that would be required to shatter the crankcase end-cover. Assuming the tensile breaking stress of the 10 mm. thick cast iron to be 20,000 lb. per square inch, it was found that the minimum pressure at which the cover would fail was between 7½ lb. and 12 lb. per square inch.

(To be continued.)

ANNUAL REPORT OF THE INSTITUTE OF ELECTRICAL ENGINEERS.

THE report of the Council of the Institution of Electrical Engineers for the year ended March 31, 1952, which was presented at the annual general meeting on Thursday, May 15, records that activities at home and overseas were maintained and that the membership continued to grow. Much attention was paid to the development of technological education and detailed discussion took place between the education committees of the three major engineering institutions. As a result, a common policy was established, which will be developed at further conferences. Reference is made to the Joint Engineering Conference, which was held in London on the occasion of the Festival of Britain last year, and to the Conference of Engineering Institutions of Western Europe and the United States of America (EUSEC), which took place at The Hague in September, 1951. At the latter gathering, it was decided to convene a Round Table Conference in England early in 1953 at which views on the educational methods used in each country will be exchanged. The Council have decided to encourage the use of the Rationalised M.K.S. System of units, but have directed that, for the present, questions set in Institution examinations should not necessitate a knowledge of that system by candidates. The finances of the Institution have suffered in some measure from the ill effects of the inflationary trend and some increase in subscription rates is foreshadowed.

The rate of increase in membership was practically

maintained, the number elected during the year being 2,296, compared with 2,431 during the previous season. On April 1, 1952, there were 27,753 corporate members on the register out of a total membership of 37,253. During the 12 months under review, 1,284 meetings of members, the council and the various committees were held. These included 48 meetings of the four specialised sections, the membership of which continues to grow. Some details of their work are given in the report. Informal meetings have continued to constitute a popular part of the Institution's activities and the same is true of the meetings of the various local centres and sub-centres and the students' sections. The technical investigations with which the Institution is concerned include work in connection with codes of practice for buildings, radio interference and flameproof equipment; overhead line regulations; radio interference; electrical equipment for aircraft; general conditions of contract; the design of space-heating installations; and a number of other matters. Close collaboration continued with the Institutions of Civil and Mechanical Engineers, so that proper consideration of matters of common interest to their members was ensured, while other bodies, to which advice or support was given, included the British Council, the British Standards Institution, the Technical and Scientific Register, the Professional Engineers' Appointments Bureau, the Conference of Representatives from the Engineering Societies of Western Europe and the United States of America, the International Commission on Illumination, the International Electrotechnical Commission, and the International Commission on Irrigation and Drainage.

It was decided to disperse the bulk of the museum items which have hitherto been displayed in the Institution building, retaining only a few souvenirs of great electrical personalities. This decision was reached because it was realised that the collection was not a balanced exhibition, while account was also taken of the fact that the comprehensive collection of the Science Museum (which already includes the more interesting items on loan from the Institution) is within easy reach.

SOUTH BANK EXHIBITION BUILDINGS.—The temporary buildings on the Festival of Britain exhibition site, on the south bank of the Thames, are being demolished. The Dome of Discovery and the Skylon have been bought by George Cohen, Sons & Co., Ltd., who are demolishing them and returning the salvaged metal for scrap. The Dome contains about 600 tons of metal, including about 235 tons of aluminium and aluminium alloy, and the Skylon will yield about 23 tons of steel and 5 tons of aluminium alloy. It was estimated that the cost of dismantling these structures, keeping all the parts intact and numbered, and of re-erecting them, was prohibitive. In particular, the steel ring supporting the Dome would have to be cut in several places; on re-erection it would be impossible to restore the ring exactly to its former shape, and a considerable amount of work would, therefore, be necessary to replace all the ribs and sheets.

THE QUANTITY PRODUCTION OF GLASS BULBS FOR ELECTRICAL PURPOSES.

ONE of the principal requirements of the electric lamp and valve industries is large quantities of glass bulbs of many different types and sizes. Until about 25 years ago, these bulbs were made by hand by skilled blowers, but since then automatic machines have been designed for the purpose and are capable of quantity production on a large scale. The demands from both the home and overseas markets are, however, constantly increasing, a fact which has led the General Electric Company and the British Thomson-Houston Company, Limited, to form a new company—Glass Bulbs, Limited—and to establish a new factory at Harworth, near Doncaster, Yorkshire, which is equipped with two ribbon-type machines, the only ones of their kind outside the United States. This factory is capable of turning out no less than one and a half million glass bulbs a day; and the production necessary for all Mazda and Osram general lighting service lamps is being concentrated there. In addition, the output of this factory is sufficient to meet the requirements of the other lamp manufacturers in the British Isles and to allow an ample margin for export.

The site of the Harworth factory was chosen owing to its good rail facilities and because the gas necessary for firing the glass furnace can be obtained from an adjacent colliery. Over 600 workers are employed, and female labour is readily available in the nearby villages. The factory building is 700 ft. long by 80 ft. wide, and houses the furnace, ribbon machines, annealing lehr, inspection point, packaging lines, chemical laboratory, stores, workshops and offices. It is arranged so that full advantage can be taken of the capacity of the ribbon machines and so that the manufacture of the bulbs can be based on a highly mechanised system of flow production.

At one end of the factory is a mixing tower, to the top of which the raw materials, with the exception of the sand, are raised by suction from the railway wagons. The sand is blown up by pressure. This tower, a view of which with the suction pipes appears in Fig. 1, is of reinforced concrete and is 100 ft. high. It contains seven silos which extend from the top to the bottom and each of which has a capacity of 1,500 tons. The raw materials consist of soda ash, dolomites, limestone, sand and feldspar, in addition to cullet, or surplus glass, which is fed into its silo by a mechanical bucket conveyor inside the building. All these raw materials are obtained in this country, and are extracted mechanically from shelves at the top of their respective silos, whence they pass down chutes to automatic weighing machines two floors below. The weighing machines discharge their contents in the correct proportions into a rotary mixing drum. Remote control panels on the floor directly below the outflow at the top of the tower carry coloured indicator lights which show the conditions in the silos, when they are being replenished, as well as the passage of the materials into the weighing machines and their discharge into the mixing drum, etc. These panels,

QUANTITY PRODUCTION OF GLASS BULBS.

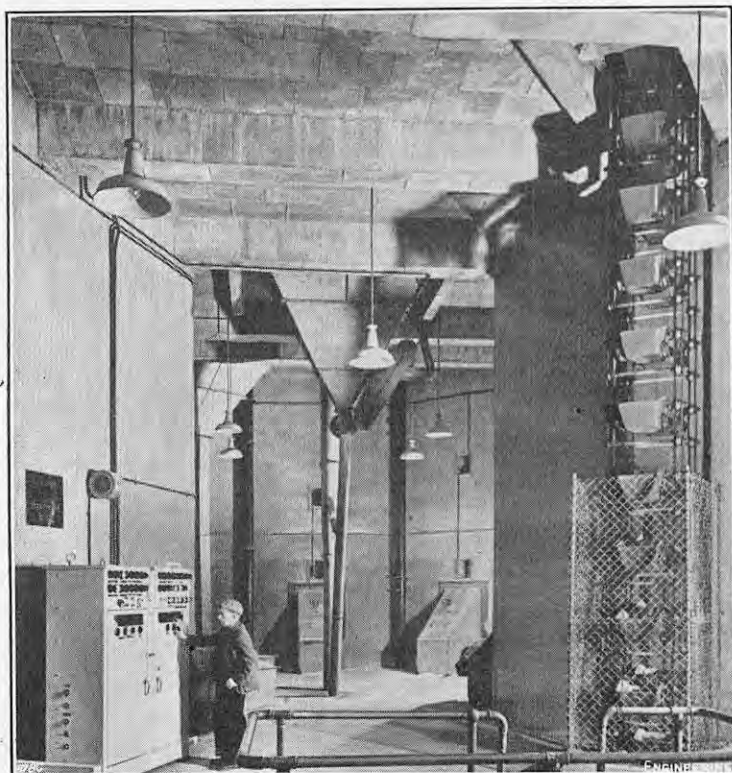


FIG. 3. CONTROL AND INDICATING PANELS; CULLET CONVEYOR ON RIGHT.

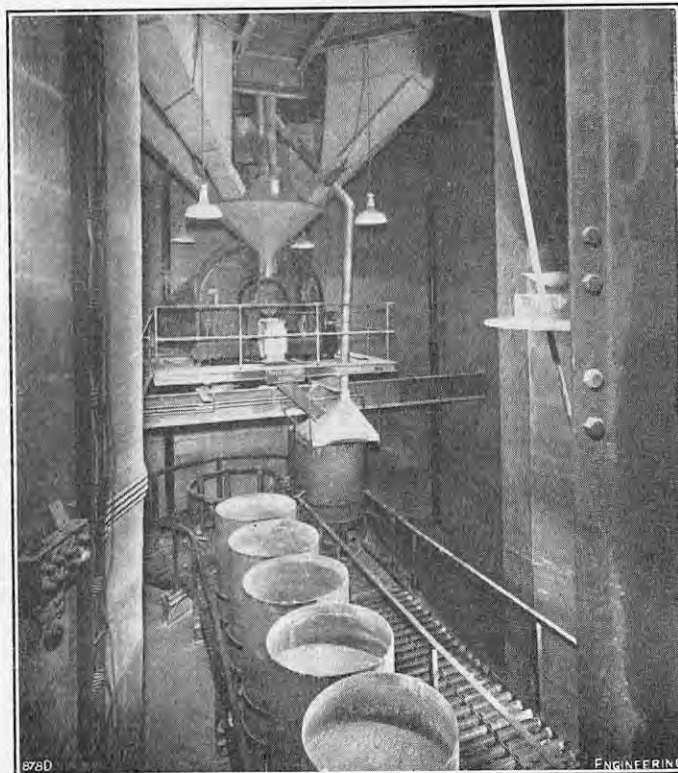


FIG. 4. MIXING DRUM AND CANISTER CONVEYOR.

which are shown in Fig. 3, also carry the push-buttons by which most of these operations can be remotely controlled. The cullet conveyor, of which mention has already been made, is visible on the right of this illustration.

The blended materials from the mixing drum are automatically discharged into canisters, which are conveyed on a roller runway, as shown in Fig. 4, and are unloaded into a hopper. This hopper, in turn, discharges into electrically-operated mobile screw feeders, which force the charge into the mouth of the furnace. This furnace, which is illustrated in Fig. 5, Plate XXXVII, is of the continuous tank cross-fired regenerative type and is capable of producing 150 tons of glass a day. It is fired by coke-oven gas and the incoming air is preheated. The temperatures are suitably graded from the melting to the refining ends and the glass finally passes through automatic forehearth, which bring it to the exact temperature necessary for feeding it to the ribbon machines. The pressure in the furnace is maintained automatically at slightly above that of the atmosphere. Remote recording and metering instruments are grouped on panels in the machine room. A view of the forehearth and the ribbon machine appears in Fig. 6, Plate XXXVII.

On leaving the forehearth a controlled stream of molten glass flows down between two rotating water-cooled rollers at one end of the ribbon machine, as shown in Fig. 2. One of these rollers has a plain surface, while the other contains pockets or circular depressions. The glass therefore issues from between them as a continuous ribbon with a series of shallow circular protuberances or "humps," and is transferred to a continuous belt of orifice plates, each of which is pierced with a circular hole that comes accurately into position beneath a "hump." As the ribbon moves forward on these orifice plates it meets a continuous chain of blow-heads. These blow-heads descend on to the ribbon from above and press into the centre of a "hump" directly over the hole in each orifice plate. The "hump" is then extruded by a puff of compressed air, which is blown through the hole in the orifice plate, the function of the latter being to determine the diameter of the flare at the top of the neck of the finished bulb. The glass blanks hang below the rapidly moving ribbon and increase in depth until they meet split moulds. These moulds rise from below on a continuous belt and close round the blanks from both sides, as shown in Fig. 7, Plate XXXVII.

The moulds now begin to rotate while the air pressure from the blow-heads is increased, so that the glass blanks are moulded to their final shape. During this operation the ribbon, blow-heads and moulds are all moving forward at the same speed. On completion of the process the moulds open and return on their belt under the machine, while the blow-heads break contact with the glass ribbon and return along the machine on the upper side of their chain. The orifice

plates, which are carrying the ribbon with the blown bulbs depending upon it, continue to travel forward while the completed bulbs are cooled by air jets. On reaching the rotating ribbon lifter the bulbs are successively tapped off by a synchronised hammer and fall into the scoops of a rotary turntable. This turntable tips them on to a moving belt for conveyance through a gas-fired lehr or annealing oven, as shown in Fig. 8, Plate XXXVII. The glass ribbon passes down to the floor below, where it is water-cooled and broken up for re-use as cullet. The orifice plates return horizontally behind the machine. As the formation of the bulbs is a delicate process, the moulds are cork-lined. The heat of the glass transforms this material into fine carbon which readily absorbs water from the cooling sprays. The water vaporises when it comes into contact with the hot glass, so that the bulbs are formed in a cushion of steam which leaves them with a polished finish.

Of the two machines installed at Harworth, the larger has a pitch of 3.9 in. from centre to centre of the orifice plates, the latter being of seven different sizes, while the depths of the pockets are either $\frac{3}{8}$ in. or $\frac{1}{2}$ in. This machine has an output of 350 to 500 bulbs a minute for 75 watt, 100 watt and 150 watt general lighting service lamps. Its continuous daily output is therefore about 500,000 bulbs. The smaller machine has a pitch of 3 in. and will produce valve envelopes up to 44.5 mm. in diameter, including miniature types, as well as lamp bulbs from the 25-mm. stop and tail-light size up to and including the 65-mm. bulb for the 60-watt general-service lamp. Its continuous daily output is one million bulbs. It may be noted that an important characteristic of machines of this type is that they can blow the miniature type of valve envelope very quickly. They can also be turned over very quickly from the production of small bulbs to that of large bulbs. In addition, the product is very consistent and its dimensional accuracy is both high and constant.

Each machine is driven by a 10-h.p. direct-current compound-wound motor, which is supplied from a three-phase full-wave rectifier. The motors are operated under electronic control which is arranged so as to maintain a constant speed within $\pm \frac{1}{2}$ per cent. for a 10 per cent. variation in voltage. This enables the speed to be varied from a crawl to 1,750 r.p.m. The general works supply of power is obtained from the mains through a substation on the site and, with the exception of those on the ribbon machines, all the motors are of the alternating-current type. Diesel alternator sets have been installed to obviate any wasteful and costly delay caused by a power cut, and arrangements have also been made to fire the furnaces by oil should the gas supply fail.

After annealing, the bulbs are air-cooled while being carried by conveyors to the packing shop. Five of them are extracted every 12 minutes for examination

and dimensional checks at a control point. Continuous inspection is carried out on a quality-control basis. Packing into cartons, labelling and sealing takes place on two floors of the main factory building. The cartons are then passed to the finished store, which is a building 700 ft. long by 110 ft. wide. A railway line extends down one side of this store while on the other side are road loading docks. All these docks are under cover and the cartons are picked up, transported and loaded by battery-driven fork trucks.

TRAINING IN ELECTRONIC ENGINEERING.

In 1950, E.M.I. Institutes, the educational establishment set up by Electrical and Musical Industries Limited, Hayes, Middlesex, announced the inauguration of a specialised scholarship scheme for their four-year course in electronic engineering. Candidates for the course, the next one of which commences on October 14, 1952, should be between 17 and 19 years of age, and holders of a good General Certificate of Education, followed by at least one year's study of more advanced mathematics and physics. The course is of the "sandwich" type, three of the four years being spent at E.M.I. Institutes, for theoretical and laboratory studies, and two separate periods, each of six months' duration, being spent in the laboratories and workshops of E.M.I. Engineering Development, Limited, Hayes. During the first two college years, a broad training is given in physics, pure and applied mathematics, electrotechnology, the principles of thermionic and electronic engineering, and engineering drawing and workshop technology. The remainder of the college portions of the course is devoted to specialisation in electronic engineering, with further mathematics, the subjects for study including radio communication, line communication, and measurements and industrial applications of electronics.

Students are entered for the B.Sc. general degree of London University in mathematics and physics, and the specialised training given enables them also to obtain the City and Guilds full technological certificate in telecommunications. On completion of their course, students are encouraged to extend their studies to convert their general degree into a special degree. An important feature of the E.M.I. scholarships is that they relieve parents of most of the cost of the training. During the college years, each scholarship holder receives a maintenance grant of between 50% and 100% per annum, and during the practical training periods the students are paid. Applications for inclusion in the October course should be lodged on or before August 29 with the Principal, E.M.I. Institutes, 10, Pembroke-square, London, W.2, from whom further particulars may be obtained.

TESTS OF THE BROWN-BOVERI GAS-TURBINE LOCOMOTIVE.

Fig. 1. EQUIVALENT DRAWBAR PULL.

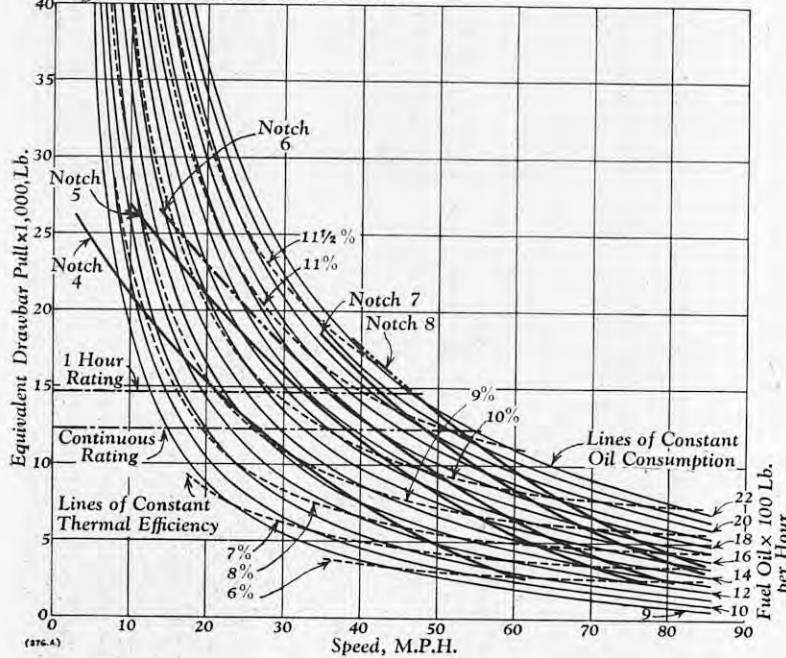


Fig. 2. EQUIVALENT DRAWBAR HORSE POWER.

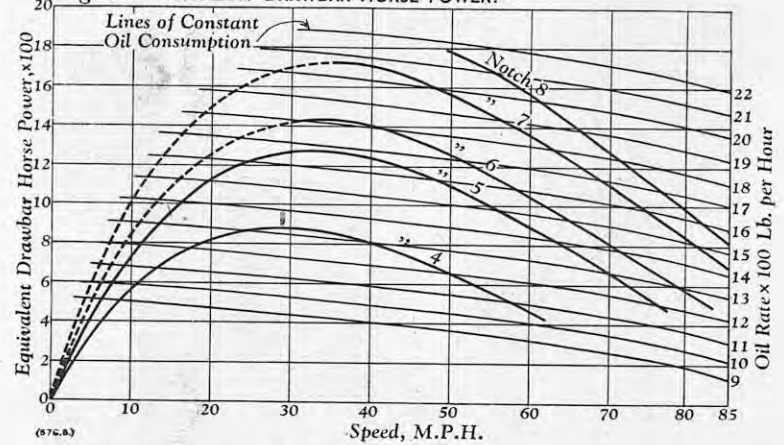


Fig. 3. PASSENGER TRAIN; LEVEL TRACK.

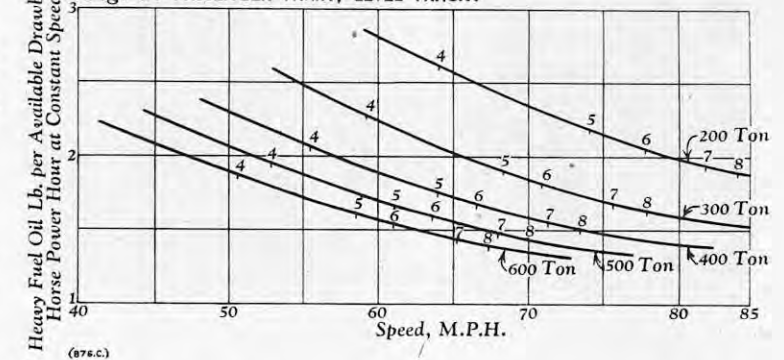


Fig. 4. PASSENGER TRAIN; LEVEL TRACK.

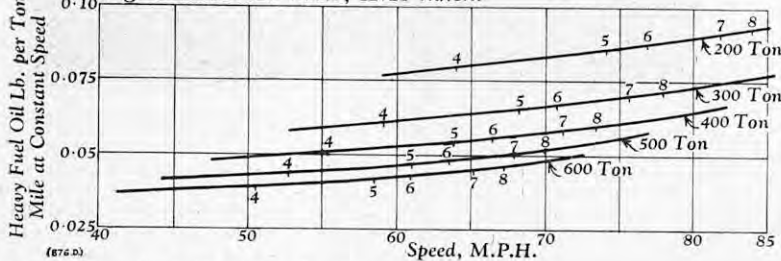


Fig. 5. PASSENGER TRAIN; 1 IN 200 RISING TRACK.

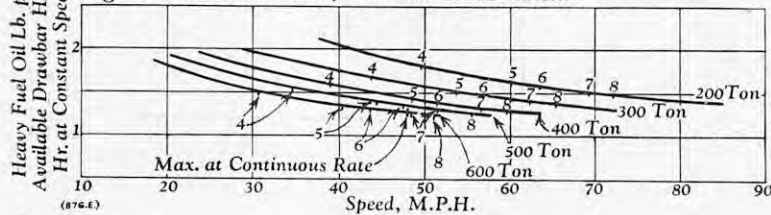


Fig. 6. PASSENGER TRAIN; 1 IN 200 RISING TRACK.

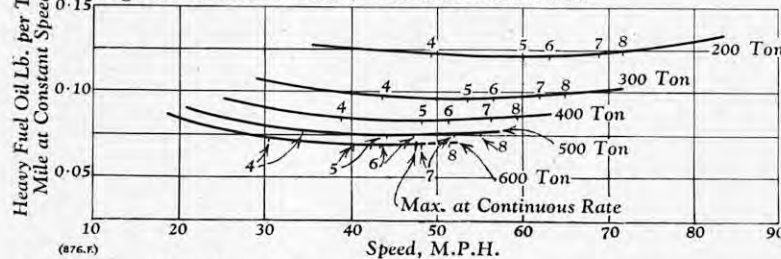


Fig. 7. PASSENGER TRAIN; 1 IN 100 RISING TRACK.

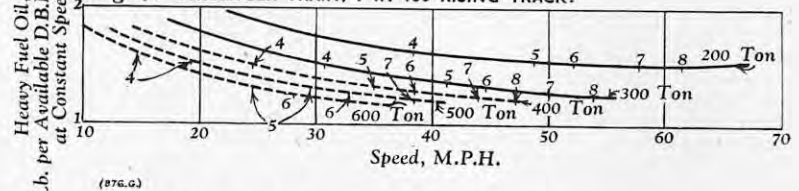


Fig. 8. PASSENGER TRAIN; 1 IN 100 RISING TRACK.

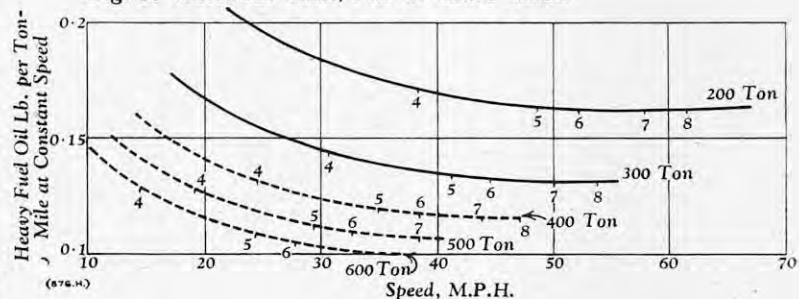
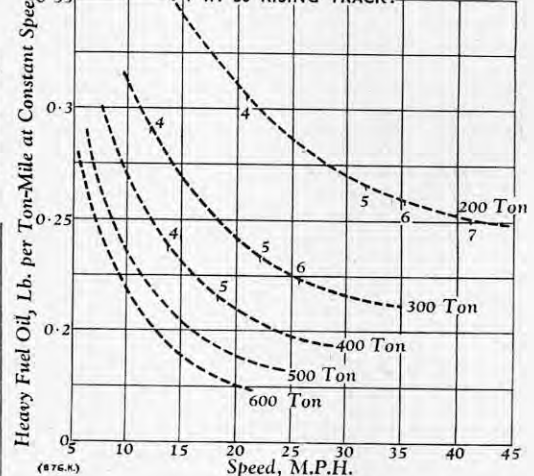


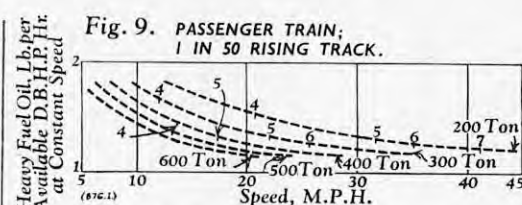
Fig. 10. PASSENGER TRAIN; 1 IN 50 RISING TRACK.



TESTS OF THE BROWN-BOVERI GAS-TURBINE LOCOMOTIVE.

We have received a copy of the following report from the Railway Executive. It gives the results of performance and efficiency tests, with a dynamometer car, which were carried out in September, 1951, on the Brown-Boveri gas-turbine locomotive, No. 18000, of the Western Region. This locomotive was delivered at Swindon in February, 1950, and entered revenue-earning service in May, 1950. The tests were part of a programme of tests of various types of locomotives which is being carried out, under the direction of the Railway Executive testing committee, for British Railways as a whole. The results are representative of the locomotive as running to-day; but the locomotive is an experimental unit subject to development work.

The object of the tests was to obtain performance and efficiency characteristics for comparison with steam locomotives. The method adopted was an adaptation of the controlled road-testing system as developed at Swindon for steam locomotives. In the adaptation the locomotive was worked for relatively long periods in selected controller-notch positions while records were taken of available effort and power at the drawbar with respect to speed and oil consumption. The analysis of these records enabled the characteristics shown in this report to be prepared. Precision oil



meters of the positive-displacement type were fitted in the heavy-oil flow and return lines to the burner. Because of the pressure and temperature conditions, one of the meters had to be totally enclosed in a special pressure vessel, and both had to have special rings and clearances arranged for the operating pistons. The meters registered electrically in the dynamometer car on the distance and time-base records, and also actuated magnetic counters. Temperatures of the oil as it passed through the meters were noted on the temperature measuring equipment of the car. On each test the oil was sampled for determination of calorific value and other particulars, including specific gravity at working temperatures. Generator output was measured by the metering equipment of the car. Gas temperatures before the turbine, and turbine speed, were observed at short intervals throughout the tests from the locomotive's own indicators.

TEST ARRANGEMENTS.

It was found possible to carry out the tests on normal revenue-earning trains without interfering with schedules. The trains chosen were the 3.30 p.m. down

TESTS OF THE BROWN-BOVERI GAS-TURBINE LOCOMOTIVE.

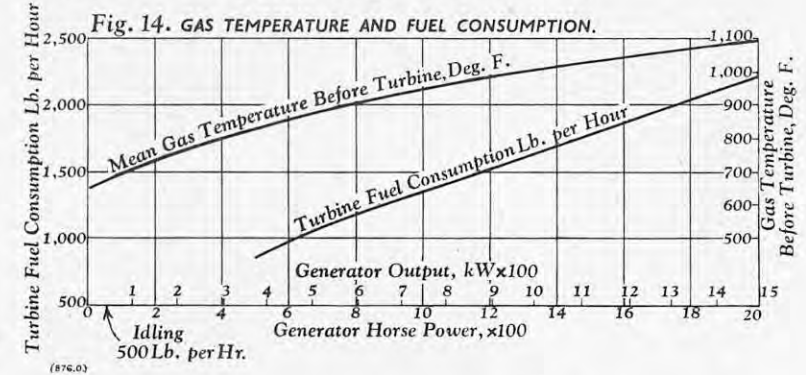
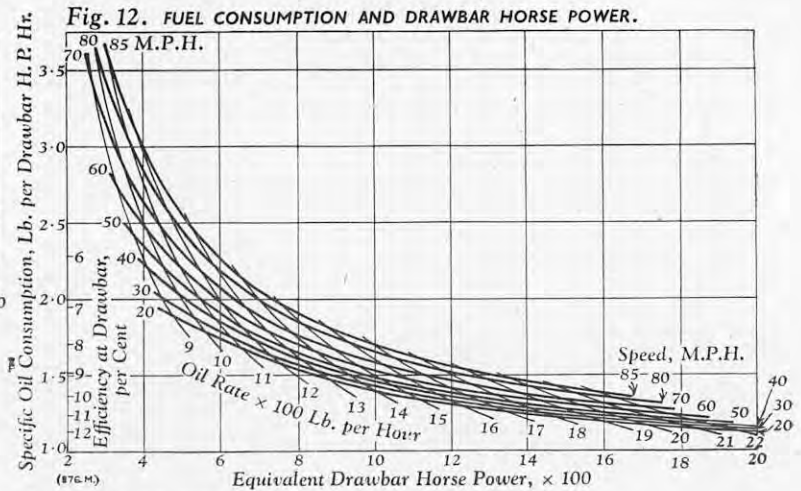
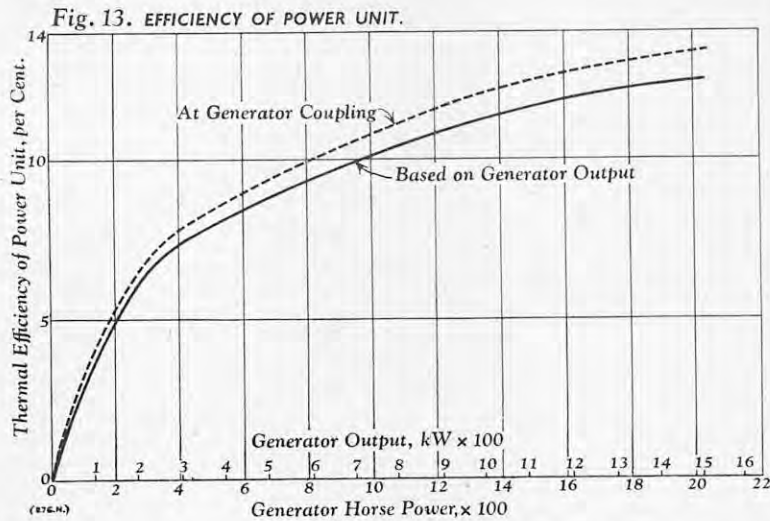
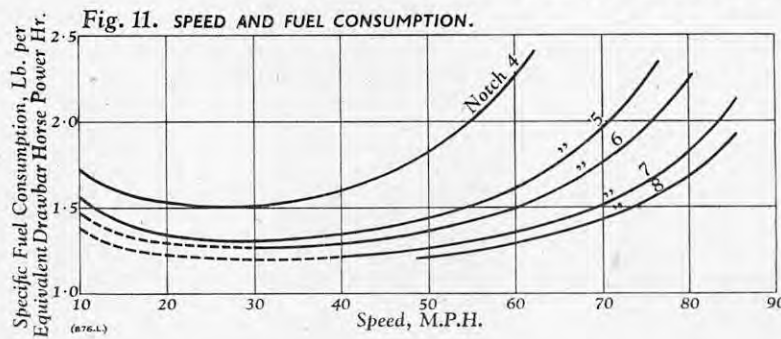


TABLE I.—AVERAGE RESULTS.

Run number	1	3	2	4*
Direction	Down	Down	Up	Up
Weight of locomotive	119.2	119.2	119.2	119.2
Tare load and No. of vehicles, tons and No.				
Paddington-Westbury	395 for 12	395 for 12	228 for 7	227 for 7
Westbury-Exeter	359 for 11	359 for 11	388 for 12	356 for 11
Exeter-Plymouth N. Rd.	239 for 7	239 for 7	388 for 12	386 for 12
Plymouth N. Rd.-Newton Abbot			225.2	153.2
Newton Abbot-Exeter			185.6	120.2
Exeter-Paddington			82,400	53,600
Distance—Actual	225.2	225.2		
Under power	182.2	189.4		
Ton-miles, excluding loco. (actual miles)	78,000	78,000		
Time—Booked running	259.0	259.0	275.0	—
Actual running	252.3	251.4	269.0	186.1
Overall (including stops)	265.5	264.4	296.3	220.0
Actual less drifting and idling (under power)	209.9	204.0	213.4	175.6
Average speed	53.6	53.7	50.2	49.4
Work done	2,520	2,824	2,621	2,135
Average d.b.h.p.	721	831	736	729
Average d.b. pull	2.25	2.59	2.46	2.47
Oil used—Heavy	4,960	5,230	5,450	4,340
Light	224	223	250	186
Total	5,184	5,453	5,700	4,526
Oil, lb. per d.b.h.p.-hr.	2.05	1.93	2.17	2.12
Oil used under power—Heavy	4,496	4,727	4,759	3,970
Light	177	172	180	148
Total	4,673	4,899	4,939	4,118
Oil rate—Heavy	1,121	1,282	1,102	1,181
Light	50.6	50.6	50.6	50.6
Total	1,171.6	1,332.6	1,152.6	1,231.6
Oil rate, drifting and standby, H. and L., Total	550.6	550.6	550.6	550.6
Gross calorific value of fuel oil, Heavy	18,530	18,580	18,680	18,740
Light	19,610	19,590	19,530	19,490
Oil per mile—	23.02	23.20	24.2	28.3
Work done at drawbar $\times \frac{100}{1}$	6.95	7.42	6.56	6.68
Total heavy oil				
Heavy oil used under power $\times \frac{100}{1}$	7.67	8.20	7.51	7.29
Work done at drawbar $\times \frac{100}{1}$				
Total heavy and light oil $\times \frac{100}{1}$	6.66	7.09	6.25	6.39
Work done at drawbar $\times \frac{100}{1}$				
Total heavy and light oil used under power $\times \frac{100}{1}$	7.40	7.91	7.22	7.02

* Test 4 terminated at Savernake.

Paddington to Plymouth train (slipping one coach at Heywood Road junction and stopping at Taunton and Exeter); and the 7.15 a.m. up Plymouth to Paddington train (stopping at Totnes, Newton Abbot, Teignmouth, Dawlish, Exeter, Taunton and Westbury). As tests the trials were satisfactory; the trial on the last day had to be curtailed at Savernake due to trouble in the bearing of the measuring wheel of the dynamometer car, but this did not materially affect the value of the results. The major part of the working range of the locomotive was covered, though working in control notch No. 9 was insufficient to enable characteristics in this notch to be obtained.

The principal data relating to the locomotive are given in the Appendix at the end of the report. Since the locomotive was built in 1949, it has run 46,000 miles in this country, which corresponds to an aggregate running time of 1,130 hours. In March, 1950, the compressor failed, and in its rebuilding provision was made to obviate such a failure in future, but this entailed alterations which, it was stated, would result in some loss of efficiency. From time to time adjustments have been made to the combustion conditions by the makers, and the results presented in this report refer to the locomotive as running in September, 1951.

TEST RESULTS.

Figs. 1 and 2 opposite, show the drawbar characteristics. In these, equivalent drawbar effort and power are directly related with speed, controller-notch, consumption of heavy fuel oil, and efficiency, and correspond to the drawbar characteristics obtained for steam locomotives, with which an instructive comparison may be made. It may be noted, for instance, that the efficiency contour enclosures characteristic of the steam locomotive are absent, and that maximum operating efficiency of the gas-turbine locomotive coincides with high power output, as opposed to a rate of working about two-thirds of the maximum in the case of the steam locomotive. The fuel was a heavy oil with a gross calorific value of 18,630 B.Th.U. per lb.

Figs. 3 to 10 translate drawbar characteristics into operating terms for working on the level and on rising gradients of 1 in 200, 1 in 100 and 1 in 50, respectively, for passenger-train loads of 200 to 600 tons. The figures on the curves indicate controller-notch positions. Performances shown by dotted lines can only be sustained for short periods and must be referred to the traction-motor limiting current.

Figs. 11 and 12 show the specific fuel consumption relative to power at the drawbar (gross calorific value 18,630 B.Th.U. per lb.). Fig. 13 shows the efficiency characteristic of the power unit. The efficiency at the generator coupling is calculated from the generator output curve, assuming a generator efficiency of 94 per cent. The calorific value of the fuel was again 18,630 B.Th.U. per lb.; the ambient temperature was 66 deg. F.

Fig. 14 gives data relative to oil consumption and gas temperature before the turbine as measured during tests. The observed temperatures lay between ± 30 deg. F. of the mean.

Average results of the tests as normal dynamometer-car trials on service trains are shown in Table I. This table contains much interesting information, such as the proportion of the total running time which is spent in standing at stations and in running without effort being exerted at the drawbar, and the oil consumption—about 1 gallon per minute—during these periods. The figures given of mean effort at the drawbar relative to maximum effort, and average efficiency relative to the maximum, are of interest. In comparing these with Figs. 1 and 2, only the oil consumption and efficiency in respect to time under power should be used (i.e., when a useful effort is being exerted at the drawbar). Reasonable agreement will be noted if this comparison is made, the results appertaining to the down trains being more comparable than the results of the up trains due to the number of stops and drifting periods which occurred on the up journeys.

FUEL OIL ANALYSES.

Eight fuel oils were sampled; Nos. 1 to 4 were heavy fuel oils and Nos. 5 to 8 were light fuel oils. A general examination was made of the oils used in the first day's runs only. Determinations of the calorific value were made in respect of all of the samples and determinations of specific gravity at elevated temperatures of the heavy fuel oils only. Details of the samples 1 and 2 are given in Table II, and of samples 5 and 6 in Table III. The methods of test employed were those of the Institute of Petroleum. Table IV gives the calorific values and Table V the specific gravities at elevated temperatures.

TABLE II.—Heavy Fuel Oils.

	Sample No. 1.	Sample No. 2.
Viscosity, Redwood No. 1, at 100 deg. F., seconds ..	836	790
Specific gravity at 60 deg. F./60 deg. F. ..	0.944	0.942
Flash point (closed), deg. F. ..	216	200
Pour point, deg. F. ..	45	45
Ash, per cent. ..	Less than 0.01	0.03
Sediment, per cent. ..	0.02	0.02
Water content, by volume, per cent. ..	Nil	Nil
Clearness ..	Opaque	Opaque
Type ..	Dark mineral	Dark mineral

TABLE III.—Light Fuel Oils.

	Sample No. 5	Sample No. 6
Specific gravity at 60 deg. F./60 deg. F. ..	0.833	0.840
Viscosity, centistokes, at 100 deg. F. ..	2.7	2.9
Distillate, recovered at 350 deg. F., by volume ..	98	96
Flash point (closed), deg. F. ..	198	174
Pour point, deg. F. ..	*Below 15	15
Water content, by volume, per cent. ..	Nil	Nil
Ash, per cent. ..	Nil	Less than 0.01
Sediment, per cent. ..	Nil	Nil
Inorganic acidity ..	Nil	Nil
Corrosion test, copper strip, at 212 deg. F. ..	Negative	Negative
Colour ..	Yellowish-brown	Yellowish-brown
Clearness ..	Clear	Clear

* A slight deposit was formed in the oil at 15 deg. F., during the determination of the pour point.

TABLE IV.—Calorific Values.

Sample No.	Fuel Oil	Calorific Value (Gross) B.Th.U. per lb.
1	Heavy	18,530
2	Heavy	18,680
3	Heavy	18,580
4	Heavy	18,740
5	Light	19,610
6	Light	19,530
7	Light	19,590
8	Light	19,490

TABLE V.—Specific Gravity at Elevated Temperatures.

Temperature, deg. F.	Specific Gravity at T deg. F./60 deg. F.			
	Sample No. 1.	Sample No. 2.	Sample No. 3.	Sample No. 4.
60	0.944	0.942	0.945	0.942
180	0.900	0.897	0.898	0.897
200	0.892	0.889	0.890	0.889
220	0.885	0.882	0.882	0.882
240	0.877	0.874	0.874	0.874
260	0.870	0.867	0.866	0.867
280	0.862	0.859	0.858	0.859
300	0.855	0.852	0.850	0.852

APPENDIX.

Gas turbine ..	7-stage.
Inlet temperature ..	1,100 deg. F.
Exhaust temperature ..	About 480 deg. F.
Nominal output of turbine ..	2,500 h.p.
Overall thermal efficiency at full load ..	16.9 per cent.
Corresponding fuel consumption ..	0.87 lb. per horse-power per hour.
Gas turbine and compressor speed ..	5,300 r.p.m.
Turbine-generator gear ratio ..	6.6:1.
Tractive effort:	
During starting ..	31,500 lb. up to about 21 m.p.h.
Continuously ..	12,400 lb. at 64 m.p.h. 8,400 lb. at 90 m.p.h.
Maximum service speed ..	90 m.p.h.
Compressor ..	22-stage.
Delivery pressure ..	36 lb. per square inch.
Calculated that, at full load, compressor induces approximately 1.5 tons of air per minute, i.e., ..	44,300 cub. ft. per min.
Traction motors ..	Four.
Continuous rating ..	397 kW, 720 volts, 585 amps, 1,550 r.p.m.
One-hour rating ..	394 kW, 636 volts, 660 amps, 1,290 r.p.m.
Gear ratio ..	3.48:1.
Individual axle drive with quill stump and spring coupling; motors and associated gear rigidly mounted on bogie frame.	

Capacities.

Heavy fuel oil ..	1,000 gallons.
Light fuel oil ..	297 gallons.
Lubricating oil ..	260 gallons.

Main Generator.

Number of poles ..	10.
Weight (approximately) ..	7,000 kg. = 6.89 tons.
Maximum operating volts ..	760.
Maximum operating current:	
For 1 hour from cold ..	2,640 amps.
Occasionally for 1 or 2 minutes ..	4,800 amps.
Armature diameter ..	1,250 mm. = 49.2 in.
Length of core ..	360 mm. = 14.2 in.
Commutator diameter ..	720 mm. = 28.3 in.
Number of slots ..	185.
Number of bars ..	Four per slot.
Size of brushes ..	55 mm. long by 40 mm. by 20 mm.

Number of brushes per arm .. 6.
At the driving end, the armature shaft is flanged and bolted to the reduction gear. At the commutator end, there is one journal-type bearing 140 mm. in diameter by 110 mm. long. Diameter of frame .. 5 ft. 7 in. (approx.).
Overall length of generator body (including gear) .. 6 ft. 1½ in.
Overall length of generator body (excluding gear) .. 5 ft. 0 in.
A centrifugal-type fan, situated at the commutator end, expels air through an outlet underneath the generator. The air inlets consist of wire-mesh covered openings in the housings between the gearcase and generator frame, and are distributed over the greater part of the periphery of the generator.
Continuous current rating and voltage .. 2,340 amps. at 675 volts.
Maximum working speed .. 875 r.p.m.

LAUNCHES AND TRIAL TRIPS.

M.S. "LADY SYLVIA."—Single-screw coaster, built by Philip and Son, Ltd., Dartmouth, for D. J. Bradley and D. J. Bradley, Junr., Rochester. Main dimensions: 135 ft. 3 in. between perpendiculars by 25 ft. by 10 ft. 9 in.; deadweight capacity, 420 tons on a draught of 9 ft. 10 in. Six-cylinder Diesel engine developing 570 b.h.p. at 400 r.p.m., constructed by Crossley Brothers, Ltd., Openshaw, Manchester. Speed on trial, 10½ knots. Trial trip, April 1.

M.S. "GOSPORT."—Single-screw collier, built by S. P. Austin & Son, Ltd., Sunderland, for Stephenson Clarke, Ltd., London, E.C.3. Main dimensions: 249 ft. by 38 ft. 9 in. by 18 ft. 4½ in.; deadweight capacity, about 2,400 tons on a mean summer draught of 17 ft. Clark-Sulzer eight-cylinder vertical two-stroke single-acting trunk-piston reversible oil engine, developing 1,150 b.h.p. at 225 r.p.m., constructed by George Clark (1938), Ltd., Sunderland. Speed in service 10½ knots. Launch, April 23.

M.S. "ROMANDIE."—Single-screw cargo vessel, built by the Burntisland Shipbuilding Co., Ltd., Burntisland, Fife, for the Suisse Atlantique Société de Navigation Maritime S.A., Lausanne, Switzerland. Main dimensions: 430 ft. between perpendiculars by 59 ft. 9 in. by 39 ft. 3 in. to shelter deck; deadweight capacity, 10,775 tons on a draught of 26 ft. 7½ in. Sulzer six-cylinder two-stroke Diesel engine, developing 3,940 b.h.p. at 121 r.p.m., installed by the shipbuilders. Launch, April 25.

S.S. "WALLARAH."—Single-screw collier, built by S. P. Austin and Son, Ltd., Sunderland, for the Wallarah Coal Co., Ltd., of London, and Sydney, New South Wales. First vessel to be built by Austin and Son for these owners. Main dimensions: 228 ft. 6 in. by 38 ft. 0½ in. by 16 ft. 2 in.; deadweight capacity, 1,570 tons. Triple-expansion steam engine developing 750 i.h.p. at 83 r.p.m., and two forced-draught boilers, constructed by the North Eastern Marine Engineering Co. (1938), Ltd., Sunderland. Speed on trial, 11½ knots. Trial trip, April 28.

S.S. "VELLETTIA."—Single-screw oil tanker, built by Swan, Hunter, and Wigham Richardson, Ltd., Wallsend-on-Tyne, for the Anglo-Saxon Petroleum Co., Ltd., London, E.C.3. Main dimensions: 610 ft. between perpendiculars by 80 ft. 6 in. by 45 ft. to upper deck; deadweight capacity, about 23,210 tons on a draught of 34 ft. 1½ in.; gross tonnage, 18,661; cargo-tank capacity, 26,362 tons. Impulse-reaction steam turbines with double-reduction double-helical gearing, to develop a maximum of 13,000 s.h.p. at 106 r.p.m., and three oil-fired Babcock and Wilcox boilers, constructed by the Wallsend Slipway and Engineering Co., Ltd., Wallsend-on-Tyne. Service speed, fully loaded, 15 knots. Trial trip, May 1.

M.S. "KING ALEXANDER."—Single-screw cargo liner, built and engine by Harland and Wolff, Ltd., Belfast, for the King Line, Ltd., London, E.C.3. Second vessel of an order for three. Main dimensions: 435 ft. between perpendiculars by 59 ft. by 39 ft. to shelter deck; gross tonnage, about 5,770. Harland-B. and W. six-cylinder four-stroke single-acting Diesel engine. Trial trip, May 6.

M.S. "PRINCESS ELIZABETH."—Single-screw trawler, built by Cochran & Sons, Ltd., Selby, Yorkshire, for the St. Andrew's Steam Fishing Co., Ltd., Hull. Main dimensions: 160 ft. 6 in. by 29 ft. by 14 ft. 6 in. Eight-cylinder Diesel engine developing 1,500 b.h.p., constructed by Crossley Brothers, Ltd., Manchester, and installed by Amos and Smith, Ltd., Hull. Launch, May 10.

BRITISH STANDARD SPECIFICATIONS.

The following publications of engineering interest have been issued by the British Standards Institution. Copies are available from the Sales Department of the Institution, 24, Victoria-street, London, S.W.1, at the price quoted at the end of each paragraph.

Length Bars and Accessories.—The latest addition to the series of specifications for engineers' precision tools, B.S. No. 1790, relates to length bars of the cylindrical-bar type in inch and metric sizes, having parallel end faces finished by lapping. Three grades of accuracy are stipulated, namely, for reference, inspection, and workshop purposes. Recommended sets of workshop bars are tabulated in an appendix. [Price 3s., postage included.]

Scheme of Symbols for Welding.—A recent revision of Section 7 of B.S. No. 499, *Glossary of Terms Relating to the Welding and Cutting of Metals*, first published in 1933 and first revised in 1939, has now been published. Section 7 covers a scheme of symbols for welding, and the new revision contains radical alterations of the former practice. One of the aims of the compilers has been to secure co-ordination between British and American practice as part of a scheme including engineering standard specifications in general. [Price 6s., postage included.]

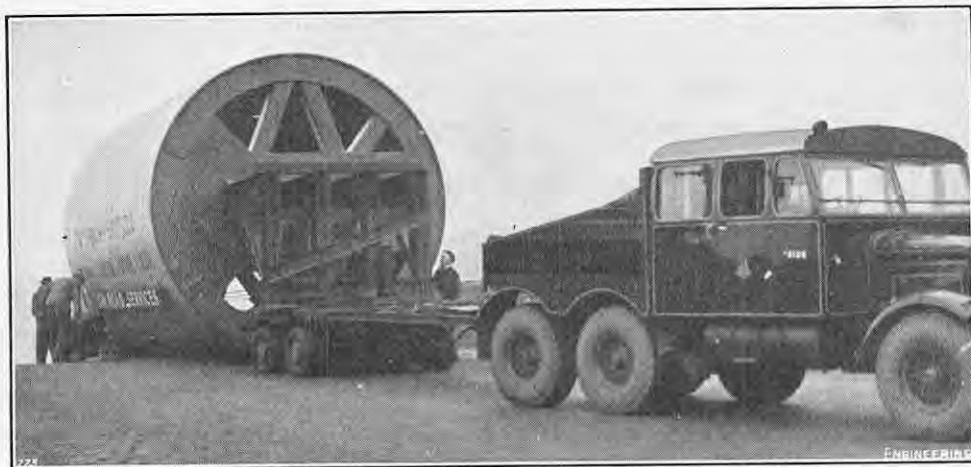
Electricity Meters.—A comprehensive revision of B.S. No. 37, covering electricity meters, has been undertaken by the Institution. A new arrangement has been adopted, the requirements for various types of electricity meters being given in separate parts, preceded by a part dealing with general requirements applicable to all meters. This first part and also part 2, dealing with single-phase two-wire whole-current credit-type meters, are now available, having been issued as a single publication. Part 1 covers reference standards and definitions, and such matters as general construction, terminals, diagram of connections, temperature rise, insulation, and direction of rotation of the rotor. Part 2 deals with the standard ratings and dimensions of the type of meter which it covers and also such matters as speed of rotation, power losses, limits of error, excess-current tests and facilities for adjustment. Appendices deal with measures for the protection of the pivot and jewel of a meter while it is in transit, various methods of test, precautions necessary to ensure accurate performance in service, and other matters. Subsequent parts of the specification will be issued in due course and will deal with pre-payment, polyphase, kW demand, transformer-operated, direct-current, portable and precision meters. [Price 4s., postage included.]

Aluminium and Aluminium-Alloy Sections.—As an addendum to B.S. No. 1161:1951, which deals with aluminium and aluminium-alloy sections for general engineering purposes, the Institution have now issued a pamphlet, designated PD 1331, and entitled "Notes on Aluminium and Aluminium-Alloy Sections." The notes relate to metal in the form of extruded sections complying with B.S. No. 1161, and they recommend that, in choosing an alloy for a particular purpose, consideration should be given not only to the mechanical and structural strength of the material, but also to the ease with which it may be formed and then incorporated into a structure, and its durability under conditions of service. Notes on the working and heat treatment of the various alloys, and tables of torsion constants for the sections specified in B.S. No. 1161, are included. [Gratis.]

Nickel-Clad Steel Plate.—The requirements of nickel-clad steel plate, i.e., steel plate to which a layer of nickel is integrally and continuously bonded, on one or both sides, are contained in a new specification, B.S. No. 1822. The base steel is required to comply with grades 151, 154 or 157 of B.S. No. 1501, which relates to carbon-steel plates, sections and bars for use in the chemical, petroleum and allied industries. A high-purity nickel is specified for the cladding metal, and tests to ascertain the efficiency of the bonding between the nickel and the steel are included. [Price 2s., postage included.]

Rubber Mats for Electrical Purposes.—A first revision of B.S. No. 921, covering solid-rubber insulating mats for use as floor covering near electrical apparatus where circumstances involve the possibility of direct contact with conductors, has now been issued. In the revision, the voltage of the equipment for which the mats are intended to be used is limited to 650 volts r.m.s. to earth. The original 1940 edition covered mats for use up to 3,300 volts to earth, and the limit of 650 volts has been introduced in order to avoid any misapprehension regarding the requirements of the Electricity (Factories Act) Special Regulations, 1908 and 1944. The present edition specifies requirements for the construction, dimensions, finish and marking of the mats, together with particulars of the electrical, mechanical and ageing tests to which they are to be subjected. [Price 2s., postage included.]

ROAD TRANSPORT OF LARGE STEEL CYLINDER.



TRANSPORT BY ROAD OF A LARGE STEEL CYLINDER.

IN the fulfilment of the re-armament programme, the nature of most of the work precludes the publication of details, though it is often of general engineering interest. An example is provided by a contract undertaken recently by Messrs. Costain-John Brown, Limited, 73, South Audley-street, London, W.1, for the construction of certain large-scale testing equipment at one of the Government experimental stations. This contract required the construction of two cylinders each 19 ft. in diameter and 24 ft. long, with inner and outer walls of steel separated by a course of concrete and with a smooth internal surface and an accuracy on the diameter of $\pm \frac{1}{8}$ in.

In general, it is advantageous to fabricate such large cylinders in the shops and deliver the completed unit to the site. Owing to its size, however, this course proved impracticable for the outer cylinder and, as a consequence, it was delivered in segments which were welded together on the site. The inner cylinder, however, did not lend itself so readily to this method, as the close tolerances necessary would have made final erection at site a lengthy and difficult procedure. It was decided, therefore, to investigate the possibility of conveying the complete cylinder to the site by road and, after a careful survey of the routes, it was ascertained that, by constructing a special transporter, it would be possible to adopt this course. The transporter, with the leading tractor, is shown in the illustration above.

The cylinder was fabricated in the shops of Messrs. Thomas Firth and John Brown, Limited, Sheffield, who succeeded in achieving an accuracy of $\frac{3}{32}$ in. on the diameter and in limiting the error in circularity to $\frac{5}{32}$ in. Construction of the cylinder involved the rolling of six segmental plates $1\frac{1}{2}$ in. thick, each weighing 6 tons, to a radius of 7 ft. 6 in. and extending the curvature to the edges of the plates; the use of intricate jigs and fixtures when welding the segments together; and the construction of a special oven for stress-relieving the completed cylinder. The transporter for conveying the completed cylinder to the site was designed by Messrs. Costain-John Brown, Limited. It consisted basically of a beam disposed along the axis of the cylinder and connected thereto by temporary internal frameworks spaced so that the weight of the cylinder was transferred to the beam as a distributed load. The beam was built up from four 20-in. by 7½-in. rolled-steel joists arranged side by side with intervening spaces, and each joist was supported by a vertical column consisting of two 12-in. by 4-in. channel sections set back to back. The horizontal beams were tied together at their ends and the vertical supports at their bases to form a rigid structure, further strengthening being given by a channel bolted to the supports so that it crossed them at an angle, and by struts which joined each beam to the base of its corresponding column to form triangulated joists.

The upper portion of each turntable was formed by a flat plate welded to the base of each column, which was connected through a king-pin to a similar plate forming part of an eight-wheel bogie. It will be appreciated that the structure so formed was in the form of a shallow inverted U with strengthened corners and, as the pull was taken at the extremities of the vertical arms, it was necessary to provide means for transmitting the tractive effort directly between the two bogies without imposing undue bending moments on the end columns. This was accomplished by means of a number of wire ropes which joined the "feet" of the two columns, the ropes being provided with turnbuckles so that they could be brought to the correct tension. Two tractors were used to move the trans-

porter and cylinder, one hauling at the front and the other pushing at the rear, the overall length of the complete unit, including tractors, being 111 ft., and the all-up weight 90 tons. The rear tractor was also used for steering, locking pins being removed from the rear turntable assembly when it was required to negotiate a sharp corner. The transport contractors were Messrs. Pickfords, Limited, and movement of the assembly to the site was accomplished without trouble, the journey of over 200 miles occupying 4 days.

STRENGTHENING WELDED TANKERS.*

As a result of the recent serious casualties which have occurred in two T2-type tankers, the Bureau has decided that it is necessary that measures be taken to provide additional safeguards in this class of vessel against a repetition of such failures as have resulted in a complete severance of the hulls. The Committee on Naval Architecture, and subsequently the Technical Committee of the Bureau, have given careful consideration to the circumstances surrounding the latest failures. They have made a review of all available information obtained from the records of ships in service, from previous casualties, and also from the large amount of research work which has been continuously carried on in connection with the special problems attendant upon welded construction.

As a result of these deliberations, it has been decided that the T2-type tankers are to be provided with at least eight riveted crack arresters in the girth of the ship, spaced with due regard for the loss of intact plating resulting from a crack extending between any of the arresters; that the attachments of the bilge keels to the shell are to be riveted; and that, in conjunction with these alterations, there is to be provided such additional effective longitudinal material as will result in a general increase of 15 per cent. in the longitudinal strength of the vessel as measured by the section modulus of the midship section when compared to the modulus of the original basic design.

The longitudinal extent of the alterations should be approximately the same as the longitudinal extent of the present riveted arresters, due regard being given to avoiding an abrupt termination of the additional material. A slot and riveted strap, a heavy internal girder connected to the plating by riveting, or a doubling plate attached to the plating by riveting, is to be considered as a crack arrester. During the construction programme, there were incorporated into the hulls of approximately the last two-thirds of these vessels heavy I-beam girders under the deck. These girders can be counted as additional effective material over and above the original design, provided they are connected to the deck. Where the connections are made by riveting, these girders can be included as crack arresters. In view of the close proximity of the bilge keels to the existing riveted crack arresters, it is not intended that the riveted bilge keels will be included as one of the additional arresters required.

The committees also recognise the fact that, in the T2 tankers, the ratio of the cubic capacity of the cargo tanks to the available deadweight for cargo is such that, when carrying all but the lightest of petroleum products, it is necessary that one or more tanks be empty or only partially filled. This excess cubic capacity permits some variations in the arrangements of loading at proper trim which, in many cases, can be used to good advantage in reducing the sagging moments resulting in high tension stresses in the bottom

* Circular issued by the American Bureau of Shipping. Abridged.

structure. Similarly, the arrangements for ballasting may be varied to a considerable degree and there are many combinations which could be used to good advantage in reducing the stresses in the structure. The Bureau is collaborating with the U.S. Coast Guard in the preparation of a manual on loading arrangements applicable to these vessels which will be issued as a guide to owners and operators.

A great many of these vessels have had previous alterations, some of which have resulted in the provision of additional longitudinal material of varying degree which can be included in assessing the required added strength and which, in some cases, can be adapted by simple alterations, into an arrangement which can be considered to be the equivalent of a crack arrester. The service records of these vessels indicate that serious failures occur almost exclusively under the conditions of low temperature and heavy seas, such as are encountered only in the winter season.

TRADE PUBLICATIONS.

Cranes and Hoists.—The Wharton Crane and Hoist Co., Ltd., Reddish, Stockport, have published a catalogue giving comprehensive technical information regarding the lifting equipment manufactured by them.

Alkaline Accumulators.—Full particulars of their "Lightweight" alkaline accumulators are contained in a pamphlet received from Venner Accumulators Ltd., Kingston By-Pass, New Malden, Surrey.

Electric Overhead Hoists and Cranes.—Details of the electric overhead hoists and cranes constructed by them are given in a well-illustrated pamphlet received from Steels Engineering Products, Limited, Crown Works, Sunderland.

Electrical Control Boards.—Fully illustrated details of the electrical control boards manufactured by them for a variety of purposes are contained in a booklet received from the General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2.

Welding Fume Extractor.—A revised illustrated pamphlet giving particulars of the Weldafume unit, for removing fumes, dust and smoke from the vicinity of welding operations, has been issued by Keith Blackman, Ltd., Mill Mead-road, London, N.17.

Granulators.—We have received from British Jeffrey-Diamond, Ltd., Stennard Works, Wakefield, Yorkshire, an illustrated pamphlet giving a description and specification of their swing-hammer granulator for reducing hard materials to a cubical product.

Valves.—The Wellman Smith Owen Engineering Corporation, Ltd., Parnell House, Wilton-road, London, S.W.1, have issued a revised illustrated brochure describing the operating principles and mechanical features of Ross operating valves to control single-acting and double-acting air cylinders.

Lighting Installations.—Architects and consulting engineers will find much useful information regarding contemporary lighting installations in a pamphlet entitled "Lighting Problems and their Solution," which has been published by the General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2.

Hydraulic and Electrical Aircraft Equipment.—A loose-leaf catalogue giving, on each sheet, dimensional general-arrangement drawings, design data, and functional diagrams of one component from their complete range of hydraulic pumps, jacks, selectors, valves, pipe couplings, and their electrical switches and indicators, has been issued by Dowty Equipment Ltd., Arle Court, Cheltenham, Gloucestershire.

Industrial Furnaces, Heating and Ventilating Equipment.—The Incandescent Heat Co. Ltd., Cornwall-road, Smethwick, Birmingham, have issued an illustrated catalogue, "Industrial Heat Engineering," giving brief general descriptions of their wide range of furnaces, kilns, ovens, and foundry equipment, gas-atmosphere generators, reciprocating and rotary pumps, dust collection and filtration plants, etc.

Laboratory Centrifuges.—We have received from Sharples Centrifuges Ltd., Woodchester, Stroud, Gloucestershire, an illustrated leaflet describing their super-centrifuge for laboratory use, which develops a centrifugal force up to 62,000*g*. It is designed for recovering solids from liquids, clarifying liquids, or separating two immiscible liquids, and operates with continuous flow.

Single-Roll Breakers.—British Jeffrey-Diamond Ltd., Stennard Works, Wakefield, Yorkshire, have issued an illustrated leaflet describing in detail the construction and operation of their single-roll breakers, which are made in two types and seven sizes. The Mark I breaker is designed for general applications, particularly for small products of about 1½-in. cube. The Mark II breaker is suitable for handling large hard feeds and for installations where it is essential for the fines to be kept down to the minimum.

HYDRAULIC SELECTOR VALVE WITH ELECTRIC CONTROL.

DOWTY EQUIPMENT, LIMITED, CHELTENHAM.

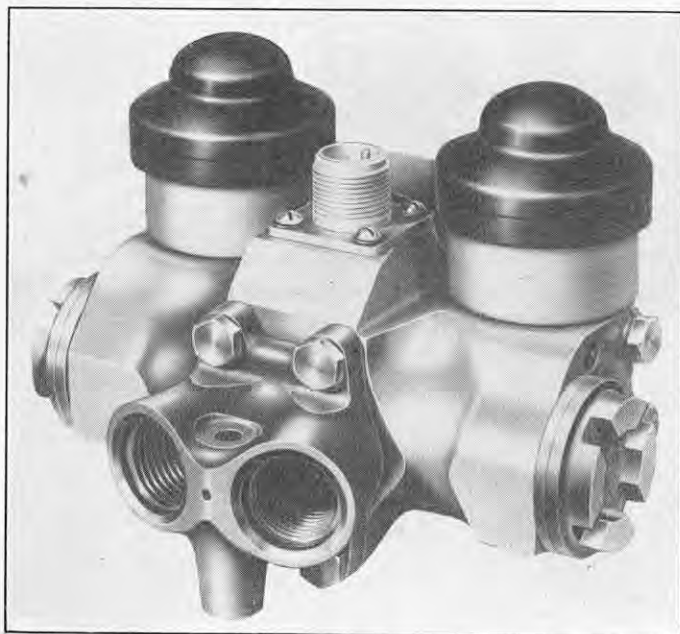


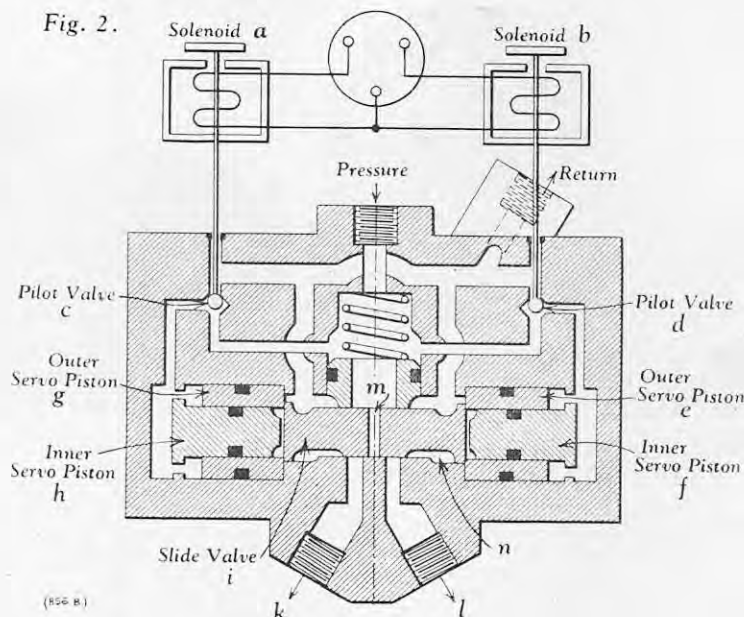
FIG. 1.

HYDRAULIC SELECTOR VALVE WITH ELECTRIC CONTROL.

THE photograph reproduced in Fig. 1 shows a Hydrel lightweight hydraulic selector valve, with twin solenoids for electrical control, which has been developed in the first place for use in aircraft hydraulic systems by Messrs. Dowty Equipment, Limited, Arle Court, Cheltenham, Gloucestershire. It is suitable for many other applications, however, involving remote control of a hydraulically-actuated mechanism. The component is a four-way three-position valve which, in the neutral position, isolates the service lines connected to the hydraulic actuator from the pressure and return lines. It is designed for hydraulic systems with operating pressures up to 4,000 lb. per square inch at any temperature between +70 deg. C. and -54 deg. C., and has a normal flow capacity of 20 gallons per minute. It weighs 2.5 lb. Also available in the Hydrel range, with similar performance characteristics, are three-way twin-solenoid valves, with or without a neutral position, and two-way single-solenoid valves. The latter type of valve weighs 1.9 lb.

The operation of the four-way three-position valve may be understood by referring to the diagram reproduced in Fig. 2. It will be seen that each solenoid *a, b*, is connected to a pilot valve *c, d*. When the solenoids are not energised, the pilot valves are held against their upper seats, and fluid under pressure entering the selector at the pressure inlet, passes through the pilot valves *c, d*, and acts equally on both pairs of inner and outer servo pistons, *e* and *f, g* and *h*. The outer pistons are held against stops at the inner ends of the cylinders, and thereby the slide valve *i* is centralised, blocking the service outlet ports *k, l*. If, now, the pilot or flight engineer causes solenoid *a* to become energised, the corresponding pilot valve *c* is shifted from its upper seat on to its lower seat, shutting off the pressure line from the servo pistons *g, h*, but connecting them with the return line to the hydraulic reservoir so that the pressure on the servo pistons *g, h* is reduced. Fluid pressure acting on the inner servo piston *f*, therefore, shifts the slide valve *i* so that the central port *m* registers with the service outlet *k*, and fluid pressure is directed through *m* and *k* to operate the actuator. Hydraulic fluid displaced from the actuator enters the selector through the other service port *l*, which is now connected by way of the outer port *n* of the slide valve with the return line to the hydraulic reservoir. This state continues until the solenoid is de-energised by the pilot or flight engineer. The pilot valve *c* then returns to its upper seat, and pressure equilibrium is restored, centralising the slide valve. The converse action takes place when solenoid *b* is energised, in this case fluid pressure being directed to the service port *l*, and port *k* being connected with the return line to the reservoir. Selection of either service from neutral is completed in 0.12 second; and the return to neutral is performed in 0.03 second. Should the electric supply fail, the slide valve moves automatically to the neutral position so that pressure is maintained in the selected service.

Fig. 2.



CONTRACTS.

MARCONI'S WIRELESS TELEGRAPH CO. LTD., Chelmsford, Essex, have obtained a contract for the supply of a 5 kW medium-frequency broadcast transmitter for the Falkland Islands. Another contract, obtained by the firm from the Corporation of Trinity House, London, is for 20-watt duplicate medium-frequency navigational radio beacons for lighthouses and light vessels at upwards of 40 places on and around the coasts of Great Britain and Ireland. The equipment will comply with regulations laid down at the conference for the reorganisation of maritime radio beacons in the European area, held in Paris in April, 1951.

JOHN BROWN & CO. LTD., Clydebank Shipyard, Glasgow, are to build the hull and machinery of a small hospital ship to be used as the Royal Yacht in peacetime. She will have a displacement of about 4,000 tons and will be 380 ft. in length, with a beam of 55 ft. The ship will be equipped with three masts and one funnel and will be capable of a speed of 21 knots.

VICKERS-ARMSTRONGS LTD., Vickers House, Broadway, London, S.W.1, have received an order for six Viscount propeller-turbine aircraft from Trans-Australia Airlines. The value of the order is approximately 1,500,000l., and it is intended that deliveries shall start in 1954.

BRITISH TIMKEN LTD., Duston, Northampton, announce that, following a contract for the supply of 60 engine sets of tapered roller bearings for new locomotives for the South African Railways and Harbours Administration, further contracts have been placed with British Timken S.A. (Pty.) Ltd., to equip a further 130 steam locomotives and 60 electric locomotives with tapered roller bearings. As a result, the firm have orders from this administration for a total of 1,550 tapered roller-bearing cannon boxes, 3,184 tapered roller-bearing axleboxes and 146 engine sets of tapered roller-bearing crankpin equipment.

THE ENGLISH ELECTRIC CO. LTD., have received an order for the Diesel-engine and electrical equipment for thirty-one 350-h.p. 0-6-0 type Diesel-electric shunting locomotives for British Railways. The locomotives are to be built in 1953 and the main frames, wheels, cab structures and mechanical parts will be made and assembled at the British Railways workshops at Darlington and Derby. The firm have also secured a contract from the Bureau of Reclamation of the United States Department of the Interior for an 80,000-kVA transformer for the Folsom power-plant switching installation on the Central Valley project in California.

"TWISTEEL" REINFORCEMENT LTD., 43, Upper Grosvenor-street, London, W.1, are to supply and deliver reinforcement for the new road-motor depot of the London Midland Region of British Railways in Pancrasway, King's-road, London, N.W.1.

FAIRCLOUGH LTD., Chapel-street, Adlington, Lancashire, have obtained the contract for the lowering of the Wyre Dock sills and entrance floor, at Fleetwood, for the Docks and Inland Waterways Executive.

BOOKS RECEIVED.

- Electrical Communications Experiments.* By PROFESSORS HENRY R. REED, T. C. GORDON WAGNER and GEORGE F. CORCORAN. John Wiley and Sons, Incorporated, 440, Fourth-avenue, New York 16, U.S.A. [Price 6.75 dols.]; and Chapman and Hall, Limited, 37, Essex-street, Strand, London, W.C.2. [Price 54s. net.]
- D-C Power Systems for Aircraft.* By R. H. KAUFMANN and H. J. FINISON. John Wiley and Sons, Incorporated, 440, Fourth-avenue, New York 16, U.S.A. [Price 5 dols.]; and Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 40s. net.]
- Productivity and Probability.* By T. F. O'CONNOR. Mechanical World Monographs No. 65. Emmott and Company, Limited, 31, King-street West, Manchester. [Price 5s.]
- The Artificial Satellite.* Edited by L. J. CARTER. The Proceedings of the Second International Congress on Astronautics, London, 1951. British Interplanetary Society, 12, Bessborough-gardens, London, S.W.1. [Price 5s. 6d., post free.]
- United States National Bureau of Standards. Handbook No. 51. Radiological and Monitoring Methods and Instruments.* The Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., U.S.A. [Price 15 cents.]
- United States National Bureau of Standards. Miscellaneous Publication No. 203. Index to the Reports of the National Conference on Weights and Measures From the First to the Twenty-Sixth, 1905 to 1951.* By WILLIAM S. BUSSEY and MALCOLM W. JENSEN. The Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., U.S.A. [Price 20 cents.]
- The Scientific Education of Physicists.* The Institute of Physicists, 47, Belgrave-square, London, S.W.1. [Price 2s., post free.]
- Proceedings of the 36th Annual Highway Conference.* Held at Grand Rapids, Michigan, March 13, 14 and 15, 1951. The University of Michigan, Ann Arbor, Michigan, U.S.A.
- A Textbook of Mechanics.* By J. G. JAGGER. Blackie and Son, Limited, 16-18, William IV-street, London, W.C.2. [Price 60s. net.]
- North of Scotland Hydro-Electric Board. Annual Report and Statement of Accounts.* 1st January, 1951, to 31st December, 1951. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 1s. 9d. net.]
- Ministry of Transport. Railway Accidents. Report on the Fire which Occurred in an Express Passenger Train on 14th July, 1951, near Huntingdon in the Eastern Region, British Railways.* H.M. Stationery Office, Kingsway, London, W.C.2. [Price 1s. 6d. net.]
- Ministry of Labour and National Service. Report of the Joint Standing Committee on Safety in the Use of Power Presses. Fencing of Press Brakes.* H.M. Stationery Office, Kingsway, London, W.C.2. [Price 1s. 3d. net.]
- The Society for the Protection of Ancient Buildings. Report of the Committee for the Seventy-First-Seventy-Third Year, and an Account of the General Meeting, with the Address by the Rt. Hon. Lord Macmillan, G.C.V.O. October, 1951.* Offices of the Society, 55, Great Ormond-street, London, W.C.1.