Birkenhead's Alwen Water Supply.

On Monday last the ceremony of turning on the Alwen water supply in Hamilton-square, Birkenhead, was performed by Alderman Henry Bloor, chairman of the Water Committee of the Corporation.

It is more than twenty years since the late Dr. G. F. Deacon, M. Inst. C.E., was first called upon to advise the Corporation of Birkenhead upon its water supply, and it was upon his suggestion that it was decided to obtain a supply from North Wales. On Dr. Deacon's death, in 1909, the responsibility of preparing the design and supervising the construction of the works was entrusted to the firm of Sir Alexander Binnie, Son, and Deacon. In 1915, the late Sir Alexander Binnie was obliged to retire from practice owing to ill-health, and the work has been completed by his two surviving partners. In the year 1907, the Corporation of Birkenhead obtained an Act of Parliament empowering it, among other things, to impound the waters of the rivers Alwen and Brenig in the county of Denbighshire. The two rivers are in adjacent valleys which converge towards one another, and extend, approximately, from north to south. At a distance of about 1¼ miles below the site on which the dam has been built across the Alwen, the two rivers meet, and thence flow into the river Dee about 3 miles above the village of Corwen. It was decided to proceed, at first, only with works on the river Alwen, leaving those on the Brenig for a future occasion. The first stone of the Alwen dam was laid on October 3rd, 1911, by Alderman Bloor, who, as has been said above, turned on the water when the scheme had been brought to completion. The work of constructing the dam had proceeded sufficiently far in the year 1916 for the valves to be closed, thus intercepting the flow of the river and causing the reservoir to commence to fill. After a period of twelve months the reservoir was filled and water began to flow over the overflow sill. The preparation of the site for the reservoir necessitated the removal of a million or so cubic yards of peat and the construction of a dry stone wall taken down to solid ground below the peat, round a large portion of the area occupied by the lake. The wall was capped by a substantial concrete coping. Towards the top or northern end of the reservoir a concrete weir known as the Nant Heilyn weir has been erected to carry a footway, some 150 yards long, to afford means of access from one side of the reservoir to the other. The structure is shown in Fig. 1.

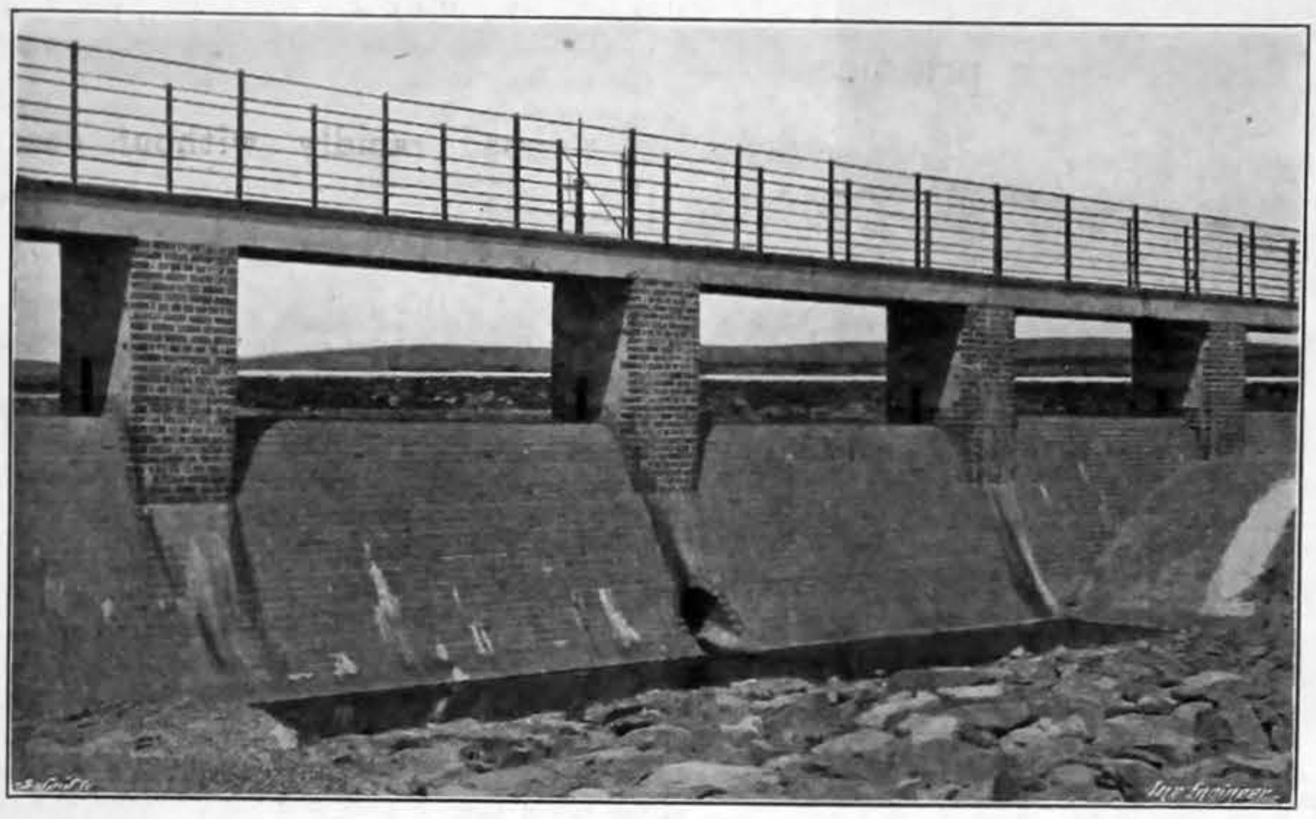


FIG. 1—THE NANT HEILYN WEIR

We have referred on several occasions in the past to the Alwen undertaking, notably in our issues of January 7th and March 3rd, 1916, when we gave illustrations not only of the dam, but also of a large covered service reservoir, which possesses a number of interesting features. We may, at the present time, however, usefully recall some of the principal features of both dam and reservoir and add to them some details of the remaining work of taking the water to Birkenhead, which has since been carried out.

The reservoir formed by the Alwen dam has an approximate length of 3 miles and an average width of about one-fifth of a mile. The lake has a water area of 365 acres, and the volume of water impounded is over 3,000,000,000 gals. The drainage area is 6313 acres, and the average rainfall within the watershed is 52in. per annum. It is calculated that the daily supply of water available will amount to 10,800,000 gals. Of that quantity 3,600,000 gals. per day has to be allowed to flow down the bed of the Alwen as compensation water, so that the quantity which can be passed on to Birkenhead is 7,200,000 per day.

The dam is curved in plan to a radius of 500ft., but is nevertheless of gravity section. It reaches to a height of some 100ft. above the original bed of the stream, and has a length at crest level of 375ft. That so large a body of water can be impounded by such a comparatively short dam will give some idea of the configuration of the valley in which it is built. It is hard, in fact, to imagine a better site for the purpose. The structure is of masonry, but it is faced on its upstream side by smooth concrete blocks, and on the downstream side by rock-faced concrete blocks, the latter having been so cleverly made that they have every appearance, even at quite a short distance away, of being of granite. Views of the upstream and downstream faces are given in Figs. 2 and 3 respectively. The concrete blocks were all made on the site from 1 to 5 concrete, and were given about three months in which to mature before being built in. They have been extraordinarily successful, and that they have been so is considered by the engineers to be due to the fact that they were constructed in moulds which, when being filled with concrete, were carried on a table designed to vibrate during the process. The result of this special form of tamping—if so it may be called—was to expel the air from the mixture and to produce exceptionally compact blocks. A view of one of the moulds on the vibrating table is given in Fig. 5. The blocks used varied in weight from ½ to 2 tons each.

The overflow sill, which is at an elevation of 1190ft. above Ordnance Datum, is divided into eight bays, each 20ft. in width, whilst piers projecting above the sill carry a concrete roadway 10ft. in width. Fig. 4 gives an excellent view of the overflow sill with water coming over it in some quantity. Horizontal pipes passing through the masonry are connected to a vertical pipe which stands in a 12ft. shaft connected to a tunnel 12ft. in diameter passing through a portion of the dam. The vertical pipe is curved at the base of the shaft to run horizontally along the bottom of

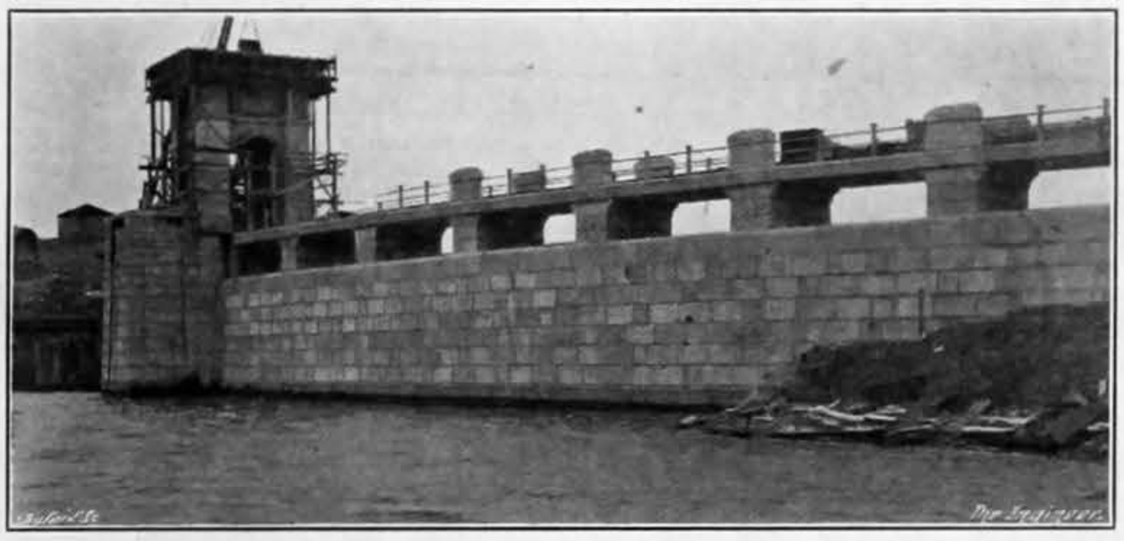


FIG. 2—UPSTREAM FACE OF ALWEN DAM SHOWING OVERFLOW SILL

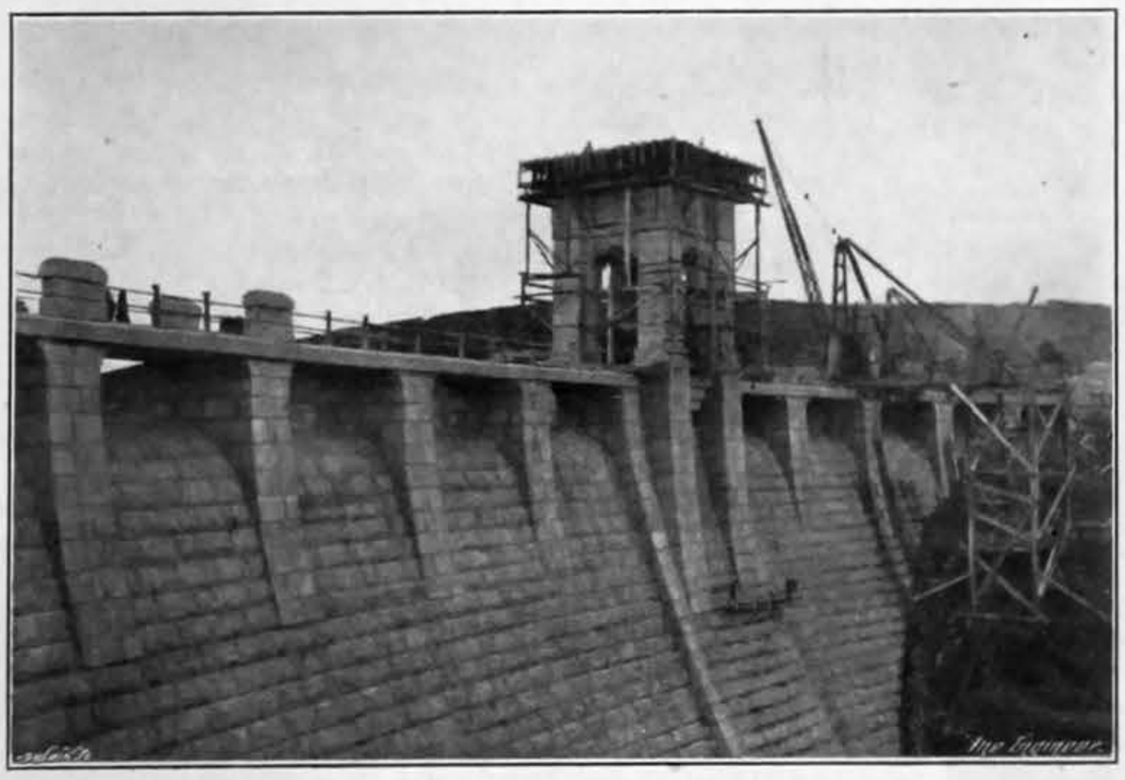


FIG. 3—DOWNSTREAM FACE OF DAM

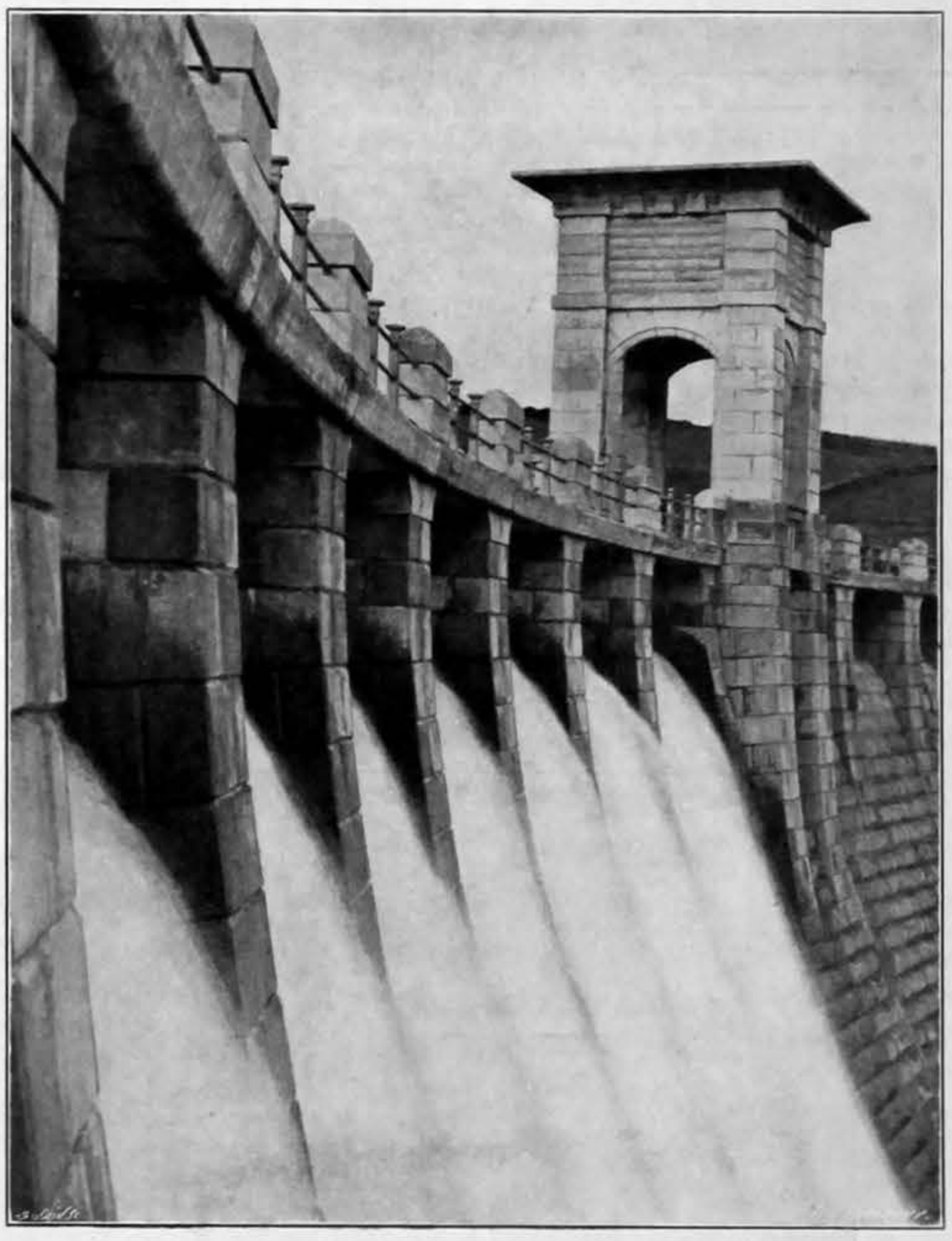


FIG. 4—WATER DISCHARGING OVER SILL OF DAM

the tunnel. The latter terminates in a valve chamber in which are housed turbines and electrical equipment which generate electricity by the passage through them of the 3,600,000 gals. per day of compensation water. The electric current so produced is employed for illumination and also for working some mechanical filters and their accessory machinery. We understand that as an average the quantity of energy thus made available is about 44 horse-power. The impounded water, seeing that a large portion of the gathering ground is thickly covered with peat, is frequently much stained, and it was decided that it was necessary, in order to remove that stain, to treat the water, before admitting it to the pipe line, with lime water, and then to pass it through mechanical filters. The slaking of the lime takes place first of all in one or other of the four concrete tanks seen in Fig. 6. When the view was taken the tanks were not quite finished, but now that they are, a roadway runs up beside them, up which the lime is brought in wagons and tipped into them, the slaking water being added by hose. The slaking process is completed in the pits which are illustrated in Fig. 7, and which just hold enough for a day's supply. From the pits the liquid is taken down in pipes to the filters, which are contained in a brick house, part of which is devoted to dwellings for the attendants. The building is situated some few hundred yards below the dam, and it contains ten batteries of Bell mechanical filters. The pipes from the reservoir pass through the building, and branch pipes are connected to each battery of five filters.

The greater portion of the 42 miles of aqueduct between the filter house and Birkenhead consists of cast iron pipes, which vary in diameter from 36in. to 19in. It passes, on its way, through portions of Denbighshire, Merionethshire, Flintshire and Cheshire, and the route taken by it is shown on the sketch map —Fig. 8. At four places in its length it was found necessary to construct tunnels. The first occurs about half a mile below the dam, and it is 170 yards long. The second, which is named the Bwlch, and which is at the foot of the mountain known as Moel Famma, is 350 yards long. The third, which is 250 yards in length, passes underneath the river Dee at Connahs Quay, while the fourth, which is under the high ground immediately to the south of Birkenhead, is 175 yards long, and is known as the Mere Hall tunnel. The first two and the last are driven through rock, and their construction presented no special difficulties. In the case of the tunnel under the Dee, however, conditions were entirely different, and called for special treatment. Trial borings had revealed the fact that the material through which the tunnel would have to be taken consisted for the most part of fine sand charged with water. The river at the place of crossing is a navigable channel, and in the Act sanctioning the scheme it is laid down that for a length of 100ft. under and across that channel no portion of the aqueduct should be at a higher level than 10ft. below Ordnance Datum. The level of the deepest part of the channel is 8ft. 6in. below Ordnance Datum, and the top of the tunnel as driven is about 12ft. below that depth. It was finally decided to effect the crossing of the river by sinking two shafts, one on each side of the river, and 759ft. apart from centre to centre and by connecting the two shafts by means of a circular tunnel driven in very much the same manner as were the London tube railway tunnels and lined exactly as they are with cast iron segments bolted together. The vertical shafts were of 13ft. 10in. in external and 13ft. internal diameters, and they were, like the tunnel, lined with cast iron segments. The tunnel was driven on a falling gradient of 1 in 107 from the Welsh towards the English side. Consequently, the shafts are not both the same depth, that on the Welsh side being 60ft. 9in. from the top to the cutting edge, the corresponding dimension on the English being 69ft. 3in. The actual depth of the cutting edge below the ground surface was 57ft. on the English side and 45ft. on the Welsh side. The tunnel between the two shafts has an internal diameter of 8ft. It is designed to take two lines of cast iron pipes each 25in. internal diameter, but only one line is at present laid.

In sinking the shafts, water was very soon met with, and excavation in the ordinary manner became impossible. Excavation by grabbing was therefore resorted to. In describing the operation of sinking the shaft on the English side, which was the first to be undertaken, Mr. R. F. Baker, M. Inst. C.E., in a paper which he read last February before the Liverpool Engineering Society, stated that "grabbing was commenced on April 25th, 1919, and by June 6th the cutting edge had reached a depth of about 50ft. from the surface. During the operation, kentledge, consisting of steel piles, pig iron, &c., was added as required. As the shaft was remote from any buildings and no damage could be caused by settlement, a pump was fixed in the cylinder, and it was found that, by keeping the level of the water inside the cylinder a few feet lower than the level outside, the bottom was stirred up, so that it was possible to bring up a grab full on each occasion, and the sinking was considerably expedited. There was, of course, some drawing of the ground around the cylinder, but this was kept filled in with the sand which was excavated."

When the cutting edge was 50ft. below the surface of the ground, there remained about 7ft. 6in. to complete the sinking of the cylinder to its full depth, and it was decided to do that portion under compressed air. Air locks were accordingly constructed in the cylinder. In spite of delay due to that and other causes, including the difficulty in getting material and the breaking of a valve on one of the air compressors—which necessitated the flooding of the cylinder while repairs were being effected—sinking and concreting were completed by August 20th of the same year. The shaft was then again flooded and the concrete allowed to set under water.

Contrary to usual practice, the steel deck and air lock were, according to Mr. Baker, fixed near the top of the shaft cylinder and compressed air was put on when the air-tight deck was slightly above ground level. The whole of the kentledge was also applied at the top of the cylinder, but the success achieved in sinking fully justified the procedure adopted. The maximum air pressure required at the bottom of the English shaft amounted to about 23 lb. per square inch.

As has been said, the English shaft was the first to be sunk, and, in order to avoid the expense of having two sets of air locks, those used on the English side were transferred to the Welsh side after their work on the former was completed. The operations on the Welsh side were exactly like those already described, and need not be further alluded to.

In the shield employed for driving the tunnel, the cutting edge at the top extended 1ft. 6½in. beyond the cutting edge at the lowest part of the invert, so that a projecting hood or chamber was formed in which

FIG. 5—BLOCK MOULD ON VIBRATING TABLE

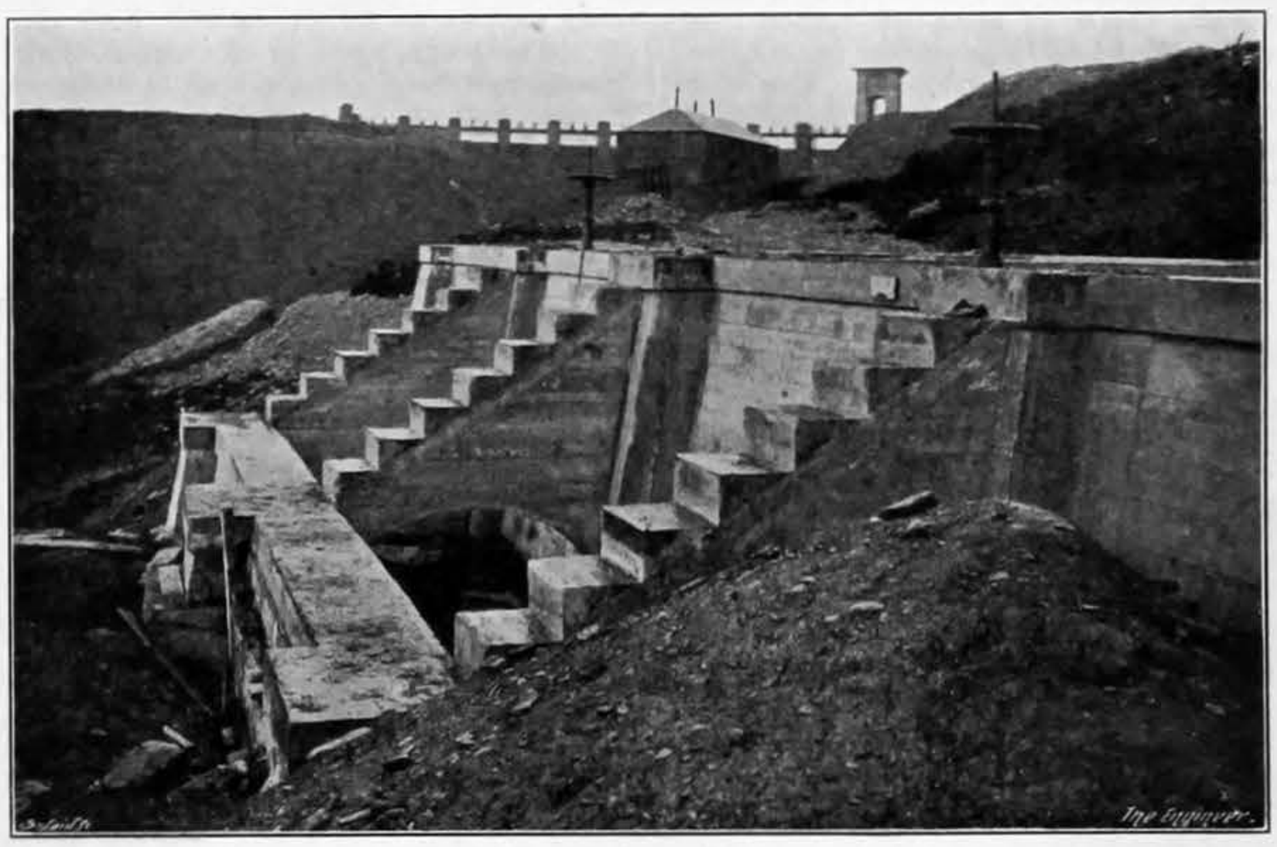


FIG. 7—SECONDARY LIME-SLAKING PITS

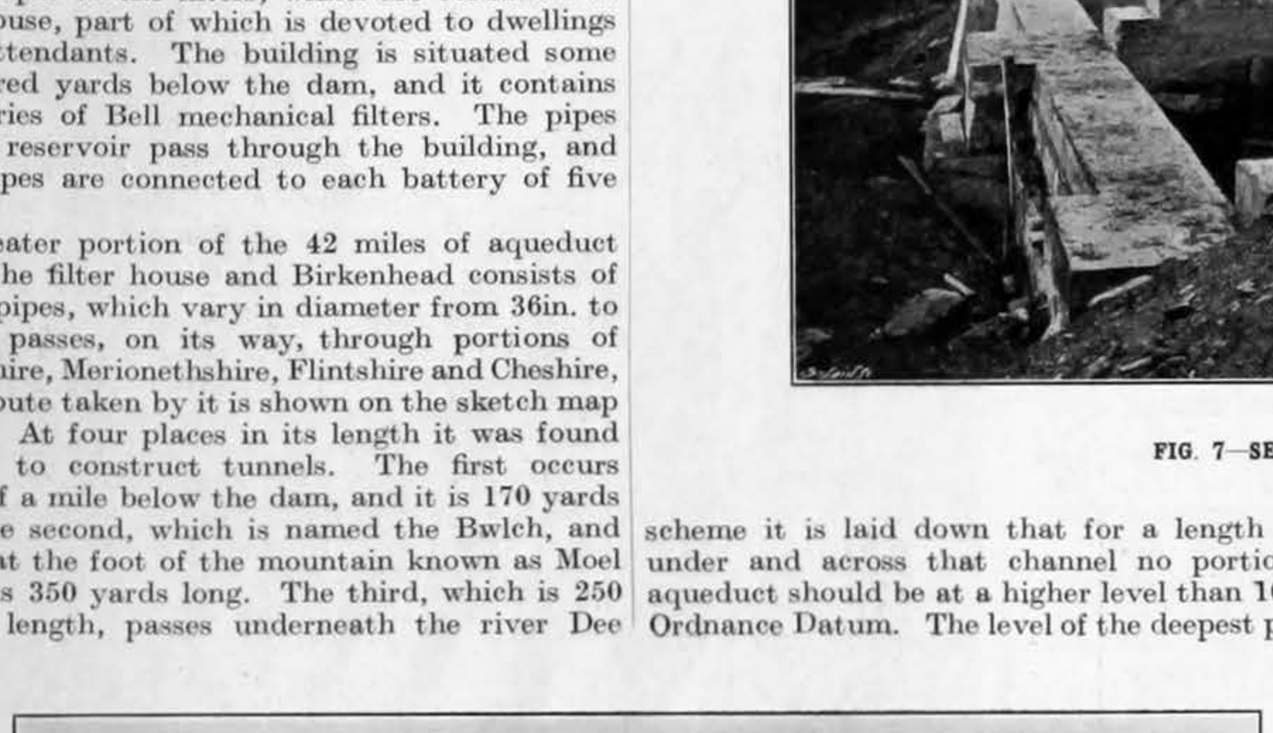


FIG. 6—PRIMARY LIME-SLAKING TANKS

the miners could work in safety. The arrangement also enabled the excavated material to be entirely removed from the lowest part of the invert, so that the shield could be advanced easily and that there was no danger of the cutting edge being deformed by contact with boulders or other obstructions. The shield was pushed forward by six hydraulic rams 7in. in diameter and having a 22in. stroke. The pressure was provided by a hydraulic pump working in the tunnel and driven by high-pressure air. The tunnel lining is built up of cast iron segments 20in. wide, seven segments and one key forming the complete ring. The metal skin is $\frac{7}{8}$in. thick, and there are thirty-six bolts at each circumferential joint.

The clay pocketing system was, Mr. Baker explains, adopted throughout the tunnelling. Pockets 22in. in length were scraped out ahead of the cutting edge of the shield, the top of the hole being about 2in. above the cutting edge of the hood. As soon as one hole had been excavated, it was at once filled in with tempered clay. Another hole was then formed on one side of the first hole and clayed up in a similar manner, and so on, first on one side and then on the other of the original hole, until a ring of tempered clay had been put in for three parts of the way round the circumference. When the shield was forced forward, the cutting edge of the hood entered the clay pocket and a skin of clay was formed and left over the top of the shield, where, as the shield advanced, it remained and prevented the escape of air at the tail of the shield. The compressed air in the tunnel working supported the clay until grout was put in and there was no disturbance of the ground above caused by settlement.

Tunnelling was commenced from the Welsh side on November 24th, 1919. For several weeks prior to February 10th, 1920, the progress averaged thirty-three rings—equal to a length of 55ft.—per week. On that date, when the shield had just started to be moved forward for ring No. 279, a "blow" occurred in the face and the tunnel was partially flooded. The air pressure at the time was 15 lb. per square in., and it immediately dropped to 9 lb. One of the miners who was standing on the platform in front of the shield was carried by the first rush of air through the diaphragm and upwards into the hole formed by the "blow." He was, however, dragged out by the foreman in charge, and, with the exception of being bruised about the face and neck, where he had come against the cutting edge of the shield, he had suffered no serious injuries. All the men in the tunnel made their way in safety to the shaft. The water rose in the tunnel to the level of the top of the opening of the diaphragm, and a considerable volume of sand found its way into the tunnel near the face.

Soundings taken in the river over the site of the "blow" showed that a crater measuring 12ft. in diameter and 4ft. 6in. deep had been formed. When the hole had been filled with clay the water in the tunnel was carried to the surface by means of the "snore" pipe, and the sand was removed. The work of filling in the crater in the river and removing the sand from the tunnel occupied less than a week. Tunnelling operations were resumed on February 19th, and were finally completed without further untoward incident on April 27th, when the cutting edge of the shield reached the shaft on the English side of the river. On June 14th the air was finally released from the tunnel. During the whole of the work only the air locks which had been employed for sinking the shafts were used.

Some little trouble was experienced in running the pipe line over the marshes on the shore of the estuary of the Dee immediately after leaving the shaft on the English side. At first it was proposed to carry it on steel piles in shallow trenches, but the nature of the subsoil rendered that course impossible, and eventually it was decided to lay the pipes on the surface of the ground and to cover them with earth—a method which has, so we understand, answered admirably.

The remaining feature of outstanding interest in the undertaking is the covered service reservoir which has been constructed at Cross Hill, near Barnston, and which has a capacity of some 30,000,000 gals. The Act provides for the construction of two exactly similar reservoirs, but only one has, at present, been built. In design the reservoir is, we believe, absolutely unique, and it is claimed to be probably the most economical reservoir which has ever been constructed. It covers an area of no less than 4 acres, and is a concrete, brick and steel structure, hexagonal in plan, and 32ft. deep, 5ft. of which is below ground level. The roof is formed of 217 concrete domes, built *in situ*, each of which is 30ft. in diameter. The domes are supported on reinforced concrete groins carried by 432 concrete block pillars of hexagonal cross section. The method of construction is well shown in the engravings Figs. 9 and 10, and in Figs. 11, 12, 13 and 14 on page 194. The floor is of 5 to 1 Portland cement concrete faced with asphalt. The walls—as may be seen in Fig. 13—were constructed as a series of horizontal arches composed of 5 to 1 Portland cement concrete faced with brickwork, there being fifty-four of these arches. The asphalt of the floor is continued under the brickwork facing and up between the brickwork and concrete of the side walls. The arches transmit the thrust of the earth, with which the completed reservoir is covered, to plate girders, which, in turn, transmit the thrust to the floor and roof. The plate girders are enclosed in concrete and brickwork. The concrete pillars are provided on their tops with a triangular piece of steel plate, the corners of which are bent up so as to have bolted to them channel irons curved to bow form, these bows being taken from pillar to pillar and from pillar to side arches—as seen in Fig. 13—and afterwards encased in concrete—as seen in Fig. 9—while Fig. 14—page 194—shows the

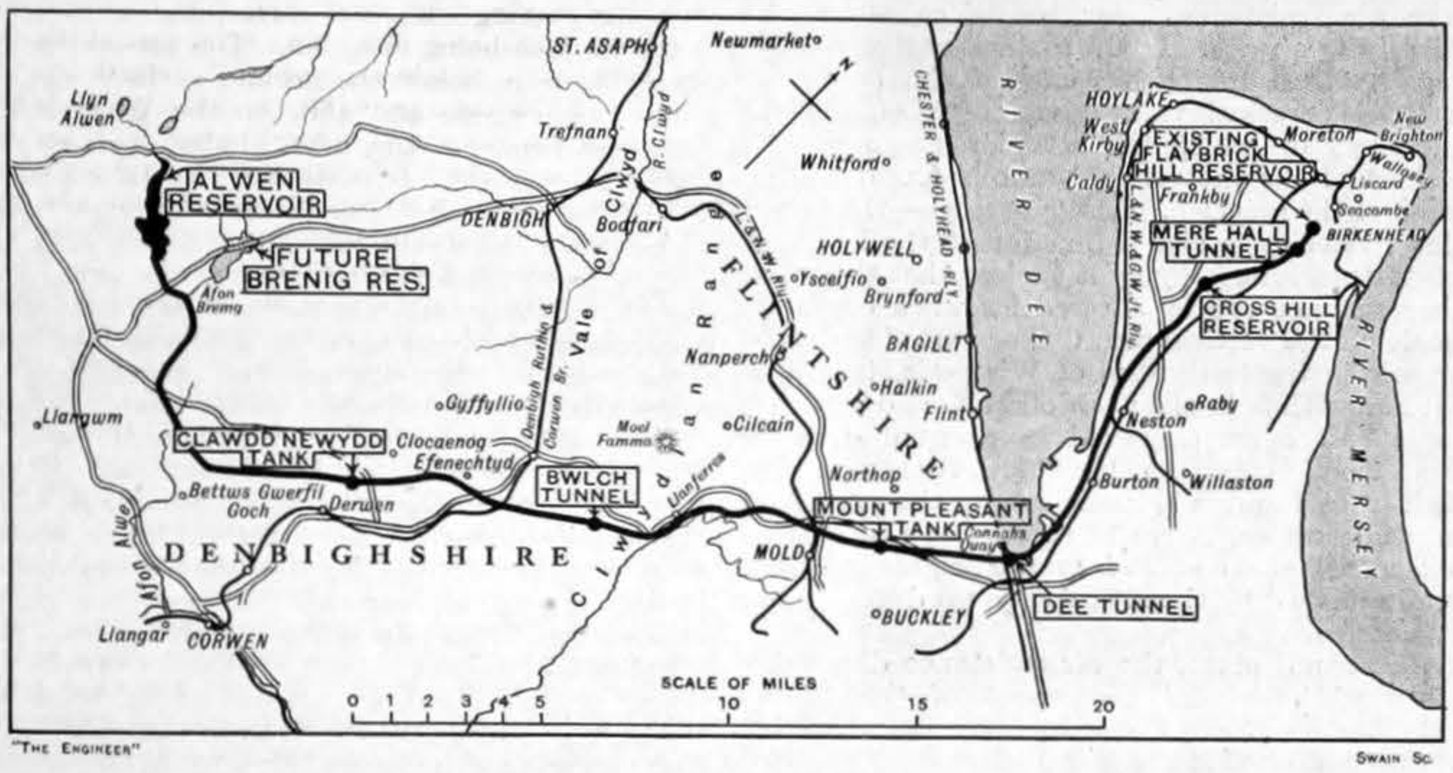


FIG. 8—SKETCH MAP SHOWING ALWEN RESERVOIR AND ROUTE TAKEN BY PIPE LINE

FIGS. 9 AND 10—INTERIOR VIEWS OF CROSS HILL RESERVOIR WITHOUT AND WITH ROOF

centering and shuttering, and also gives some idea of the huge extent of the reservoir used for the purpose. The domes were formed *in situ* by the use of movable stagings, two of which are to be seen in Fig. 10, and on the top of which was erected, for each dome, the special wood centering shown in Fig. 11. The concrete of the domes is entirely without reinforcement, and is of the cross section seen in Fig. 12—page 194—which shows a test section of exactly the same dimensions as those in the dome, which was specially built for test purposes. After the concrete in the dome had set the centering was taken down in sections and used for other domes. There was no attempt to make bonds between the domes and the concrete groins. The sides of the latter were, however, inclined so as to give the haunches of the former a secure seating, and, just before the concrete of the dome was put in position, the surfaces of the sides of the groins were given a serving of neat cement. Asphalt was laid over the joints between groins and domes and taken some little way up the domes all round and cemented so that no rain water might get into the reservoir, and a series of closed drainage channels, made of moulded concrete, was constructed between the domes so that any rain that fell might be led away from the roof. The interior of the reservoir is distinctly effective, the general aspect being decidedly reminiscent of ecclesiastical architecture. The portions of the walls of the reservoir which project above the ground level are supported by an earth embankment which is carried up above the level of the roof in such manner that the whole of the reservoir is completely covered from view.

At Clawdd Newydd, 10 miles distant from the dam, and at Mount Pleasant, to the north-east of Mold, break pressure or balancing tanks have been constructed, the water level in them being 995.5ft. and 521.0ft. respectively. The top water level in the Cross Hill reservoir is 233ft. above Ordnance Datum.

The contracts for the construction of the Alwen dam, of the other work in the neighbourhood of the dam, of the Cross Hill reservoir, and of a portion of the pipe line, were entrusted to Sir Robert McAlpine and Sons, while the major portion of the pipe line, including the Dee tunnel, was laid by John Cochrane and Sons, Limited.

A Course-setting Bomb Sight.

In our issue of August 29th, 1919, we illustrated and described in considerable detail two forms of aerial bomb sight designed by Major H. E. Wimperis, R.A.F., which had been extensively used on British aeroplanes and seaplanes during the war. These two designs—one for low altitude work and the other for high—were expressly constructed for bombing "up wind" or "down wind," and were not suitable for use when the machine was flying across the wind at any angle. The practice of bombing up or down wind was very generally followed during the earlier portion of the war, but with the growth in the systematic use of the seaplane or flying boat bomber for attacking the enemy's submarines, it became highly important to provide means whereby our machines could attack without reference to the direction of the wind, the fact having been noted that the time lost by the machine while getting into the wind was frequently sufficient to enable the target to escape.

In our previous article we remarked that while we were unable to describe it in detail, there had been evolved a later type of bomb sight than either then illustrated, which permitted the attack to be delivered at any angle to the wind. This newer pattern of sight was the invention also of Major Wimperis, and was used at first by our anti-submarine patrol craft. Later it was adapted to high altitude bombing work. The example illustrated herewith is of the latter type. Our engravings, in fact, are reproduced from photographs of a sight actually fitted in one of the machines that were ready to bomb Berlin in the last few days of the war.

The bomb sight illustrated is now no longer a secret device, as it was when we wrote our previous article, and can, therefore, be described in detail. It is distinguished from those previously dealt with by the embodiment in it of a small magnetic compass. This compass is introduced essentially to provide the means whereby the necessary allowance can be made for the fact that the aeroplane at the moment of bombing is not flying parallel with the wind. At the same time the presence of the compass makes the sight, apart from its use for bomb-dropping purposes, a valuable navigating instrument, as will presently be shown; it is for this reason that it is known as a course-setting bomb sight.

To deal first with the instrument as a bomb sight, we may recall from our previous article that a bomb dropped from an aeroplane flying parallel with the wind appears to the pilot to fall vertically below his machine, and that if it is released when the machine is at the point O—Fig. 1—it will strike the ground at T at the same instant as the aeroplane reaches the point A vertically over the point T. The correct instant at which to release the bomb can thus be determined by laying off on a suitable sighting arrangement a horizontal distance B C proportional to the speed G of the machine relatively to the ground and a vertical distance C D proportional to the average velocity of fall V of the bomb. The bomb should then be released at the instant when the target T cuts the line of sight along B D. The same line of sight would, of course, be obtained by erecting B E upwards to represent V, the average velocity of fall of the bomb.

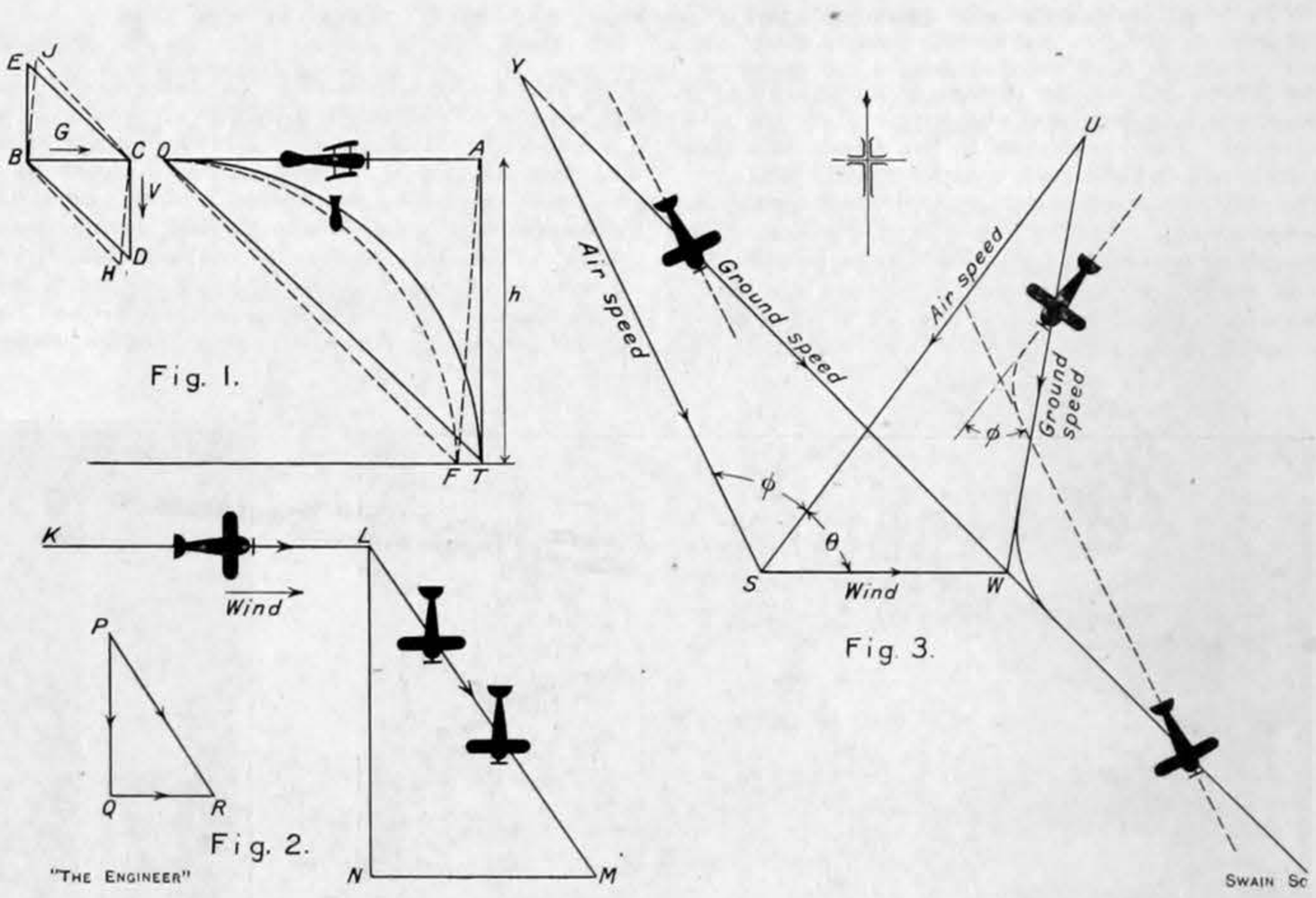
The bomb, it will be understood, does not fall along the line O T, as seen by an observer on the earth, but along a path joining these two points which is parabolic except in so far as it is modified by the air resistance. Air resistance affects the sighting in two ways. In the first place it makes the average vertical falling velocity of the bomb less than the theoretical value given by $v = \sqrt{(g\,h/2)}$. The amount by which the actual average velocity falls short of the theoretical value is found to be a function of the height h. As the average—theoretical—falling velocity is also a function of the height at which the machine is flying it is clear that this effect of air resistance can be allowed for when engraving the scale on the vertical arm C D or B E of the sight. This scale in the later form of Wimperis sight illustrated herewith is in the position B E, and is, in the example before us, engraved in unequal divisions marked from 1000ft. to 14,000ft. Although it is marked in feet and is actually set by the pilot from his altitude meter, it really represents the average velocity of fall of the bomb from the heights indicated on it, diminished by the retardation produced by the air resistance.

In the second place, the air resistance diminishes the forward horizontal component of the bomb's velocity, and makes it increasingly less than the horizontal velocity of the aeroplane with which it starts its parabolic descent. The actual effect of this retardation is to make the bomb fall short of the target by an amount T F, which is proportional to the height h. Since T F is proportional to A T, it follows that the angle T A F—the angle of trail—is constant for all heights for all bombs stowed in the same manner. This effect of air resistance can most simply be allowed for by setting the arm C D or B E of the sight not vertically, but inclined, as at C H or B J, so as to make it parallel with A F. The trail angle is about $2\frac{1}{2}$ deg. for bombs stowed horizontally and about $4\frac{1}{2}$ deg. for bombs stowed vertically nose upwards. In one of the earlier forms of sight previously illustrated means were provided for setting the "height bar" C D at either of these angles. In the form illustrated herewith the bar can be raised from its folded position to the $4\frac{1}{2}$ deg. inclination only.

It is to be particularly noted that the horizontal distance B C is to be proportional to the speed of the machine relatively to the ground, and not its speed relatively to the air, a quantity which is much more readily determinable by the pilot. The ground speed is the sum or difference of the air speed and the speed of the wind, so that in order to set the distance B C correctly the pilot must know the speed of the wind as well as his air speed. In order to find the speed of the wind the pilot can adopt the method of flying parallel with the wind and then turning his machine through approximately 90 deg. as measured by his magnetic compass. Thus, in Fig. 2, the machine is shown flying along K L parallel with the wind, a condition rendered obvious to the pilot by the absence of "drift" in the land below. Turning the machine through approximately 90 deg. by compass, he will not proceed along L N but will fly crab-wise along L M. A point on the ground below the engine will not pass to the rear below the tail, but towards L, along a path M L inclined to the fuselage centre line. If he lays off P Q parallel with the fuselage centre line and proportional to his air speed and draws P R parallel with the direction of the observed drift along M L, then Q R will represent the speed of the wind in magnitude and direction. At the same time P R will represent his velocity relatively to the ground.

Having determined the speed of the wind in this manner, the pilot, with the older forms of sight, resumes his course parallel with the wind, and having set the distance B C—Fig. 1—to represent his air speed plus the wind speed and C D to represent his altitude, he is ready to bomb an approaching target. A down-wind attack is usually followed by one up wind. In this case the distance B C is set to represent the air speed minus the wind speed. In the earlier forms of sight two interconnected back sights were provided, which were so arranged that the setting of the one for bombing up wind automatically set the other for bombing down wind.

For bombing land targets the necessity for carrying out the attack either up or down wind was not a very serious restriction. But in the case of anti-submarine work the time spent in aligning the machine with the wind and in executing the manœuvre required to get a good "run up" on to the target was found to delay and frequently to frustrate the attack. If the submarine endeavoured to escape on a course parallel with the wind, so much the worse for the submarine. If, however, the commander knew his business, he would increase his chances of escaping by retreating in a direction more or less at right angles to the wind. A sight was thus required that would enable our pilots to run up to the target at any angle relatively to the wind and so carry out the attack with the least possible amount of manœuvring.



FIGS. 1, 2 AND 3—BOMB DROPPING AND NAVIGATION DIAGRAMS

Let us consider an aeroplane endeavouring to carry out a bombing attack while flying at some angle θ—Fig. 3—relatively to the wind. If U S represents the air speed of the machine laid down parallel with the fuselage centre line, and if S W represents the direction and speed of the wind, then U W is the ground speed of the machine. A bomb released from the aeroplane will fall in a parabolic curve lying in the vertical plane containing the line U W. It may appear at first sight that the wind acting on the bomb after its release would deflect it out of this vertical plane. The explanation of why this deflecting effect is apparently neglected is to be found in the fact that it has already been allowed for. If there were no wind, U S, and not U W, would indicate the path of the machine over the ground, and a bomb let fall from it would descend in the vertical plane containing the line U S. The action of the wind results in the bomb being deflected away from this plane by an amount represented by the line S W, that is to say, by the amount required to carry it into the vertical plane containing U W.

If, then, the pilot erects a vertical at U—U X, let us say—to represent the average falling velocity of the bomb, then X W will be his line of sight with full allowance made for the height at which he is flying, his air speed, the speed of the wind, and the angle θ between these two velocities. If he now alters his course through an angle φ as measured on his magnetic compass, his speed over the ground will, in magnitude and direction, be Y W, assuming that the wind remains constant and that he does not alter his air speed by opening out or throttling down the engine. His correct line of sight is now Z W where Z is a point lying vertically above Y at a height representing the average falling velocity of the bomb. The points X

and Z would, of course, not be strictly vertically over U and Y, but would lie 4½ deg. forward of the vertical to represent the trail angle.

The diagram Fig. 3 contains all the essential elements of the newer form of Wimperis sight. These elements consist of (1) a bar—represented by U S or Y S—permanently fixed parallel with the fuselage centre line and adjustable in length by means of a scale engraved on it in order that it may serve as a measure of the air speed; (2) a "wind bar" S W hinged to the end of the air speed bar and adjustable angularly and in length to represent the direction and speed of the wind; (3) an upright rising from U or Y engraved with a scale of heights; and (4) a drift bar U W or Y W fixed to the foot of the upright at U or Y and pin-and-slot connected to the end W of the wind bar. In the first half-tone engraving these four parts are respectively marked A, B, C and D.

It will be gathered that the sliding carriage on the upright C is adjusted to the flying altitude against the scale on the upright, and that on each side it carries a ring back sight. Two rings are provided, because in some settings of the device the line of sight on one side or the other of the upright—but never on both simultaneously—is obscured by the drift bar and wind bar. The upright is mounted to rotate on a vertical pivot, and is connected at its foot solidly to the drift bar, in such a way that the line joining the centres of the two ring sights is always at right angles to the drift bar, no matter how the latter may be moved by the adjustments made in the

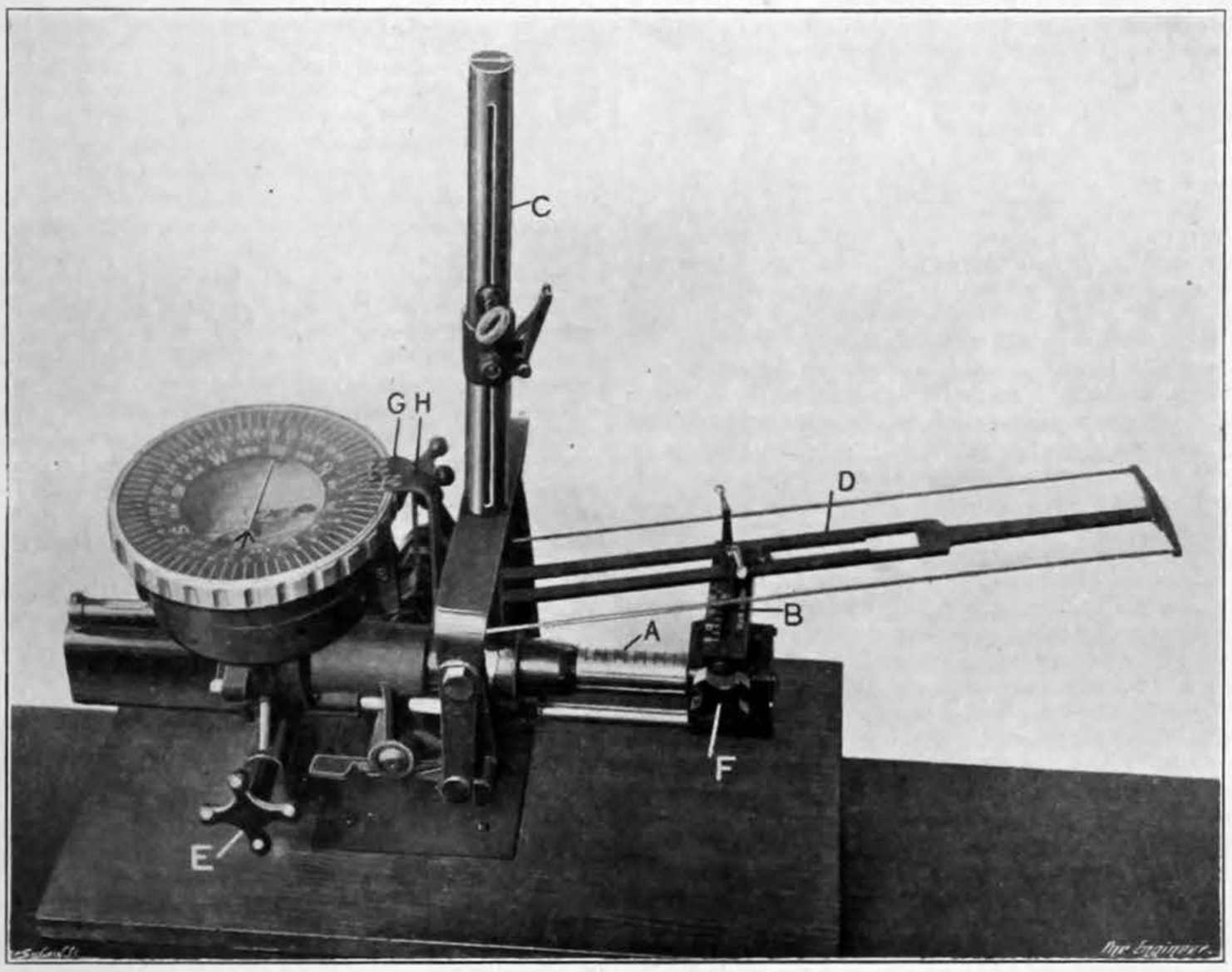


FIG. 4—THE WIMPERIS COURSE-SETTING BOMB SIGHT

length of the air speed bar or wind bar. The air speed bar is a brass tube that may be racked in or out by means of the handle E. At its outer end it carries the pivot of the wind bar. Did the construction of the instrument permit it, it would be found that zero air speed would be registered when the centre line of the pivot was coincident with the centre line of the upright. The wind bar is a slotted box containing a screw which can be turned by means of the handle F. A carriage on this screw works against a scale on the box and is coupled to a slider moving within a slot in the drift bar. The slider supports two bead foresights. The line joining the centres of the beads always remains at right angles to the length of the drift bar. The drift bar is engraved with a scale of speed in miles per hour, and in conjunction with a fiducial mark on the slider enables the pilot, when the instrument is properly set for wind and air speed, to read off his ground speed at a glance. A second scale on the drift bar enables him at the same time to read off the time he will take to cover ten miles over the land. Lying below each bead in the vertical plane defined by the bead and the centre of the associated ring back sight, a wire is attached to the drift bar. These two wires, when the sight is set, indicate what objects ahead will become targets if the existing course is preserved, and also serve to determine the direction of drift when the pilot is measuring the wind speed in the manner previously explained.

It is obvious from Fig. 3 that the essence of the whole device is the preservation of the direction and length of the bar S W as a constant indication of the direction and speed of the wind, no matter how the pilot may alter his course. If the wind is blowing from the west the bar S W must constantly point to the east whatever may be the direction in which the aeroplane is flying. It is easy enough to preserve the length of the bar constant, for it can only be varied by the deliberate adjustment of the handle F—Fig. 4. Hence the only consideration the pilot need give this aspect of the matter is to set the length correctly at the beginning of his patrol, and test occasionally thereafter for changes in the velocity of the wind.

As for direction, the bar S W has obviously to behave after the manner of a weather vane. An actual weather vane arrangement is, it may be supposed, impracticable. A gyroscopic attachment naturally suggests itself, but in the Wimperis sight no attempt is made to obtain the directional adjustment of the wind bar automatically. The means adopted are based on the simple fact that if the wind is coming from, say, the magnetic west, the required condition will be fulfilled if at every alteration of the course the wind bar is adjusted by hand so as to point always 90 deg. east of magnetic north. Were the the magnetic needle strong enough, it might be coupled to the wind bar in order to effect the required movement when the course is changed. As it is not strong enough the manual agency of the pilot is called in to do the work.

To this end the pin on which the wind bar pivots is connected through bevel gearing to a shaft inside the air speed bar. At the rear end this shaft is squared and passes through the boss of a bevel wheel which is constantly in mesh with a bevel fixed to the pivot pin carrying the compass bowl. In this way any angular movement of the compass bowl produces an equal angular movement of the wind bar. A diametral wire carrying an arrow point is fixed across the mouth of the bowl just below the glass cover plate. This wire, known as the wind arrow, is set parallel with the wind bar during the construction of the instrument, and in all positions of the bowl remains parallel with the wind bar when the sight is in use. If, then, the wind is known to be coming, say, from the west, the pilot, each time he changes course, turns the bowl by hand so as to make the wind arrow—and therefore the wind bar B—point from the west relatively to the magnetic needle, which is supported at the centre of the bowl beneath the wind arrow.

In an ordinary compass the card is attached to the needle and moves with it. In the present arrangement the card, in the form of an annulus, is fixed on the underside of the glass cover of the bowl, the card and glass being mounted within an aluminium ring sitting on the lip of the bowl. The card, the glass and the aluminium ring form one unit, and by means of two toggle catches can be clamped to the bowl so as to move with it, or unclamped therefrom so as to permit of independent rotation relatively to the bowl and the wind arrow fixed across it. Let us suppose the wind is known to be coming from the west. Flying for the time being on any course, the pilot unclamps the card and turns it until the north point—coloured red for distinction—is over the north end of the magnetic needle—also coloured red. Holding the aluminium ring with the left hand so as to preserve this alignment of the card, he turns the bowl with his right until the wind arrow is pointing from the west, and thereupon clamps the card relatively to the bowl. On changing course at any time thereafter, the north point of the card swings away from the north end of the needle. By rotating the bowl the pilot brings it back into coincidence. Thus, by keeping "red on red" when the course is changed, the pilot preserves the direction of the wind arrow, and therefore of the wind bar constantly coincident with the direction of the wind. Once correctly set—provided, of course, there is no change in the wind—the simple movement indicated by "red on red" thus adjusts the sight for any change of the course.

The use of the instrument for navigation purposes can also be explained by reference to Fig. 3. Let us suppose that Y is the starting point of an aeroplane which it is desired to fly to a point W distant, say, 100 miles from Y, and lying south-east of it. Let us take the air speed of the machine at 105 miles an hour and the wind at 30 miles blowing from the west. The pilot must know the inclination of the line Y S to the north and south direction, for, in order to make good the course Y W, he must hold the axis of his machine at the inclination of Y S and not of Y W. Setting the wind bar to 30 and the air speed bar to 105, he unclamps the card, and holding "red on red," turns the bowl until the wind arrow is pointing from the west. Clamping the card and continuing to keep "red on red," he manœuvres his machine until the

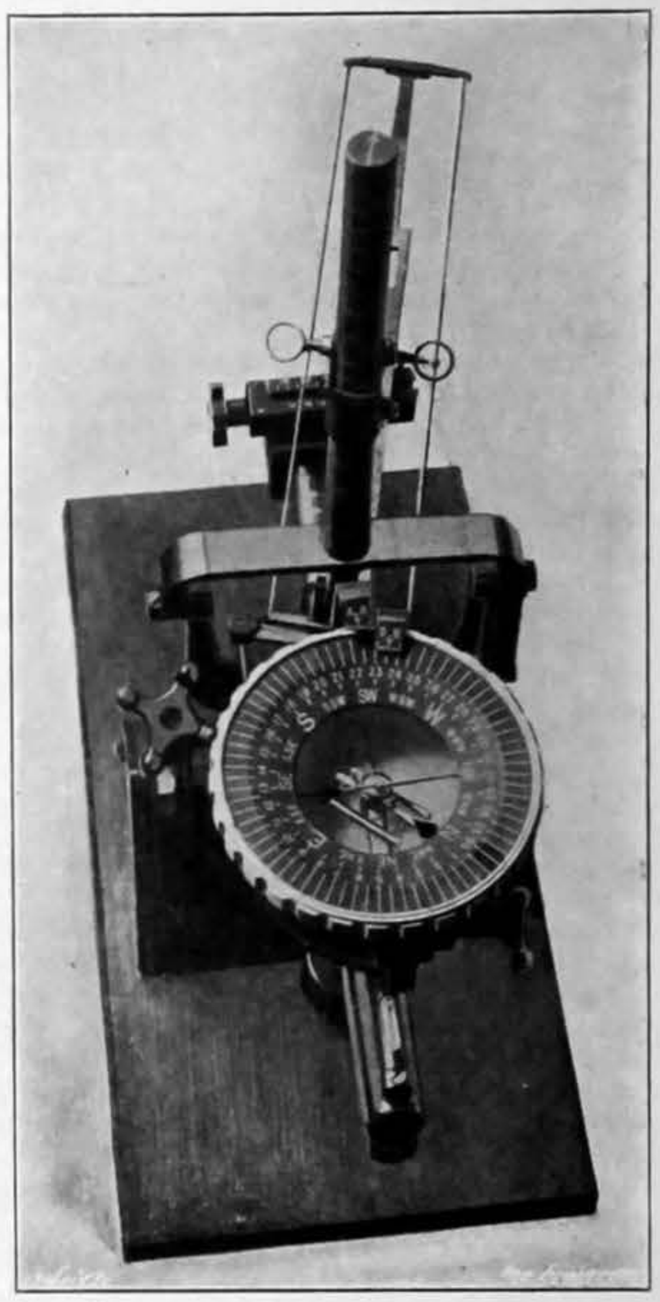


FIG. 5—VIEW OF BOMB SIGHT AS SEEN BY PILOT

drift bar is pointing south-east, *i.e.*, at 135 deg. relatively from the north. The air speed bar will then point in the direction of Y S, and taking the reading indicated on the card—namely, in this case, 147 deg.—he transfers it to his navigating compass and holds the machine to it. At the same time he can read his ground speed—namely, 120 miles an hour—and the time required to cover 10 miles—namely, 5 min.—on the scales engraved on the drift bar.

Arriving at his objective, he turns his machine round for the homeward trip. Holding red to red, he manœuvres until the drift bar is pointing nort-west, or to 315 deg. He will then find that the air speed bar is pointing to 304 deg., that his ground speed is 78 miles an hour, and that he will take 7¾ min. to cover 10 miles.

To enable the pilot to determine readily when the drift bar is pointing in a given direction, an index G is arranged to project over the edge of the compass card. This index is connected by a parallel motion with the drift bar in such a way that when the drift bar is swung through an angle α to one side or the other of its median position, the index moves round the circumference of the card through an angle α relatively to the axis of the compass bowl. Again, to enable the pilot to determine in what direction the air speed bar is pointing, a fixed index H, projecting over the edge of the card, is provided and serves substantially as a lubber line.

In the example of course-setting given above it is perhaps worth noting that had there been no wind the out-and-home journey would have been covered in 1 hour 54 min. With the wind as stated, the double trip, it is apparent from the figures given, takes 2 hours 7 min. These figures illustrate the well-known fact that no matter in what direction the wind is blowing, an out-and-home trip always takes longer than it would if wind were absent. This statement is true even if the wind is blowing exactly parallel with the course to be made good.

The Nickel Industry of Canada.

(*By a Correspondent.*)

From an industrial point of view nickel must be regarded as one of the "younger" metals, for its industrial history begins about the middle of the nineteenth century. In 1875 nickel ore deposits previously discovered in the French Pacific island of New Caledonia began to be exploited on a considerable scale and the production of nickel soon increased beyond the requirements of consumers. In 1887 the newly discovered nickel ore deposits of Sudbury, Ontario, began to deliver the metal. The first important mining was done in 1886 by the Canadian Copper Company, but the extent and richness in nickel of these Ontario deposits was not realised till some time later. It was soon found that at Sudbury, nickel ore deposits existed which dwarfed all others into comparative insignificance, and that from being a comparatively rare metal, nickel would henceforth be available on a scale comparable with some of the so-called "common" metals. To-day the Sudbury nickel ore deposits are responsible for about 80 per cent. of the world's requirements.

The enclosing rocks at the Sudbury mines are of a character to make the mining of the ore quite an ordinary mining task. Some of the outcrop ore bodies were at one time worked as open pits, but this method of working has now been superseded by shafts and drifts underground.

The stoping method adopted is chiefly that known as shrinkage stoping, in which a block of ore between two levels is attacked at the bottom and broken on to a floor beneath, only enough ore being taken away to give room to the men engaged in breaking it down. When all the block has been broken down, the stope may be regarded as an ore bin filled with broken ore, which can be drawn off through chutes at the bottom as required. The ore as mined is coarsely crushed in rock breakers and subjected to a partial calcination, usually in heaps in the open air. The fines are better calcined in a reverberatory furnace. The object of this partial calcination is to remove a part, but not the whole, of the sulphur in the ore. Enough sulphur must be left for the subsequent operation, which consists of smelting the ore in a blast-furnace with coke and a suitable flux. The products of smelting are a slag which contains a large proportion of the iron originally present in the ore, as a silicate, and a mass of mixed sulphides of nickel, copper and iron, which collects at the bottom of the furnace and can be tapped independently of the slag. The smelting is thus a concentrating operation by which the valuable part of the ore is separated from the worthless gangue material. The next stage consists of "bessemerising," in which the mixture of molten sulphides is subjected to an air blast in a converter in the same manner as molten iron is de-carburised, but in this case the purpose of the operation is to convert the iron sulphide to oxide, which is slagged away, leaving a "matte" rich in nickel and copper sulphides, but low in iron. This matte also contains practically all the precious metals originally present in the ore. The next stage in the treatment is the separation of the nickel and copper in the matte, which is a metallurgical problem of some difficulty, and one which adds largely to the cost of nickel recovery from its ores. Numerous methods have been suggested from time to time to effect this separation, but of them three main processes have survived, all of which are being used at the present time for separating and refining the metals contained in the Sudbury matte. The International Nickel Company, which handles by far the largest proportion of the Sudbury nickel output, use a method known as the Orford process. In this process the matte is fused with sodium sulphide, which dissolves the sulphides of iron and copper, allowing the heavier nickel sulphide to settle out from the fused material. The two products can thus be tapped off from the furnace separately. Usually the separation is not complete at the first melting, but if the melting be repeated once or twice a nickel sulphide free from copper can be obtained.

The nickel sulphide is roasted to oxide and reduced with carbon in oil-fired furnaces. The mixture of sodium and copper sulphides is leached with water by which sodium sulphide is recovered and made available for subsequent use, and the copper sulphide is smelted to blister copper which is electrolytically refined.

Another process successfully employed for refining nickel matte is that known as the Mond process. This is the invention of that talented scientist, Dr. Ludwig Mond, the originator of the ammonia alkali industry and the discoverer of Mond gas, &c. This process is in operation at one place only, namely, Clydach, near Swansea, to which works the matte is shipped from Canada. This process is one of great ingenuity. Up to the obtaining of a nickel-copper matte low in iron the procedure is the same as for the Orford process, but from that stage the procedure is quite different. The bessemerised matte is roasted to expel sulphur, and the oxidised product is then leached with a 10 per cent. sulphuric acid solution. The sulphuric acid exercises a selective action, taking up the copper chiefly. When about 70 per cent. of the copper has thus been dissolved out, the remainder is washed free of acid and transferred to towers which can be heated to 350 deg. Cent. The material, in the form of powder, is made slowly to descend these towers, meeting an up-flowing stream of water gas, by which, at the above temperature, the nickel and copper oxides are reduced to their respective metals. From these towers the material is conveyed to other towers in which a temperature of 80 deg. Cent. is maintained. It here meets a stream of producer gas which is rich in carbon monoxide. A chemical combination takes place between the nickel and carbon monoxide, resulting in the formation of a volatile product known as nickel carbonyl, which has the formula $Ni(CO_4)$. This compound, mixed with the producer gas, is then passed through vertical cylindrical chambers heated to 200 deg. Cent. internally. At the temperature employed the nickel carbonyl is decomposed into nickel and carbon monoxide, and the products of decomposition are made to pass through a mass of nickel granules on which the nickel is collected as concentric layers. When the granules reach a given size they are screened out, and small granules are added to replace them. The nickel obtained in this process is practically pure. A copper-nickel residue remains, which is again worked up to the desired proportions of the two metals and thus enters the towers again. The copper solution obtained in the sulphuric acid treatment is evaporated to obtain copper sulphate crystals, which find a ready sale as such. The precious metals become concentrated in the residues until they have formed a rich product, which is treated separately for their recovery. It is obvious that this process requires high technical supervision, and probably for this reason it has not been adopted by other refining metallurgists.

The third process of refining nickel matte is of Norwegian origin, and bears the name of its inventor, Dr. Hybinette. This process has been adopted by the British America Nickel Corporation, which was formed with a view to treating the matte to obtain metallic nickel in Canada. The British Imperial Government was, and may still be, financially interested in this Corporation, and its action in this matter from a commercial standpoint was the subject of severe adverse criticism by a Committee on Expenditure which investigated the transaction.

The Hybinette process consists of grinding and roasting the matte to expel sulphur, leaching out a portion of the copper with a 10 per cent. acid solution and melting the residue to form anodes containing about 65 per cent. of nickel. An electrolyte is prepared by dissolving nickel sulphate in the proportion of 45 grammes of the sulphate to the litre of water, and this is used for recovering the nickel from the anodes by electrolysis. A direct current is employed at a voltage of 160 to 170. As electrolysis proceeds and the anodes dissolve in the electrolyte, an enrichment of copper takes place, and when this reaches 2 to 3 grammes per litre, the electrolyte is passed over waste anodes. The copper is precipitated from the solution as cement copper on the nickel in the anodes, the nickel acting in the same manner as the iron used in copper precipitation from weak copper solutions in mine waters and other copper-bearing liquors. At the same time an equivalent quantity of nickel is taken into solution which restores the electrolyte to its required composition. The nickel obtained by this process is upwards of 99 per cent. fine. The precious metals become concentrated in the anode slimes from which they are periodically recovered. The process is said to be quite satisfactory. For the moment it is suspended in Canada because of the depressed market for nickel.

The nickel obtained by these various processes finds its way to market in various forms, depending to some extent on the preferences of the buyers. They include (*a*) grains, rondelles, or powder reduced from nickel oxide; (*b*) concentric layers deposited round a nucleus from nickel carbonyl; (*c*) cathode sheets resulting from electrolytic deposition; (*d*) blocks of the metal made by reducing nickel oxide at a temperature above the melting point of nickel; and (*e*) malleable nickel, which is nickel which has been de-oxidised by metallic magnesium. The block form is the one chiefly used by steel makers. But for rolling, forging and drawing it is necessary to use malleable nickel.

The refining of Canadian nickel until recent years has been entirely carried out either in England or the United States. As the result of local pressure and the representations of the British Government, refineries have now been established in Canada, in which a part, at any rate, of the annual production of matte can be treated. The International Nickel Corporation commenced to refine nickel matte at Port Colborne, in Ontario, in 1918, and this plant has an annual capacity of about 5000 tons of refined nickel. The British America Nickel Corporation also has a refinery at Deschenes, on the Ottawa River in Quebec Province, with an annual capacity of refined nickel of about 7500 tons, which, it is said, can be increased at comparatively little cost.

The Uses of Nickel.

Nickel is one of the most useful of the non-ferrous metals, whether unalloyed or in combination with other metals. Its anti-corrosive properties make it particularly suitable for cooking utensils and for many items of laboratory equipment. It is the standard metal for electro-plating for which it has no rival in commercial work. Many European and other countries employ nickel as coinage, sometimes with, and sometimes without, alloying. But it is estimated that upwards of 75 per cent. of the total output is used as an alloying agent in "nickel" steels. This term covers extremely varied products of iron carbon and nickel and also products which contain in addition manganese and small proportions of other elements. For general engineering purposes simple nickel steels (iron carbon and nickel) containing from 2 to 4 per cent. of nickel are perhaps the most important; but nickel-chromium steels are coming into extended use owing to their remarkable properties. Nickel-copper steels, in which the copper constituent is kept at about one-third of the nickel present and does not exceed 1 or 2 per cent. in all, show excellent mechanical properties, giving a tensile strength up to 150,000 lb. to the square inch with very considerable ductility.

Steel containing nickel and also chromium and molybdenum is a material with very remarkable physical properties. According to M. H. Schmid, who recently read a paper on the subject before the American Society for Testing Steel, a steel of the following percentage composition was tested, with results given in the table below. Carbon, 0.22 to 0.30; manganese, 0.50 to 0.70; silicon, 0.10 to 0.20; chromium, 0.70 to 0.90; nickel, 2.75 to 3.25; molybdenum, 0.30 to 0.50; and about 0.030 each of sulphur and phosphorus. This steel was drawn at various temperatures after quenching in oil at 1450 deg. Fah.

Drawing temperature. Deg. Fah.	Elastic limit.	Ultimate strength.	Elongation, per cent.	Reduction in area, per cent.	Brinell hardness.
500	233,000	249,800	14.0	46.8	455
900	170,000	189,200	16.0	51.6	363
1000	161,000	180,700	18.5	58.3	344
1100	149,000	166,800	18.5	60.0	328

High nickel steels are made having special properties. One of these is the steel known as "invar," which possesses the special property of varying in volume but very slightly with change of temperature, and being thus an ideal material for measures of length. The nickel proportion in this steel is about 36 per cent. Another alloy containing 60 per cent. nickel, 12 per cent. chromium, and 26 per cent. iron is known as "nichrome." It retains its strength and properties at high temperatures, and is of special value as an electrical resistance element.

Nickel forms valuable alloys with copper known as cupro-nickels. The best known of the nickel-copper alloys is perhaps the very valuable material known as "Monel" metal, which is obtained directly from the smelting and reduction of the Sudbury ores, the nickel and copper being reduced without separation. Monel metal is a silver-white alloy, and it takes a brilliant polish. It can be cast rolled and treated in various ways like copper and steel. It is as malleable as copper and can be drawn into the finest wire. It is also highly resistant to corrosion either by sea water or at high temperatures. Its tensile strength varies from 70,000 lb. to the square inch for castings to 110,000 lb. for cold drawn rods. It is being used in large quantities for a large number of purposes for which no other metal or alloy is equally suitable.

A series of investigations by Leon Guillet, recently reported, on the effect of nickel in low copper brasses, has established the fact that a small amount of nickel can replace a much larger quantity of copper in such brasses with considerable advantage to the mechanical properties. Some of these have ultimate strength up to 90,000 lb. to the square inch and 20 per cent. elongation. The results of these researches are said to show that nickel is destined to play the same important *rôle* in the manufacture of brass as it does in steel.

The non-ferrous alloys of nickel include a very large number of other highly useful and valuable materials, which, however, cannot be dealt with within the limits of this article. New alloys of this type and new properties of those already known are of frequent discovery.

The chemical compounds of nickel of industrial importance are not numerous. Nickel oxide is used in the manufacture of certain kinds of pottery glazes and for a number of minor purposes. The double sulphate of nickel and ammonium is the salt chiefly employed in nickel electro-plating, and the cyanide is also used for the same purpose. Nickel salts are also employed in small quantities in the dyeing industry, but only when cheaper substitutes cannot be used.

As a catalytic agent, nickel in the form of the finely divided metal, and also as certain organic salts, is of great importance in the "hardening" or hydrogenating of oils to obtain from them solid fats. Other catalysts are known which act in the same way, but nickel is the only one so far known which is sufficiently active for commercial use.

The manufacture of margarine and also some other edible fats from oils such as palm oil and cotton seed oils depends upon this property of nickel. Another use for nickel in a catalytic capacity is in the enrichment of water gas and other gases of low calorific value. In this case the nickel brings about the production of methane from carbon monoxide and hydrogen under suitable conditions of temperature and pressure, thereby reducing the volume but greatly improving the fuel value of the gas.

A Seven-Day Journal.

Sheffield Manufacturers' Protest.

Considerable apprehension has been aroused among Sheffield manufacturers as to the provisions of the United States Emergency Tariff Act. The light iron and steel industries, especially the cutlery trade, will, it is feared, be seriously prejudiced by the increased duties, and it is probable that unless some concession can be obtained, the United States market may be closed to Sheffield manufacturers. So serious a view is taken of the possible effect of the new tariff proposals that a strong deputation has left Sheffield for Washington to put the case of the light iron and steel industries before Chambers of Commerce in the United States. On the broader question of the effect of the tariff on British trade the Federation of British Industries is, at the request of the Government, collecting information which will be placed at the disposal of the Board of Trade so that Government action may be taken if desired.

Salt Crystals for Magnifying Sound.

A good deal of interest has been aroused by the claims put forward in connection with the use of Rochelle salt crystals for magnifying sound. The suggestion that these crystals may be utilised to enable the deaf to hear should, however, be received with caution, and no claim in this connection is made either by the Western Electric Company, which is associated with the use of these crystals, or by the American Telephone and Telegraph Company, which is also interested. Experiments are being carried out in the laboratories of the new companies. All that is claimed is that the composite crystals of Rochelle salt possess the property of magnifying sound, and it is this property which has raised hopes that something may be achieved which will make it possible for deaf people to improve their hearing. Mr. E. Kilburn Scott, who gave a demonstration of what can be achieved with these crystals at the recent meeting of the Faraday Society, is extremely hopeful on this subject.

Glare in Factories.

There is no doubt that the introduction and extended use of high intensity gas-filled electric lamps in factories has accentuated the evils arising from glare which is as frequently a cause of eyesight strain and accident as defective illumination. The Departmental Committee which has been investigating lighting conditions in factory and workshop has made some definite recommendations on the subject. It is suggested that every light source having a brightness of more than five candle-power per square inch within a distance of 100ft. of any worker shall be shaded in such a manner that no part of the filament, mantle, or flame is distinguishable through the shade. An exception is made for conditions in which the angle between the line from the eye to an unshaded source of light and a horizontal plane is not less than 20 deg., or, in the case of any person working at a distance of 6ft. or less from the source of light, of not less than 30 deg. Means should also be taken to prevent direct reflection into the eyes of the worker, to obviate the formation of shadows, and to secure constancy in artificial illumination. As these recommendations, if adopted, would in many cases involve extensive alterations of the lighting system, the Committee proposes that a reasonable time should be allowed before the suggested requirements become operative.

Chemical Workers' Wages.

The ballot of the Federation of Chemical Workers on employers' proposals to reduce hourly rates of wages has proved hostile to the scheme put forward. It is stated that a ballot of 30,000 workpeople showed that only 434 were in favour of accepting the reduction, and that 10,500 voted against it. Employers have been notified that failing an adjustment of the situation the whole of the workers in the Federation will go out on strike on August 27th.

No Munitions of War.

It has always been recognised that it would be possible by an international agreement of workers to make war impossible by refusing to undertake the production of munitions. It is interesting to note, therefore, that the International Congress of Metal Workers, which has just been held in Lucerne, has unanimously adopted a resolution in favour of refusing to manufacture munitions of war.

St. Lawrence River Improvement.

An important scheme for the deepening of the St. Lawrence River at an estimated cost of £50,000,000 is dealt with in the report of the International Waterways Commission. It is proposed to deepen the river to enable ocean-going vessels to proceed as far west as the Chicago Port Arthur and Duluth. Two canals designed to straighten out the navigation of the river at Iroquois and Morrisburg, both in Ontario, are shown on the plan. These canals would have an average bottom width of 300ft. An associated development would be the laying down of hydro-electric plants to utilise the power of the St. Lawrence, which is estimated at about 5,000,000 horse-power. The advocates of the scheme justify the high costs on the ground that hundreds of millions of dollars a year would be saved to both the United States and Canada, and the belief is expressed that the water-power part of the scheme would repay the capital cost within a comparatively short period.

Synthetic Petrol.

Experiments are still being conducted with the object of finding substitutes for petrol. One of the latest announcements in this connection is that M. Mailhe, a professor of science at Toulouse, has succeeded in obtaining oil from flax which can not only be used for motive power in place of benzol or petrol, but in the manufacture of explosives, colouring matter and perfume. He expresses the belief that many other vegetable and animal oils can be used to produce synthetic petrol.

Wages Reductions.

Official statistics show that reductions of wages which came into force last month affected the earnings of about 3,600,000 workpeople. The payments of weekly full-time wages showed a decrease of over £1,000,000. Since the beginning of the present year there has been a reduction in the amount paid in weekly wages of about £2,765,000. The number of workpeople affected is nearly 5,700,000. Industries in which a reduction of wages took place last month were engineering, coal mining, railways and textiles.

Shoreham Mystery Towers.

The Shoreham Harbour Trustees have not yet succeeded in obtaining the removal from the harbour of the huge concrete towers which were constructed during the latter part of the war period for use in the English Channel. A strong protest was made at a meeting of the Trustees which was held in Brighton a few days ago, of the neglect of the Admiralty either to remove the towers, which are a hindrance to navigation, or to pay any sum by way of compensation or rent for the use of the harbour. It was decided to make a further application to Whitehall.

Large British Contract for India.

In view of the important orders which have been lost by the British engineering trades owing to the inability to quote prices which could compare with those of foreign firms, it is satisfactory to learn that Dorman, Long and Co., Limited, are to supply the steel for 105 miles of water mains in Bombay. The actual tenderer was a Calcutta firm, but it is understood that they are backed by the well-known Middlesbrough steel company. It was feared that American steel makers might be able to quote more attractive terms, but it is stated that in addition to the tender which has been accepted, the second lowest tender was also that of a British firm. The sum involved is about £2,500,000.

Labour View of Railways.

That the Railways Bill constitutes a revolution of the British railway system is the definite opinion of Mr. J. H. Thomas. By operating the companies in four groups, he believes that much waste will be eliminated, without any public inconvenience being suffered. He recognises that owing to trade depression the full advantages of the new system cannot be realised for some time to come, and expresses the hope that railwaymen will do their part to contribute to the improved efficiency of the service. The machinery set up will, in Mr. Thomas' view, tend to closer understanding between the officials and the men, and he reminds the latter that good conditions of service and wages can only be justified by good work. Government control gave the worst of both the competitive system and nationalisation.

London Traffic.

At a time when the railways have been handed back to private control, without the backing of a subsidy, the decline of traffic on the London Underground Railway and the associated omnibus business is causing some anxiety. Unless the second half of the present year shows an improvement on the first—which is not expected—it is probable that when the figures for the complete year are available a falling off of about 40 millions in the number of passengers carried by the railways may be recorded, and of 24 millions in the case of omnibus traffic. Some economies have been made in operating expenses, but the savings possible under that head are by no means proportionate to the decline in the volume of traffic handled. The wages bill, partly owing to actual increases, but also as a result of the fewer hours worked, has gone up by leaps and bounds. With less traffic to handle, the number of men employed on the railways has increased by one-third.

Shipyard Joiners' Strike Settled.

After fighting for eight months for the retention of wage rates which employers found it impossible to pay, the shipyard joiners have decided to resume work at the lower scale offered. There is to be an immediate cut of 6s. a week, and a further reduction of 3s. a week in October. The balance of 3s. to complete the 12s. which was the amount of the state of trade advance which has been in question, will be the subject of discussion with other matters in December. The curious feature of the situation is that carpenters and joiners in the important Belfast shipyards have long since accepted the wage reduction, and that men have been working at Portsmouth on ship repair work at lower rates than those now offered by employers. The strike has had disastrous results on the shipbuilding and ship-repairing trades, a great deal of work having gone to foreign yards which would, under normal circumstances, have been carried out by British firms. The direct loss in wages has been severely felt, and unemployment has been caused among many classes of shipyard workers, while British shipbuilding has received a blow from which the industry will take a long time to recover. There may be no connection between the two events, but it is a significant coincidence that the strike has collapsed contemporaneously with the announcement of the intention to close the Yarrow yard.

Imperial Wireless Chain.

The Postmaster-General opened yesterday at Leafield the first link in the Imperial Wireless Chain. The station has been designed for a range of 2000 miles at all times of the day under normal conditions. The next station to be completed will be that at Cairo, which it is expected will be put in operation in November. Plans for the other stations are now being prepared, and it is hoped that their construction will be commenced early next year, and that all the stations will be in operation within a period of two years. The stations for which plans are now being prepared are being designed for the use of wireless telephony as well as telegraphy.

Naval Engineering Interests in Russia.

It is reported from Copenhagen that negotiations between the groups owning the Vickers and Armstrong dockyards in Russia and the Soviet Government regarding the concession of the naval dockyard at Nicolaieff on the Black Sea are progressing satisfactorily. It is understood that all raw material which would be imported for carrying on the work of the dockyard would be imported at prices to be fixed by the Russian Commissioner for Foreign Trade, and that 25 per cent. of the output would be the property of the Soviet Government.

Welsh Water for Birkenhead.

The turning on of a new water supply from the Cross Hill reservoir for Birkenhead on Monday last marks the completion of a scheme of drawing water from Wales, the works in connection with which have been under construction for ten years, and have cost nearly £1,500,000. For the time being, owing to the delay in the completion of the filtration plant, the supplies from the new reservoir will be limited to 4,000,000 gallons a day, but ultimately 7,000,000 gallons a day will be available. The supplies are being drawn from the Alwen and Brenig reservoirs in South Wales, and it has been necessary to construct 42 miles of conduits between the reservoirs and the Cross Hill reservoir.

National Shipyards.

A report which has just been issued shows that the gross cost of the National Shipyards was £6,500,000, while the amount realised by sales and disposals was £2,431,263, leaving an estimated deficit of over £4,000,000. The method of disposing of oil tankers, which only realised an average price of about £24 per ton, whereas older vessels have been sold at prices ranging from £27 to £37 per ton, is criticised, and the opinion expressed that the arrangement for the sale of these vessels was not conducted on a business-like footing. While criticising these transactions, however, the Committee does not dissent from the opinion expressed by the Select Committee on National Expenditure that the operations of the Ministry of Shipping have as a whole been conducted with marked efficiency and with very satisfactory results financially.

Developments in Power Station Design.

No. V.*

One of the firms which is now giving a good deal of consideration to the development of efficient steam-raising plant and to firing boilers with pulverised fuel with a view to their use in power stations is that of Fraser and Chalmers, Limited, of Erith. It may be remembered that some years back the firm developed the Bettington boiler with vertical tubes, a combustion chamber inside the nest of tubes and a pulverised fuel burner for injecting the fuel through a nozzle upwards into the combustion chamber. The objects of using pulverised fuel were those already mentioned, namely, to provide for intimate contact of small fuel particles with the air, so as to obtain complete combustion, and to reduce the amount of excess air, and thus increase the combustion temperature so as to make the boiler give a high efficiency. A drawing of the boiler is given in Fig. 12, and the tables below give the results of tests made on it in its original form. Fig. 13 is a CO_2 recorder chart.

Since the original Bettington boiler was developed it has been improved in various directions, and it is now manufactured for high pressures. The principal characteristic of the modern boiler is that the headers are composed of small circular drums, which can be built for high pressures and high temperatures. The boiler can, if necessary, be fired with gas, colloidal fuel or oil, but it is the opinion of the makers that the two latter fuels are not likely to be used to any great extent. Prior to the introduction of the Bettington boiler in 1905, pulverised fuel had been used in connection with various existing boiler installations, but with little success, the furnaces and flues, it is said, choking up very rapidly, especially when the coal contained a high percentage of ash. Furnaces constructed to burn pulverised fuel borne on currents of air work with a certain critical rate of propagation of flame from layer to layer, and if the rate of travel of the material slightly exceeds that speed, the combustion wave gradually creeps in the direction of the flow of the material, and finally goes out. This, the makers of the Bettington boiler contend, is a common fault of furnaces using pulverised coal or other fuel in which the gas, products of combustion or unburnt fuel and the supporter of combustion are not directed back on themselves during combustion, and the trouble is attributable to the fact that every mixture has a definite but slow velocity of flame propagation. The moment the velocity of the incoming mixture exceeds that of the combustion wave the latter creeps forward, and the flame is extinguished. The velocity of the combustion wave depends upon the inflammability of the dust, and it increases with the volatile matter and moisture contained in the fuel and the temperature of the mixture. The velocity of the incoming material and the temperature of the mixture are the only factors that can be varied in order to secure a stationary combustion wave. By causing the mixture to turn upon itself and spread out in a circular or cascade form in a vertical and circular combustion chamber, not only are a regenerative action secured, and the point of ignition brought close to the point of admission, but the act of changing the direction of the flow of gases changes the velocity of portions of the stream, and the returning products of combustion and burning material in doubling back envelop the incoming material, so as to form a layer between the incoming stream of the igniting and burning material in such a way as to produce a protecting body for the walls of the furnace, thereby extending the life of the furnace and preventing a blow-pipe action upon the walls.

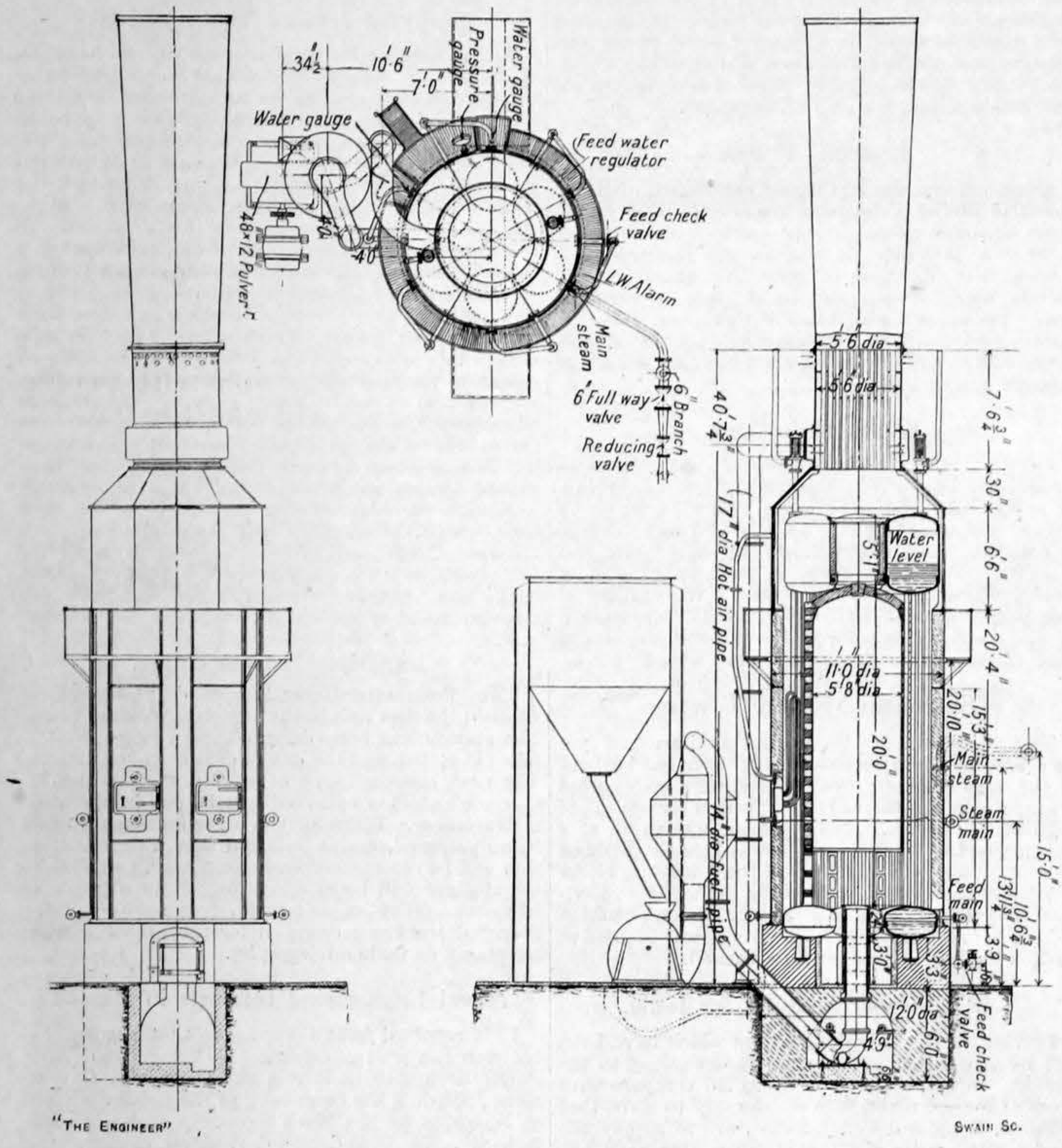


FIG. 12—THE BETTINGTON BOILER ARRANGED FOR BURNING PULVERISED COAL

Results of Test in the Original Bettington Vertical Boiler Fired with Pulverised Coal.

Coal used	O.R.C. nuts.	"Dant." Clifton and Kersley.	"Dant." Ellesmere.	South African. Partings	South African. Pickings	South African. Duff.	Welsh. Anthracitic duff.	Wetbank slack.	Wetbank slack.
Analysis (on dry coal)—									
Ash	22.18	23.00	21.12	22.58	21.30	19.92	12.64	17.89	17.89
Volatile matter	25.97	20.00	26.46	27.38	27.68	22.94	11.66	23.40	23.40
Sulphur	—	—	3.13	0.85	0.95	0.76	0.99	—	—
Fixed carbon	51.85	57.00	52.42	50.04	51.02	57.14	75.70	58.71	58.71
Calorific value on dry coal, B.Th.U.	8710	10,700	11,250	10,098	10,494	11,088	12,276	11,109	11,109
Ditto, expressed as pounds water, evaporated from and at 212 deg. Fah.	9.01	11.08	11.65	10.45	10.86	11.48	12.71	11.5	11.5
Absolute steam pressure, pounds per sq. in.	140	164.5	164.8	152.3	152.15	130.45	151.1	189	189
Average temperature gases escaping from boiler, deg. Fah.	514	592.7	658.8	558.3	587.5	603.7	560.3	—	—
Average temperature feed water, deg. Fah.	76.6	—	56.6	56.0	56.0	56.0	57.2	77	78
Pounds dry coal fired per hour	1084	1020	1179.2	1183.3	1347.8	1183.5	1242.2	3676	3372
Pounds of water evaporated per hour, from and at 212 deg. Fah.	8495	8476.8	10,290.4	9437.2	11,321.4	10,909.5	11,776.4	34.000	32.000
Ditto, per pound of coal, from and at 212 deg. Fah.	7.15	8.309	8.726	7.975	8.40	9.218	9.48	9.27	9.50
Thermal efficiency based on coal	79.3	75.0	74.9	76.31	77.35	80.30	74.59	80.6	82.6
Percentage of moisture in coal during test	8.66	15.6	2.00	1.6	2.00	2.4	0.8	2.20	2.20

Results of Three Tests on a Bettington Boiler at Different Rates of Evaporation and Without an Economiser.

	Low rate.	50 p.c. overload.	100 p.c. overload.
Coal used	Broomhill nutty slack	"Griff" fine slack (Nuneaton)	Broomhill nutty slack
Rate of coal feed per hour, lb.	897	2,078	2,733
Pounds cold feed water evaporated per hour	6,828.6	11,790	17,307
Feed temperature, deg. Fah.	60	50	64
Absolute pressure, lb. per sq. in.	165	166	165
Superheat, deg. Fah.	130	195	168
Temperature of escaping gases, deg. Fah.	580	698	750
Equivalent lb. water evaporated and superheated from and at 212 deg. Fah. per hour	8,714	15,621	22,374
Equivalent lb. water evaporated but not superheated, from and at 212 deg. Fah. per hour per sq. ft. water H.S.	3.91	6.83	9.88
Pounds water evaporated per lb. coal from and at 212 deg. Fah.	9.71	7.55	8.18
Horse-power developed by boiler (Centennial Standard)	253	454	650
CO_2 per cent., by "Sarco" recorder	12.5	12.83	17.5
Analysis of dry coal—			
Ash, per cent.	14.33	16.2	14.33
Volatile matter, per cent.	32.55	16.57	32.55
Sulphur, per cent.	0.99	0.93	0.99
Fixed carbon, per cent.	52.13	66.3	52.13
Net calorific value, by Bomb calorimeter, B.Th.U.	11,870	9,648	11,870
Efficiency of boiler, per cent.	79	75.6	66
Percentage of moisture in coal as fired	3.85	14.39	3.85

The regenerative and enveloping action enables a material low in volatile gases to be used, the substantially pure carbon being raised to the necessary temperature for combustion by the enveloping products of combustion. In other forms of furnaces, the makers explain, this initial heat must be supplied by an inflammable gas or by the volatile constituents of the coal, such as the hydro-carbons, in conjunction with the heated walls of the furnace. When burning carbon, coke, anthracite coal, wet coal or low-grade coal containing low volatile combustibles, the regenerative and enveloping action is claimed to be of considerable importance. The fact that the heat required to ignite the incoming material is derived principally from the hot products of combustion, which when returning flow back adjacent to the material, and in the opposite direction, ensures the maintenance of a hot zone near the point of entrance of the material, and it is therefore evident that the heat for ignition is supplied almost entirely to the incoming material from the returning products of combustion and burning material.

In the past, the makers explain, there have been difficulties in the direction of pulverising the fuel sufficiently finely, and difficulties because the ash becomes melted into a slag, but primarily with the refractory material, which is required to withstand the high temperature without melting. In the furnace of the new Bettington boiler the last-mentioned difficulty has been overcome by the special design of the vertical combustion chamber, in which the material is kept in suspension until complete combustion is effected. Moreover, the incoming material and supporter of combustion are to some degree insulated at the region of most energetic combustion by the enveloping or adjacent current in the opposite direction. The ash is deposited in a space at the base of the boiler, after it has been partially cooled and separated from the brickwork lining, whilst the products of combustion as hot gases are brought into contact with the furnace lining and give up a portion of their heat, by transmission through this lining, to the boiler elements surrounding the lining.

The heating up and continuous ignition of the incoming stream of dust and air are brought about mainly by the enveloping sheath of products of combustion composed of a mixture of gases, principally CO_2, H_2O and N, and at a temperature of about

* No. IV. appeared August 12th.

3500 deg. Fah. Ignition is independent of the incandescent brickwork. Experiments have shown that the point of explosion does not rise more than 10 per cent. with the highest feed velocities it is possible to employ. The tendency is for the enveloping gases slightly to increase in temperature as the velocity is increased, and these returning gases always ensure that the brickwork around the point of ignition is incandescent. With gravity and momentum acting in the same direction, no separation can take place in a continuous stream of mixture, no matter what difference there may be between the weights of its constituents. The amount of air used in a completely closed circuit, no distillation or loss of hydro-carbon can occur. It is said to be possible to dry coal containing 10 per cent. of moisture without the least difficulty. The product delivered to the boiler usually issues from the nozzle at a temperature of about 200 deg., but this, of course, varies slightly with the quantity of moisture originally contained in the fuel. Slides are provided in the pulveriser inlet for regulating the amount of air required for complete combustion, and the coal feed is operated by means of a variable speed friction wheel driven from the pulveriser shaft. Adjustable slides are also fitted in the feed hopper. Usually the

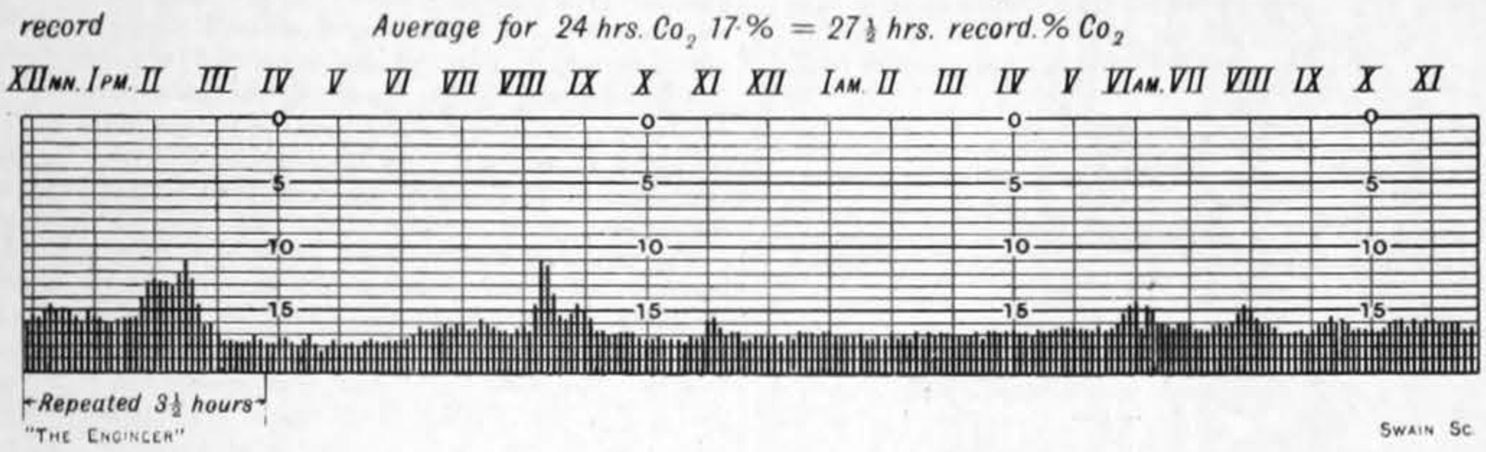


FIG. 13—CARBON DIOXIDE RECORDER CHART

can be reduced to the minimum required for the chemical reaction involved, the carbon contents of the fuel, and the safety factor of the refractory material employed.

In most pulverised fuel plants it is usual to employ a separate drying plant in addition to the pulverising plant, but in the case of the Bettington system the pulveriser is made to serve for drying and blowing, in addition to pulverising the coal. Beaters operating in conjunction with vanes are mounted upon a shaft within a chamber, with the inner wall concentric for the greater part of its circumference to the axis of rotation, and a separator is combined with the pulveriser is driven directly through a flexible coupling by an electric motor or small steam turbine, but it is obvious that it can be driven in other ways, according to local conditions.

The boiler itself consists of mild steel top and bottom headers connected together by solid drawn steel tubes, the number of sections formed in this manner depending upon the capacity of the unit. To facilitate cleaning and inspection, each header is provided with a manhole cover, the top headers being also fitted with a number of steel caps to enable the tubes to be withdrawn. Each header is connected by equalising tubes in the steam and water spaces, so as to

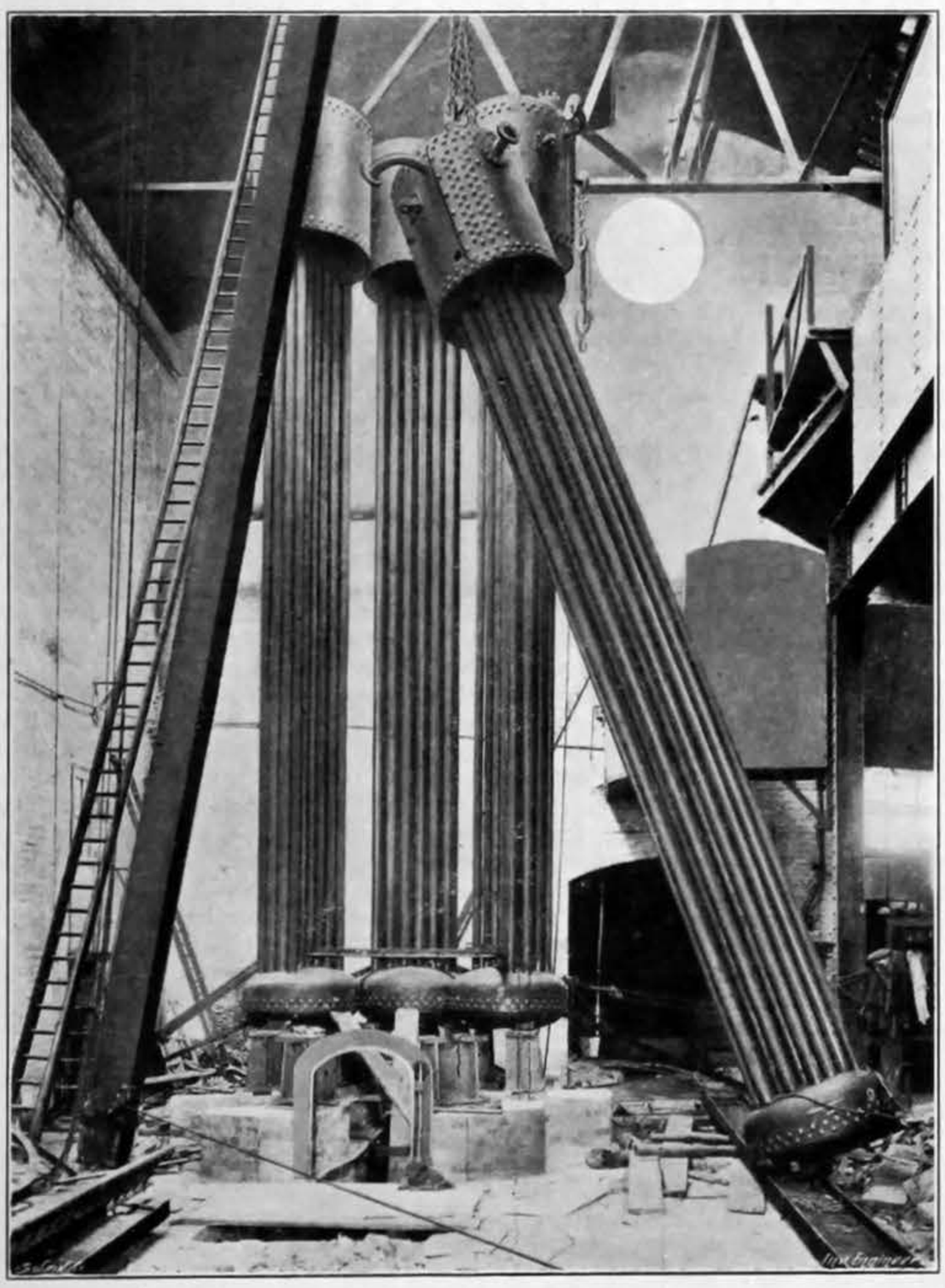


FIG. 14—BETTINGTON BOILER IN COURSE OF ERECTION

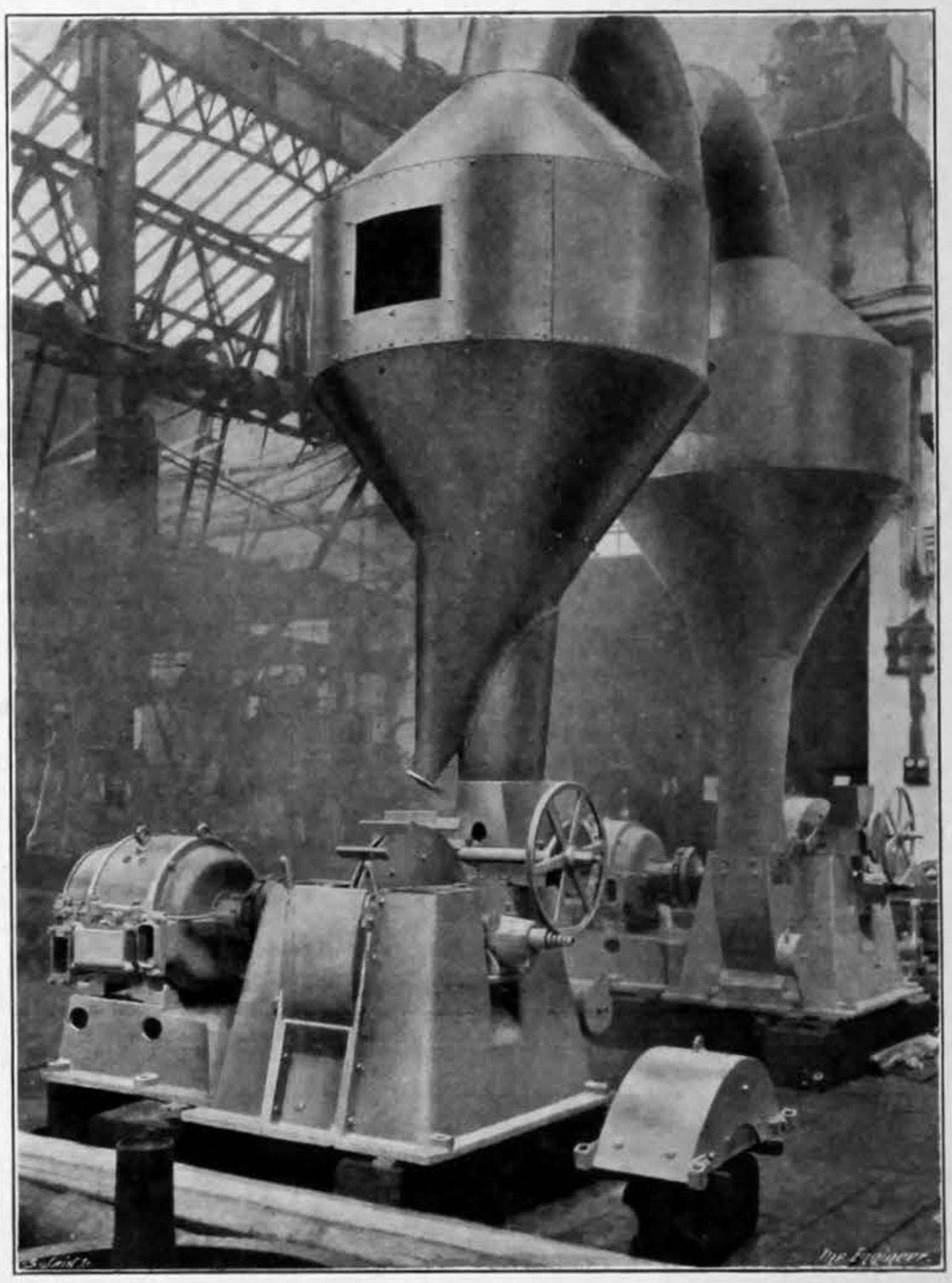


FIG 15—FUEL PULVERISER

grinding element for segregating the ground particles. This separator is mounted directly on the discharge side of the pulveriser and forms the complete pipe line for the fuel delivery to the boiler. Eighty-five per cent. of the pulverised fuel will pass through a 200-mesh screen. Hot air at a temperature of 450 deg. Fah. is drawn from an air heater, fitted at the base of the chimney, directly into the suction side of the pulveriser, where it intermixes with the coal, and as the amount of coal to be dried is only the quantity which is being blown into the boiler per minute, the drying can easily be done in this short period. Moreover, as the drying is done close by the boiler and ensure a constant flow, and is also provided with a steam outlet pipe which is connected to one of the sections of the superheater, the whole being mounted together to form a complete boiler unit. If one of the sections of the superheater fails it can immediately be withdrawn, and by the introduction of a short make-up pipe the boiler can again be put into service. Any one of the boiler sections can also be taken out by removing the outer casing and a spare section can be put in its place.

The boiler is now designed for pressures up to 500 lb. per square inch and for a superheat of 300 deg. Fah. The greatest amount of evaporation takes place in the inner row of tubes, and the circulation is very rapid. As the tubes are vertical, the amount of scale deposit is small, and any loose scale formed is ejected by the rapid circulation into the bottom header where it can readily be blown out. Similarly, as all the tubes are vertical and straight, soot or dust does not accumulate on them. As each tube is directly connected to the steam header, there is a very large surface for the liberation of steam, and no possibility of steam pockets. Owing to the symmetrical construction and concentric method of firing these boilers, it is claimed that all differential stresses are eliminated, and that no abnormal stresses are set up when the boiler is working at its maximum rate.

Briefly, the advantages claimed for the boiler are improved efficiency in fuel consumption, economy in labour, saving in space, rapid steaming, elasticity in capacity, and the possibility of using cheap and inferior coal. Owing to the high temperatures and to the complete combustion of all the fuel in a large combustion chamber, the boiler is said to be smokeless at all rates of firing. We are informed that experience has shown that it is possible to work the boiler continuously with 17 per cent. of CO_2, and that the thermal efficiency ranges between 79 and 82 per cent.

A Bettington boiler in the course of erection in Messrs. Fraser and Chalmers' works is shown in Fig. 14, and Fig. 15 shows a pulveriser.

The First Motor Ship with Double-Acting Two-stroke Engines.*

On the expiration of the Diesel master patents in the years 1909/10, a boom in marine motor building was anticipated by, among others, the Maschinenfabrik Augsburg-Nürnberg and Blohm and Voss. These firms accordingly jointly founded a research association for the purpose of developing the engine to the dimensions requisite for its use in warships. The double-acting two-stroke engine, it was held, could alone be expected to fulfil the object in view. It was decided to start by building small units, so that the problem might be studied with a minimum of expenditure. In order that the experiments should not be confined to the testing shop, but be extended to ascertain the suitability of this new type of engine for practical mercantile marine work, a twin-screw cargo vessel of 1863 net register tonnage was built by Blohm and Voss, to be fitted with engines of the class in view. The first set of engines constructed for

* From an article by R. Dreves in a recent issue of *Zeitschrift des Vereines Deutscher Igenieure.*

this vessel was not installed on board, cracks having formed in the cylinders during the shop tests. The engines were accordingly used for experimental purposes, and to gain experience for the construction of the next set.

The new engines had three working cylinders of 480 mm. diameter and 710 mm. stroke, and developed 830 brake horse-power at 120 revolutions per minute. The injection compressor was of the three-stage type, and was driven from a crank on an extension of the main crank shaft. The cylinder diameters were 510 mm., 445 mm. and 115 mm. respectively, with a common stroke of 350 mm. The three scavenging pumps, 650 mm. diameter by 500 mm. stroke, were driven by rocking levers from the crossheads of the three working cylinders, while the fuel pump, 18 mm. diameter by 60 mm. stroke, was driven from the cam shaft through excentrics. The rocking levers of the first and third cylinders also drove two bilge pumps and two pumps for the piston cooling water.

In designing the engine, the essential feature considered was reliable running, everything else, such as weight, cost of construction and to a certain extent fuel consumption, being subordinated thereto. The only condition laid down as regarded weight was that it should not exceed that of a steam engine set of equal capacity. Consequently, not only the bearings, but also such other parts as the base plate, standards, &c., were carried out in unusual dimensions; in fact, if the saving of weight had been any consideration, these parts could have been reduced by at least 50 per cent.

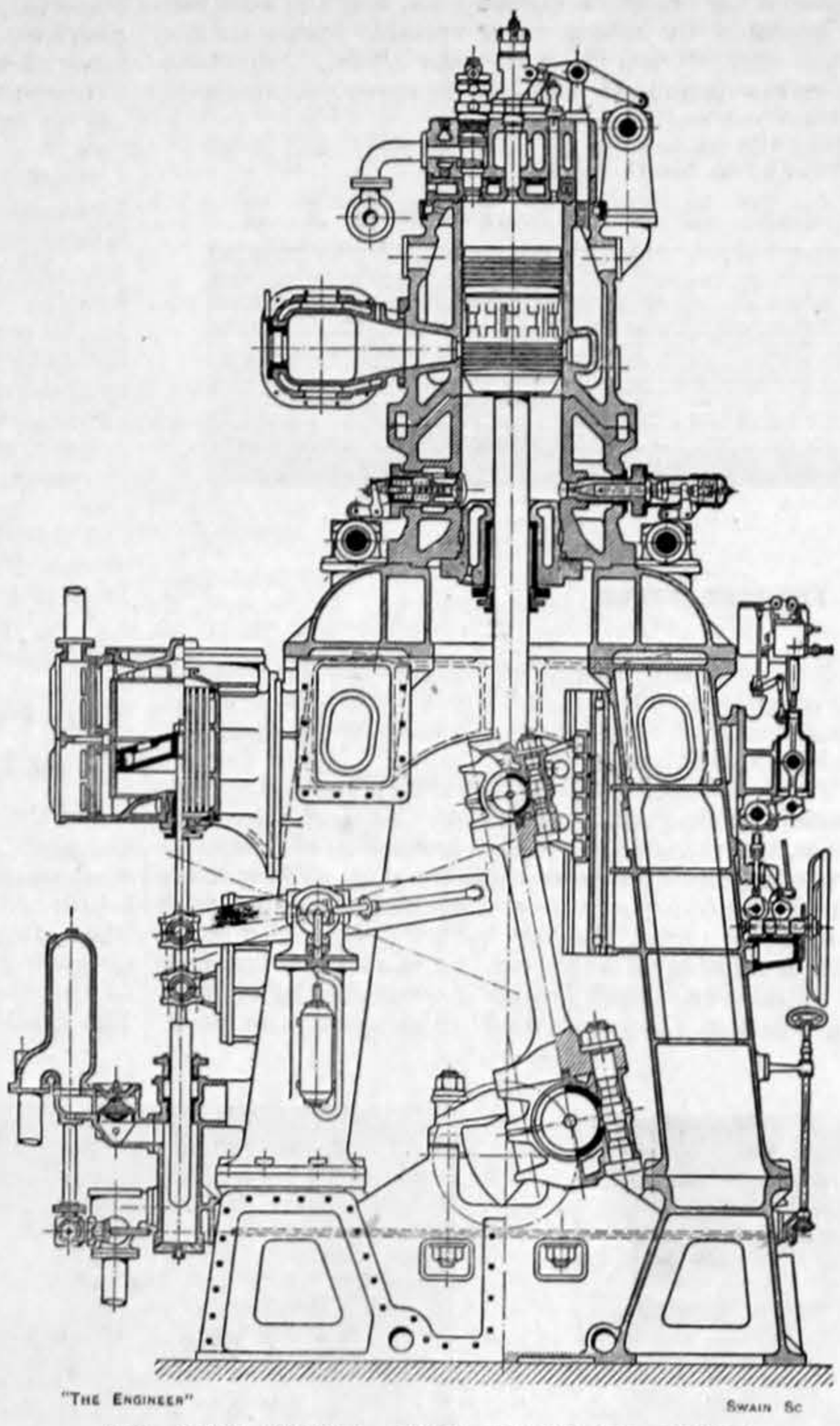
The crank shaft was divided into three sections—according to the usual practice in marine engines—and had two bearings between each successive pair of cranks. In this way, the load on the bearings was kept down very low, and as a consequence of these favourable load conditions, the bearings ran without forced lubrication just as reliably as do those of steam engines.

The working cylinders—as indicated in the accompanying engraving—were built in two parts. The cylinder foot, which served as a stiffening cross piece for the standards, carried the lower section of the cylinder, which was closed at the bottom by an inserted cover. The valves for the upper end of the cylinder were mounted in the top cover in the usual way, and comprised a starting valve, a fuel valve, two scavenging valves and a safety valve. The valves for the lower end consisted of two fuel valves, two scavenging valves, one starting valve and a safety valve. The working piston was made in two sections, the lower one being secured to the piston-rod by a cone and nut, and carrying the upper section, from which it was separated by two spacing discs, which allowed the volume of the combustion chamber to be adjusted. Each section had five self-tightening cast iron rings. The pistons were cooled with fresh water supplied to the cross head through articulated pipes mounted on the rocking levers of the scavenging pumps, the water passing from the crosshead through bends to a distributor at the lower end of the piston-rod, and through the hollow rod into the interior of the piston. The return flow was made through a tube suspended in the hollow rod back to the crosshead, and thence by way of a second articulated pipe into the re-cooler.

The valves were operated by cams, one cam shaft serving the upper valves, whilst two were provided for the lower valves—one in front and the other in rear of the cylinders. All three cam shafts were driven by worm wheels. For reversing, the two vertical shafts driving the cam shafts were fitted with couplings, which enabled the cam shafts to be turned through an angle of 35 deg. relatively to the main shaft, so that, when starting the engine in either direction, the cam shafts automatically assumed the proper angle of lag in relation to the main shaft. This turning of the cam shafts enabled double cams to be dispensed with, except for the starting valves. The fuel supply, and therefore the speed of the engine, was regulated by means of a hand wheel controlling the fuel pump suction valves. In the event of the propeller emerging in a rough sea, a governor shut off the fuel supply and prevented the engine from racing.

The engines were tested extensively, both in the shops and on board. Before erection in the ship, the first of the engines were put through a continuous six days' test, followed by a manœuvring run for twelve hours, reversing for three hours and four hours at slow speed. The fuel consumption amounted approximately to 8 oz. per brake horse-power hour, and the overall efficiency was 72 per cent. Taking into consideration the power absorbed by the scavenging pumps and the compressor, the mechanical efficiency was 89 per cent. For such comparatively small engines no better results could be expected.

In the tests on board ship, troubles and delays arose through the appearance of whirling oscillation to an extent unanticipated from previous experience. It was found impossible to run at certain speeds without endangering the whole equipment, unless these critical periods were traversed quickly. The conditions were aggravated by the circumstance that the full speed of 120 revolutions coincided with one such critical period, and in order to overcome this difficulty, considerable structural alterations had to be made. When these changes had been made, exhaustive measurements were taken with a Fraum torsion indicator with photographic attachment, an instrument which enables an accurate visible indication to be obtained of the phenomena occurring inside a shaft under the most difficult circumstances, such as when it is subjected to high-frequency oscillations or when the vessel is manœuvring ahead or astern.



TWO-CYCLE DOUBLE-ACTING MARINE OIL ENGINE

In May, 1915, the Fritz, fitted with the engines was put through her first trial trip on the Elbe, the run lasting eight hours, and proving entirely satisfactory. The measured fuel consumption amounted to about 5⅝ oz. per indicated horse-power hour at a mean output of 1093 indicated horse-power for each engine. To test the manœuvring capacity, twenty-two starts and reversals were made in 33 min. Subsequent examination of the engines revealed the development of cracks in various parts of the cylinders. The cylinders were therefore renewed on lines suggested by the experience acquired by the builders.

By reason of the delays occasioned by the war, the second trial trip, with the re-built engines, was not carried out until April, 1919. This trip also went off satisfactorily, and the subsequent inspection showed the engines to be in excellent condition. Under the provisions of the Peace Treaty, the Fritz had to be surrendered to the Allies. The builders directed the attention of the British Government to the fact that the Fritz was an experimental vessel, and that, notwithstanding the previous tests, the reliability of the new type of engine could not be ascertained until after several sea voyages had been made. The suggestion was accordingly made that several trips should be made in the Baltic before surrendering the vessel. This suggestion was not accepted, and on November 8th, 1919, the ship left for England, where she arrived safely after encountering heavy weather. Since then she has been in commission for an English shipping firm. The builders of the engines and of the vessels are continuing their work, and have recently constructed large-cylinder units which have, so it is announced, atisfied the most stringent test conditions on prolonged runs.

Obituary.

CHARLES JOSEPH WILLS.

The death of Mr. Charles Joseph Wills, recently, at the age of seventy-three years, marks the close of a long and successful career. Mr. Wills, who was one of our leading English public works contractors, was chairman of the firm of C. J. Wills and Sons, Limited, of 28, Victoria-street, Westminster, and managing partner of Messrs. Price, Wills and Reeves, of the same address. His name, which is associated with the construction of many important railway lines and docks in England and abroad, first came into prominence in connection with the construction of the Manchester Ship Canal, of which he carried out a 12-mile section in record time, a fact which not only resulted in a very considerable saving to the Canal Company, but brought to him also many large and important public works contracts.

The railway works which he carried out in England include the construction of the Sheffield District Railway, the Sheffield and Dore widening, the Ealing and South Harrow Railway for the Metropolitan District Railway Company, the Woodford and Ilford line and the widening of the main line between Seven Kings and Romford for the Great Eastern Railway. The new main line for the Great Western Railway Company between Castle Cary and Langport, and the widening on to Durston, were carried out by Mr. Wills. Completed well under the contract time, this line now forms part of the Great Western London to Exeter route. The last-named company also entrusted Mr. Wills with the construction of the Birmingham and North Warwickshire Railway, a new line from Acocks Green, on the outskirts of Birmingham, to Bearley, and the widening of its existing line from Bearley to Stratford-on-Avon, which provided an important new route between those places. For the Midland Railway Company Mr. Wills constructed the West Riding line, including the Coulsdon Viaduct and Tunnel. Numerous other railway widening and construction works were carried out by him, including extensive works for the Great Central Railway, and the construction of the Lincoln to Tuxford Railway for the L.D. and E.C.R., which is now incorporated in the Great Central system. The new tunnel at Newport for the Great Western Railway was a particularly speedy piece of work carried out to relieve the South Wales coal traffic.

In dock and harbour construction Mr. Wills carried out some of the well-known works in this country, including the Queen's Dock, Liverpool, the Barry Docks in South Wales, the Heysham Harbour for the Midland Railway Company, and the Immingham Docks on the Humber for the Great Central Railway Company.

Mr. Wills' name is also associated with many new docks and harbour improvements between England and India. Commencing in the Mediterranean, on the island of Cyprus, he constructed the harbour of Famagusta and the harbour extension at Larnaca. For seven years his dredging plant was engaged on the deepening and improvement of the Italian harbours in the Adriatic. The deepening of the harbour at Alexandria; the construction of new breakwaters and improvements and new quays for the harbour of Port Said; the construction of new quays and the deepening of the harbour at Suez; and extensive improvements in the port of Aden, were also effected by him. The last important dock works completed by him were the new docks at Bombay. His activities also extended to South Africa and Canada, and he was called in by the Greek Government to advise it on railway and port improvement projects. He was, furthermore, entrusted with a large portion of Lord Kitchener's irrigation scheme for the Egyptian Government.

During the war Mr. Wills placed the whole of his organisation at the disposal of the Government and carried out numerous heavy engineering works, both for the Admiralty and the War Office, his chief work being the construction of very extensive submarine defence works and oil fuel depôts for the Admiralty and fortifications and deep-sea work for the War Office.

The Government inquiry into the collision of the 6th instant at Selby, North-Eastern Railway, was held by Colonel Pringle on the 12th. It was made clear by the evidence that when the driver of the North-Eastern train from Bridlington to Leeds was given a "rightaway" signal by the guard he looked up, and seeing a signal "off" gave his engine steam and started. The signal in question was, however, that for the Great Northern express passing through the station on the adjoining up through line. This signal and the platform line signal are evidently on one post to the left of the platform road. One possible result of this accident may be a recommendation that where there is not sufficient space to fix the through line signal next to that line the signal shall be on a bridge or that it be of a similar design to that introduced by the Lancashire and Yorkshire Railway after the fatal collision from the same cause at Preston Junction on August 3rd, 1896, wherein the through line signal is bracketed over the platform road and cannot be seen therefrom. Another point for consideration is whether the station staff and the guard should give the "right away" signal to a driver when they see that the fixed signal is against him.

Railway Matters.

THE new steamer Versailles, of the Newhaven-Dieppe joint service, made its first public trip on the 6th instant.

BEFORE the war it was the practice of the railway companies to issue tickets at reduced rates to officers and men of the Forces when travelling on leave. These arrangements have not yet been revived in view of the general suspension of cheap travelling facilities.

THE Ministry of Transport states that the restoration of the Basingstoke and Alton Light Railway—closed during the war to allow the track material to be sent overseas—must be indefinitely postponed as the Government has no money for light railway schemes.

UP to the 5th instant the number of deaths reported as the result of the collision on July 25th between Tauroi and Peinzalok on the Burma railways was 105. The mail train from Rangoon to Mandalay came into collision with a goods train and the large number of casualties was due to the mail being crowded with passengers from a race meeting.

IT has been stated that the National Union of Railwaymen celebrated its jubilee the other day. This cannot be so, as our copy of the souvenir issued when the new offices in the Euston-road were opened in 1910 shows that the Amalgamated Society of Railway Servants—the predecessor of the N.U.R.—was established on November 27th, 1871.

THE Irish railway companies—except the Great Northern, which is definitely standing aloof—and the representatives of the men got so near agreement as to a wages board that a telegram was sent on the 10th instant to Mr. J. H. Thomas to withdraw his opposition to the vote for three millions for the Irish railways. The financial resolution was passed, and the Irish Railways Bill read a first time that night.

ASKED by Sir J. Norton-Griffiths whether the Disposal Board was quoting £1200 to £1300 for Baldwin's narrow-gauge locomotives, and that new ones were being offered by the trade at £850 to £950, Mr. Hilton Young (Financial Secretary to the Treasury) stated that the Disposal Board was now quoting the figures mentioned, but that no inquiries had recently been received for the locomotives. He was not, however, aware that new locomotives were now being offered by the trade at £850 to £950.

SPEAKING at Ipswich on the 14th instant, Mr. J. H. Thomas said that the railwaymen now had the strongest trade union in the world, but, with it, had great responsibilities. If State ownership of railways would be beneficial to railwaymen only and an injury to the State he would not hesitate to oppose it. Alluding to the decontrol of railways, he said some people had predicted a great strike when the railways were decontrolled, but, looking at the situation from all points, he could see nothing to support such a suggestion.

WITH apparently very good reason Mr. Marshall Stevens has challenged the present composition of the Railway and Canal Commission. Under the Act of 1888, it is laid down that there shall be two appointed Commissioners, "and one of them shall be of experience in railway business." Until 1918, when Mr. Gathorne-Hardy died—he had been chairman of the East London and deputy chairman of the South-Eastern—this condition had been fully complied with, but it is doubtful whether either of the present appointed Commissioners is experienced in railway business.

THE Ministry of Transport having deducted £120,000 from its claims for money expended, the Glasgow and South-Western Railway Company has postponed, like the North British Company, the payment of an interim dividend. The Caledonian and Great North of Scotland companies are not paying any interim dividend. The same reasons do not hold in their case; the dividend is "passed" because of the general uncertainty of the railway position after decontrol. The Highland is paying no interim dividend on its ordinary stock, but this is in accordance with its policy for the past few years.

A PROJECT for the construction of an iron bridge across the Sumida River in Tokyo is reported in the Japanese Press, which states that the bridge, which will start from Manseibashi, will turn toward the left and run over the Kanda River, forming a canopy for the river to the Sumida River near the present Ryogoku bridge and across the river to the Hojo side of it. The elevation will be 40ft., as it will run over the Kanda-Uyeno line, 20ft. high. The work, it is stated, will be commenced in the fiscal year 1925–6 or 1926–7. It is understood, however, that the Imperial railway authorities at Tokyo have not as yet drawn up specifications for the bridge.

ONE of the features of the Southern Pacific Railway is its versatility. It traverses eight States, and where it crosses the Sierra Nevada range it reaches a height of 7018ft. above sea level. In eastern Texas and southern Louisiana there is a heavy rainfall, whilst in the Imperial Valley of Southern California there is no rainfall at all. In one part of the system snow sheds are a necessity; in another, the heat, all the year round, is so intense that the station and other buildings require an additional roof for purposes of insulation. In some places there is practically no population; on the other hand, out of San Francisco and Oakland there is a ferry and electrical suburban service that is not excelled in the country.

ALTHOUGH an agreement between the companies and the men as to wages was arrived at in January, 1920, it was not until the 11th instant that the proposals as to signalmen's wages were accepted. The difficulty in that direction was to find a basis whereby the extent of the men's work could be gauged. One box may have a lot of shunting, another may have four running lines but not much shunting, a third may be constantly engaged on the telephone, a fourth may have the gates of a road level crossing to work, whilst a fifth may only have to control the gates and not to work them. Of all these and other examples there are varieties in degree, and the only way to gauge their responsibilities was to grant a certain number of marks for each movement a signalman has to make. That agreed to, there remained to be decided the rates of pay applicable to certain number of marks.

Notes and Memoranda.

THERE is less reason for despondency about electric vehicles than about most other branches of transport engineering, states the *Electric Vehicle*. The foundation of hope is the fact that an unsatisfied demand for battery traction exists. Circumstances may postpone the demand, but cannot kill it; and when industry and finance recover from the low fever which has been consuming them during the past few months the output of electric vehicles will once more be absorbed with a comforting readiness.

STEAM pressures have advanced very rapidly, and in this direction Britain is ahead of America. Two hundred and fifty pounds is quite common, several boilers are working at 350 lb., and in one case at 475 lb. pressure. Evidence so far collected is that maintenance is not greater on boilers working at 350 lb. pressure than those operating at lower values. Safety, with first-class construction, is not a matter of pressure, and an explosion on a plant working at 500 lb. would be little more disastrous than on one operating at 100 lb. Taking into account the present factors of safety, states a well-known authority, conditions are safer in the former case.

THE shortage of coke in Austria, due to war conditions, rendered it necessary to seek a partial substitute for heating cupola furnaces. The only promising material being oil, experiments were begun by building two burners, with the necessary air pipes, into a cupola furnace, without further alteration; and as the results exceeded expectations, the experiments were continued. The final results of the tests were considered to be highly satisfactory. The coke charge was reduced by 4–5 kilos. with an oil consumption of 1 kilo. per 100 kilos. of iron charge, while the time required for a melt was reduced by 30–50 per cent. The temperature of the iron attained the highest requirements, and no increase of sulphur content occurred.

A 60-KILOWATT electric brass melting furnace of 200 lb. capacity, designed, built and operated by students, has recently been installed in the chemical engineering laboratories of the College of Engineering, University of Wisconsin, at Madison. This is believed to be the smallest commercial furnace of this type in the United States, and the State University is the only institution of its kind which possesses such a unit. The shell and driving mechanism were made in the University mechanicians' department; the fire sand was produced in an electric resistor furnace in the chemical engineering laboratories. The foundation and lining were built entirely by students. The actual cost was £70, compared with a market price of £200.

A WROUGHT iron gas main, 10in. in diameter, originally laid in the United States for natural gas, and dug up after lying buried for twenty-six years for replacement by a high-pressure main to carry artificial gas, was found to be in good condition, according to the *Gas Journal*, excepting where the screwed joints had been weakened by corrosion. As the pipe was of the same diameter as was required for the new main, it was decided to reclaim the sound portions and use them as far as possible in reconstructing the line. The process consisted merely of cutting away the old screwed joints with an oxy-acetylene torch, and butt welding the salvaged sections. The main was then found adequate in every way for carrying the working pressure required.

IN his recent paper on "Overhead Distribution," Mr. B. Welbourne said the question of distribution by overhead wires *versus* underground cables is a controversial one, and cases may sometimes be settled by first cost considerations, but, fortunately, æsthetic and maintenance conditions are sometimes given their full value—especially in garden city scheme. In one such scheme the total first cost of the overhead distribution, including 108 public lighting fittings, has been £6800, whereas the estimate for a high-class scheme using cables throughout was only some 20 per cent. higher. Allowing for the longer life and lower maintenance charges on cables, it is very doubtful whether there was any real saving by using overhead wires in this case. Exact costs obtained from other schemes would be very useful.

IN an article by Mr. Daniel Wilson, appearing in the *Electrician*, on "Steam Raising, Yesterday, To-day and To-morrow," it is stated that thirty years ago the maximum steam capacity of boilers was about 7500 lb. per hour; to-day 130 000 lb. of steam per hour is attained. America has led the way in large boilers. Engineers in this country prefer distribution in several units. Moderate sizes of 20,000 lb. to 30,000 lb. per hour have been usual, but recently 50,000 lb. to 80,000 lb. units have become common, and boilers for 100.000 lb. per hour (actual) are under construction for the Manchester Corporation. The size of boiler has little effect on unit thermal efficiency. Thus, Detroit Station has an overall thermal efficiency of 16.5 per cent. with 130,000 lb. per hour boilers; in this country 18 per cent. is reached with boilers of moderate size evaporating 30,000 lb. per hour.

AT Clifden, in Ireland, the Marconi Company uses, according to the report issued by the Imperial Mineral Resources Bureau, some 5000 or 6000 tons of air-dried peat per annum in locomotive boilers to generate the power required in connection with its wireless station. At a linen factory in Portadown, two Crossley producers, each of which is said to be capable of developing 200 brake horse-power, are used to supply three Stockport gas engines, two rated at 120 brake horse-power and one at 150 brake horse-power. As a rule, about 250 brake horse-power is developed, and it is stated that, under test, the consumption has at different periods amounted to from 2.5 lb. to 3.16 lb. of 25 per cent. moisture peat per brake horse-power-hour. Adopting the latter and more recent figure, which is equivalent to 4.24 lb. per kilowatt-hour, this, at 10s. per ton for the peat, would work out at 0.22d. per kilowatt-hour, or about £9 per kilowatt-year, for the cost of fuel alone. From published details the plant appears to show a considerable saving on the cost compared with that when coal is used. About 1000 tons of peat per annum are used in the producers, no attempt being made to recover by-products owing to the small scale of the plant. In addition, 2500 tons are used in boilers to produce the steam required for heating and humidification.

Miscellanea.

FOLLOWING upon the issue of a circular addressed to the workmen by the Rio Tinto Company, urging them to increase their output in order to avoid the necessity of dismissals, the workmen have decided to work an hour extra daily without any increase in wages.

THE Australian Federal Government has agreed to remit the Customs duty on all machinery for State works which cannot be manufactured in the Commonwealth. This will mean a saving of many thousands of pounds a year to the Tasmanian State Government in connection with the hydro-electric undertaking, which is necessitating the importation from England and America of thousands of tons of machinery.

DURING the hearing of a claim before the Royal Commission on Awards to Inventors recently it was stated that the applicants, a firm of compass makers, lost radium to the value of £5000 before they were able to perfect the magnetic compass with luminous points used in the war on aeroplanes. During the war period they used £60,000 worth of radium. The only royalties the firm had received were 10s. on each of twenty compasses supplied by the British Government to the Norwegian Government. The Commission reserved its decision.

A DETAILED scheme to harness the tides and press them into service has just been submitted to M. le Trocquer (French Minister of Public Works) by a committee which has been engaged for two years on the study of the subject. The Minister has decided to proceed at once with the necessary investigations. An experimental power station is to be established in Brittany. A dam 150 m.—say 500ft.—in length will be constructed, and the water enclosed therein will be used to drive several hydraulic turbines. It is estimated that 4800 horse-power can be obtained by this means.

EVIDENCE of Germany's efforts to regain lost markets is afforded by the figures recently received by the Federation of British Industries regarding the exhibitors at the forthcoming Utrecht Fair. Although applications are constantly being received, the totals of exhibitors so far recorded are 706 Dutch and 372 foreign. Among the latter Germany is an easy first, 92 firms being directly represented and a further 64 indirectly through Dutch agents. The United Kingdom is a bad second, with totals of 47 direct and 30 indirect exhibitors, and is closely followed by Belgium (31 and 12) and France (21 and 10). Only four American firms are actual exhibitors, though a further 11 are represented by Dutch agents.

MR. MARCONI, who has recently returned to London, announces that he has been for the last few weeks testing a new method of wireless reception developed by one of the company's engineers which has enabled him to receive continuously from the United States without being in any way interfered with by atmospheric disturbances which are particularly prevalent at this time of year, and more severe than usual in recent weeks in consequence of the abnormal spell of hot weather. Mr. Marconi regards this advance as of the greatest importance, for it enables a wireless telegraph service to be conducted, notwithstanding atmospheric disturbances, during the whole twenty-four hours and at high speed during the greater part of the time.

IT is interesting to learn that of late the Agent-General for Western Australia has been bombarded with inquiries from all sorts of persons regarding the possibility of opening up and exploiting on a large scale the alkali which exists in very large quantities in various parts of the State. As alkali is an essential to present-day paper-making, states a contemporary, there is no reason why its production should not form an important feature of Western Australia's trade, and it is to be hoped that the exploitation of this product will be undertaken on a large scale and without delay. Western Australia is not the least progressive State in the Commonwealth, and, given intelligent co-operation between the authorities and the private individual, there is every hope that a big industry may be built up in the near future.

ACCORDING to the *Scientific American*, the battleship Maryland will be ready to carry out her official trials early in November. The Maryland is a "super-Dreadnought" of 32,600 tons displacement, is 624ft. long, 97.5ft. in beam, and has a draught of 30.5ft. The driving equipment is electrical. The motive power is provided by two 11,000-kilowatt steam turbo-generators, running at 2030 revolutions per minute. These supply power to four 7000 horse-power induction motors which revolve at 170 revolutions per minute and drive the propellers. Power for auxiliaries and general purposes is generated by six 300-kilowatt turbo-generators. Oil fuel is to be used in all the boilers. The building programme of the United States navy includes a number of electrically propelled vessels, including three more battleships of the Maryland type, six 43,000-ton battleships, and six battle-cruisers. The production of several of these is now proceeding under the direction of Mr. W. L. R. Emmet.

THE figures of those receiving unemployment pay in France continue to fall, last week's total being 37,226, instead of 39,948 the week before. At the same time, the number of applications for work which have not been met has also diminished, only 19,995 unsuccessful applications being registered last week, as compared with 23,073 in the previous week. The decrease in unemployment seems to be mainly due to the fact that at the present time as many workers as possible are needed on the land for harvesting and ploughing. The situation as far as industry is concerned appears to be stationary. With regard to mines, work is in many districts being carried on for six days a week, a five-day week, however, prevailing in other parts. There seems to be no improvement in the metal industry: in the department of the Bouches-du-Rhone two metal works have temporarily closed down, and in the North the metal works in the Maubeuge district are dismissing their workers. Machinery shops, and more particularly those working on railway material, have dismissed a portion of their *personnel* in the Gironde, the Landes, and Indre-et-Loire. These, however, are only particular cases, the unemployment figures showing that the general improvement continues.

BIRKENHEAD WATER SUPPLY—THE CROSS HILL COVERED RESERVOIR

(*For description see page* 183.)

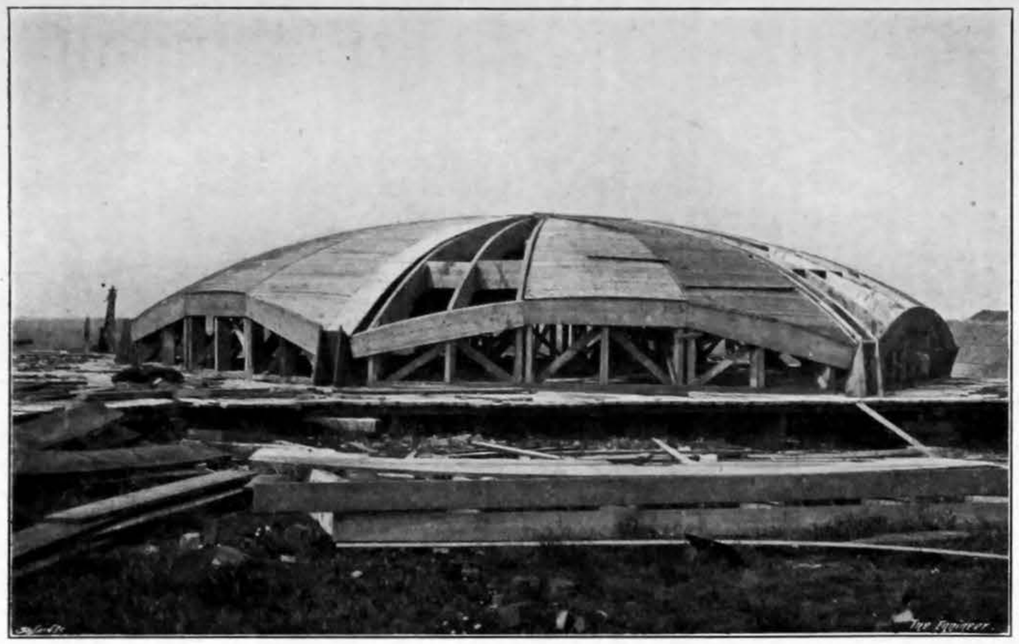


FIG. 11—CENTERING FOR DOMES

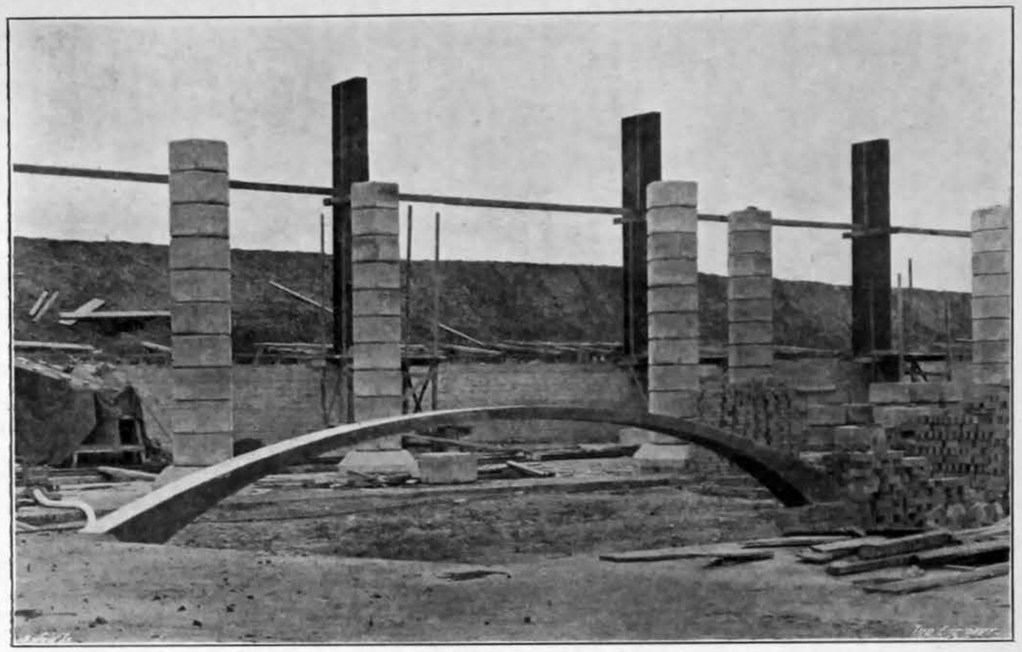


FIG. 12—TEST SECTION OF DOME

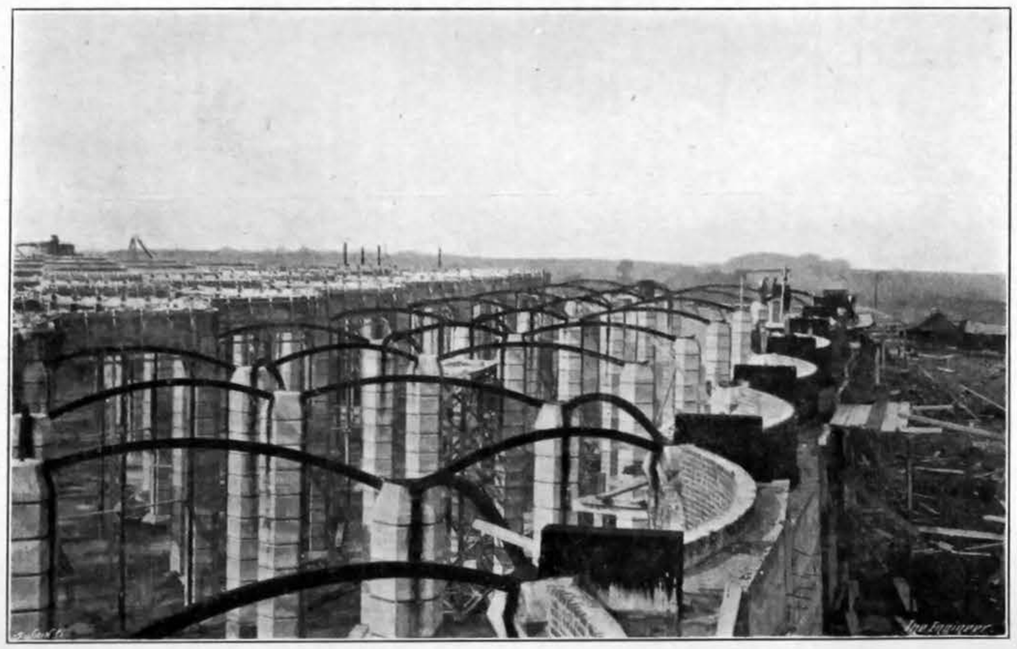


FIG. 13—VIEW SHOWING SIDE ARCHES, PILLARS, AND CHANNEL IRONS FOR GROINS

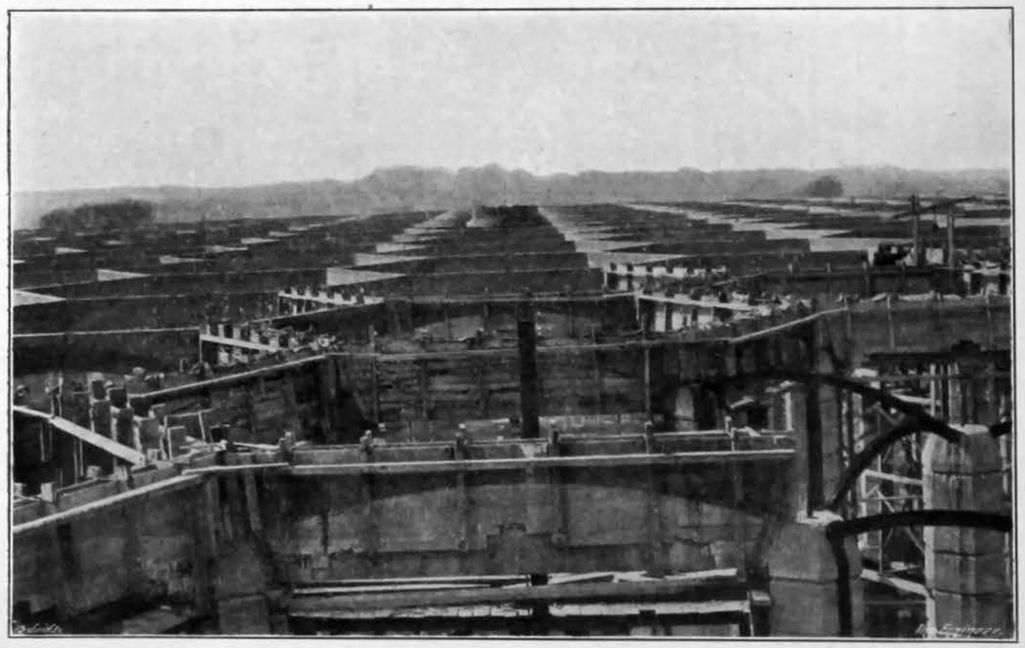


FIG. 14—VIEW SHOWING CENTERING AND SHUTTERING FOR GROINS

Contents.

THE ENGINEER.

AUGUST 19, 1921.

The Scotstoun Lesson in Practical Economics.

The announcement was made last Friday that the Scotstoun works of Yarrow and Co. would, with the exception of the experimental and research department, be closed down at the end of November. More than two years ago, when, soon after the Armistice, the firm was endeavouring to turn from war to merchant shipbuilding, high operating costs and labour troubles induced Messrs. Yarrow seriously to contemplate a gradual reduction of their activity at Scotstoun and an increase at their British Columbian yard. The crisis has now apparently been reached. Repeated strikes, reduction of output and demarcation disputes—more perhaps in the industries upon which shipbuilding is dependent than among the firm's own workpeople—have rendered the cost of shipbuilding so excessive and, in addition, have made it so impossible to guarantee definite delivery dates, that the business has ceased to be worth while, and in some instances even to be almost completely without profit. To give two specific examples from the firm's experience, we are permitted to state that a recent tender for an Indian steamer was declined in favour of a quotation from Holland, which showed a saving of fifteen per cent. in the cost. Yet Messrs. Yarrow's figure was lower than that received for the work from any other British yard, and was estimated just to cover the actual cost of building the vessel without the addition of profit. Again, the ship joiners' strike, which has now lasted eight or nine months, has compelled the firm, as it has done others, to dispatch its work in an incomplete condition. In particular, it has been forced to send some boats to China with the joinery work omitted and left for execution by native workmen. The Chinese owners have now intimated that they do not propose to order any more boats that cannot be supplied in a finished condition. These examples typify the conditions which Messrs. Yarrow—and without doubt most other shipbuilding firms—have recently had to face. No surprise can be expressed at the fact that farther business activity has, for the time being at all events, been found impossible, and that one important British firm has decided to retire from the active production of ships until such time as the position becomes less hopeless than it is at present.

From its very foundation, fifty years or so ago, the Yarrow firm has been conspicuous for its able management and its well-directed and successful efforts to improve the design and facilitate the construction of naval and mercantile vessels. All may therefore rest assured that the company has arrived at the drastic decision to close its works only after exhausting every effort to keep them open, and that no element of inefficiency or lack of scientific method on the part of the management has entered in any degree into the conditions that have put a period to the firm's work in the immediate future. The cause that has weighed with the firm is the industrial effect of present-day trades unionism. It is quite useless to argue, as some have already done and as more may be inclined to do, that the world to-day is suffering from too many ships and too few cargoes. The paucity of cargoes is in itself very largely ascribable to the throttling of industry by the trades unions. In any event, Yarrow's of all firms would be among the last to close its doors were the reason solely the reduction in the demand for ships. As it is, it is setting in this matter, as it has done in the past in happier connections, an example to other shipbuilders in the country. Whether its example will be followed we do not profess to be able to say, but that others would follow it if they could may be reasonably supposed. In certain respects Yarrow's are in a better position to close their works than are other yards. They are, for example, more or less independent of the effect which the cessation of work will have upon their shareholders, and are not handicapped by financial obligations and restrictions. Certain it is that all shipbuilding firms are not in so ready a position to cease operations, although it is clearly a matter merely of degree before even they will find it less wasteful to close than to remain open. Little or nothing has come of the numerous conferences between shipyard owners and workers that have been held in recent months. Rates of wages are still uneconomical, output is still unreasonably low, and the system of demarcation is still unduly persisted in by the workmen. "Let us have an end to this foolery of meetings and committees. Let us close our works, and then, if we get orders, we will reopen them, provided the men are willing to resume on terms that will make for other than sheer loss." That, in effect, expresses the policy Messrs. Yarrow have determined to follow. It is a policy that has been adopted elsewhere, in this country as well as in America, and has previously succeeded in obtaining the results desired. It was adopted a few months ago at the Singer works at Kilbowie, the announcement of the re-opening of which almost coincided with the publication of Yarrow's decision to close. That it is a drastic policy goes without saying, that it contains elements of danger of more than one kind we admit, but that it is a necessary policy to pursue in the circumstances is quite certain and clear.

It is unthinkable that the Scotstoun works, when they are closed in November, will remain shut for good. We earnestly trust that the simple announcement of the firm's determination to cease operations will, within the next three months, result in an improvement in the attitude of the workers that will enable the yard to remain open. It is not, however, we are convinced, with any such hope or intention that the firm's early intimation of its decision has been made. Trades unionists will find themselves bitterly undeceived if they persist in believing that the firm is "bluffing." Doubtlessly, some will refuse to admit that it could ever be less wasteful to close a yard of the size and importance of Yarrow's than to keep it open. Let those who argue thus learn the lesson in store for them. There is no compulsion upon anyone to provide the means of livelihood for others without profit to himself. Doubtlessly, too, some will say that the firm's action is dictated by a desire to exploit the worker. Consideration of who the employer is in this instance and of his well-known sympathy and friendship with his workpeople should serve to silence all such arguments. There is no employer in the shipbuilding industry who has endeavoured more earnestly to restore and extend the old friendly relationship between masters and men than Sir Alfred Yarrow. This is not the place to speak of his efforts of this kind; it is sufficient to say that, being unhampered by the conditions that prevail in gigantic establishments, he has endeavoured to know all his men personally, and he has encouraged his managers to follow his example. That some of his men have not responded goes without saying, that some of them should persist in taking a wrong view of his attitude was inevitable, but a very large proportion of the men do realise his sympathy with them, and know that he is the last employer in the world to take any action which could be described as harsh or unsympathetic to Labour. For this reason, if for no other, we rejoice that he of all employers has decided to give shipyard workers a lesson in practical economics which they sorely need, but which they would be likely to misconstrue as an effort to destroy trades unionism or unfairly reduce wages had it been made by firms with a record different from that of Yarrow's.

The Decontrol of the Railways.

The railways were returned to private management at midnight on Monday last, not because of the passage of the Railways Bill—it has not yet received the Royal Assent—but because of the expiration of the period of two years laid down in Section 3 of the

Ministry of Transport Act, 1919. Very misleading ideas prevail as to what has been the effect on the railways of the Government control. It is imagined by some that because, coincident with the arrival of decontrol, the companies have improved their train services, resumed excursions, week-end fares, &c., they did so because they were about to regain their freedom. Nothing of the kind. The faster services are due to the withdrawal, owing to the arrears of renewal of the track having been overtaken, of the condition voluntarily laid down by the companies, not to exceed, at any point, a speed of 60 miles per hour; whilst the granting of cheaper facilities is a desirable commercial step now made possible by an ample supply of locomotive power. During and since the war period there have been various kinds of restraint on passenger and goods traffic, and there have been, and continue to be, dearer fares and higher rates than those which prevailed before the outbreak of hostilities. These were not introduced as a result of control; they would have been there had the companies been independent. Actually, the railways have been left very much to themselves as regards their internal management, and, undoubtedly, in that factor has lain the success which attended their work during the war period. The control has mainly been in finance, and it has been a most essential feature. The Act of 1871, under which the control was exercised, provided that the companies were to be paid "full compensation," and as soon as their systems were taken over in 1914 an agreement was arrived at which, with a subsequent modification, ensured to the companies a yearly sum equal to their net receipts of 1913. They were, in fact, not only assured of that sum—an annual amount of over 45 millions—but against all their expenditure, which latter amounted, during the twelve months ended March 31st last, to nearly 248 millions—a total liability of nearly 300 millions a year. Neither the railways, which had to put up with it, nor the public, which had to pay for it, can complain of the control over the railways' expenditure. Where the connection with the Government has been unfortunate is as regards labour. In that matter the managers were not given a free hand, and the result has been the granting of the eight-hours' day to men who did not need it; a standardisation of grades which does not discriminate as to the amount of work each man has to do; and the awarding of high war bonuses. In another direction a mistake was, to our mind, made, and that was in the retention of the possession of the railways after the immediate "emergency" the Act provided against was passed. In discussing railway policy we have consistently maintained this point.

All the foregoing relates, however, to the past; it is the future that we desire to consider. The question should be looked at as it affects the public and the trader, on the one hand, and the railways, on the other. For the present there is little likelihood of the public, *i.e.*, passengers, being adversely affected. Just now competition is as much in evidence as before the war. Later on, though, when the companies have settled down to the new conditions and have to make ends meet the train services may be less full. It is, however, safe to anticipate that whatever restrictions may be put into force, the facilities given will still continue to be the best in the world. The trader has every reason to be satisfied with the provisions of the Railways Bill. Many of his long-standing grievances are being removed. He has, in the Railway Rates Tribunal, a body which will be readily accessible, on which he will be adequately represented, and which will determine what the rates and charges may be. The trader may, perhaps, urge that, under Section 57 of the Bill, the charges are to be such as will bring in an annual net revenue equal to that of 1913, and may, therefore, be unduly high. This, however, is subject to the approval of the Tribunal, and it will be for the trader to show, through his representatives, that the traffic will not stand the proposed charges. This section, it must be remembered, was based on the requirement of the Transportation Act, 1920, of the United States, that the charges should be such as would give a profit of 6 per cent. The rates were revised a year ago to meet this, but it is instructive that, as late as May last, they only produced 2.41 per cent. net receipts. Nor have the railways much in the Bill to complain of. It is considerably less obnoxious than appeared likely when the Minister of Transport published the outline of his proposed policy in White Paper, Cmd. 787, on June 29th, 1920. The main feature of the Bill—the grouping scheme—does not take the companies unawares, as it is in accordance with what has been their policy for the last fifteen years. Moreover, the systems are to be grouped as the companies wish and not as was proposed by the Minister. The arrangement is bound to produce many economies. Then, again, the effect of the Bill upon the railways includes its effect upon railway labour. The proposed policy outlined in the White Paper already mentioned provided for the men to be represented on the boards of management. This concession, very much, it is known, to the annoyance of Sir Eric Geddes, was declined by the men, and although the Government gave opportunities for the decision to be reversed, the men adhered to their original decision. Mr. J. H. Thomas, speaking on the Report stage of the Bill, said that, the railway chairmen having stated that Sir Eric's scheme was impossible and that neither they nor the shareholders would have anything to do with it, the representatives of the men had accepted an alternative arrangement which would enable both parties to come together. That arrangement was not forced upon them; they entered into it willingly and did not believe they had made a mistake. Viscount Churchill, the chairman of the Great Western Railway, and also the chairman of the Railway Companies' Association, speaking on the second reading in the House of Lords, paid a tribute to Mr. Thomas and the other workers' representatives, and said that he believed that the decision they had come to would tend to closer co-operation between labour and the directorate.

There remains, however, much still to be done before the Railways Act will be in full operation. There are twenty-seven constituent companies, which are to be amalgamated into four groups and are to absorb twenty-four subsidiary working and seventy-four subsidiary non-working companies. Sixteen months are allowed for all the details to be worked out, and when it is observed that the North-Western, Midland, and West Scottish Group includes companies with an aggregate capital of over 540 millions, it will be appreciated that many conflicting interests must be adjusted. The Midland, for instance, is to go into the same group as the London and North-Western and the Lancashire and Yorkshire. The latter two have already agreed to their terms, and together they become paramount. There is a tripartite agreement between them all, but it is much easier to make an agreement to allocate traffic and to share receipts than to arrive at terms as to the value of property, especially when, with the withdrawal of competition, its worth has deteriorated, if not altogether gone. Of what value is Heysham, for instance, when close by are Fleetwood and Barrow, belonging to the same concern? Then there are the jointly owned lines and stations. Where these jointly belong to companies which are in the same group, *e.g.*, the Portpatrick and Wigtownshire, the joint property has been scheduled in the Bill as to be absorbed. It may be argued that the individual company's share in a joint property will simply be transferred to the group to which the company belongs. But it is something more than that, as such a transfer would then have a wider influence and adversely affect interests hitherto untouched. The Great Central's share in the Cheshire Lines has hitherto been a small matter and, in a sense, of local concern only. But under the grouping scheme it gives the whole of the North-Eastern and Eastern Group access to Liverpool. The Midland's interest in the Forth Bridge gives the rival West Coast route a share in its ownership. In another direction difficulties are before the companies. The administrative heads for the various groups have to be appointed. The managing directors, or whatever title they will bear, at the head of three of the groups are clearly indicated. They will undoubtedly be Sir Herbert Walker for the Southern, Mr. Felix J. C. Pole for the Western, and Mr. Arthur Watson for the North-Western, Midland, and West Scottish Group. The fourth group would appear to have the choice of Sir Henry Thornton or Mr. Ralph Wedgwood. Of more interest, perhaps, to many of our readers is: Who is to be the chief of all the civil engineers and the chief of all the mechanical engineers in each group? The selection there is by no means easy. What, again, is to become of all the railway owned workshops? Sir Eric Geddes thinks there will be work for all. Whilst we hope that that may be so, it will not, we trust, be at the expense of the outside manufacturer. Labour will certainly oppose any closing of large shops.

American Ordnance Production in the Great War.

No. I.

Thanks to its four years of experience in the late war, it is doubtful whether British industry has much to learn regarding the rapid mass production of war material of any description. The full story of its achievements in this respect has yet to be told. Whether because of official reticence or of the national dislike for self-advertisement, the fact remains that the history of Britain's industrial war effort is still unwritten; and, as a consequence, none but those who were intimately associated with the work have any conception of its magnitude. Most of our late Allies have taken the wiser course of preparing authoritative records of their respective efforts in this domain, not from motives of self-glorification, but simply that present and future generations should have an opportunity of studying the processes by which the productive and mechanical capacities of entire nations was adapted to the purposes of war. The value of such records for future guidance is too obvious to need emphasis, and we are not without hope that a similar record will be compiled in this country while the data is still obtainable. Meanwhile we propose to consider at some length a remarkable publication* issued by the Bureau of Ordnance, United States Navy Department, which sets forth in great detail the activities of this Bureau in supplying the American naval and auxiliary forces with ordnance material during the period of America's participation in the war. We are indebted to the Navy Department, Washington, for special permission, conveyed through the good offices of Vice-Admiral Niblack—until recently the American Naval Attaché in London—to make use of the interesting material contained in this volume.

The origin and functions of the Bureau of Ordnance are explained in a foreword. To laymen the word "ordnance" signifies only guns and ammunition; to the naval officer it has a much wider significance, and embraces not only guns and their ammunition, but armour, fire control apparatus, torpedoes, and mines. The paragraph of the U.S. Navy Regulations which defines the duties of the Bureau reads as follows:—"The duties of the Bureau of Ordnance shall comprise all that relates to the upkeep, repair, and operation of the torpedo stations, naval proving ground, and magazines on shore, to the manufacture of offensive and defensive arms and apparatus—including torpedoes and armour—all ammunition and war explosives. It shall require for or manufacture all machinery, apparatus, equipment, material, and supplies required by or for use with the above. . . ." Some notes are given to illustrate the progress of ordnance material from the Spanish War down to 1917, the year in which America entered the fight against Germany. In 1898 the most powerful U.S. battleships were the "Oregon" class, each armed with four 13in. 35-calibre guns, eight 8in. 35-calibre guns, and four 6in. 40-calibre guns, besides a number of smaller guns and three above-water torpedo tubes. The velocity of their main battery guns was 2000ft. per second, and an extreme range of 10,000 yards could be obtained. The torpedoes had a range of 800 yards and carried a war head of 118 lb. of wet gun-cotton. Each of the ships delivered 7020 lb. of metal per broadside, firing a brown prismatic powder which emitted a dense white smoke and obscured the target from view. Range finding and control methods were very crude and inaccurate compared with those in use to-day. In 1917 the latest battleships were those of the "Pennsylvania" class, whose displacement was thrice as great as that of the Oregon, and which were armed with twelve 14in. 45-calibre guns, twenty-two 5in. 51-calibre guns—reduced during the war to fourteen—and two 21in. submerged torpedo tubes. A broadside from the main battery of the Pennsylvania delivers 16,800 lb. of metal at a maximum range of 21,000 yards, the initial velocity of the guns being 2600ft. per second. The torpedoes carried by these ships had a range of more than 10,000 yards at 27 knots, and were loaded with 317 lb. of T.N.T. The propellant used for all guns is smokeless powder, and the danger of fire in turrets and magazines has been reduced to a minimum by air and water systems. The fire of the main battery is controlled over a system of 220 telephones, fitted specially for that purpose and paralleled by an auxiliary system of voice pipes. The correct range is scientifically determined in a transmitting station and communicated to the guns by electrical devices. Moreover, the armament is worked on the director system, all guns firing simultaneously on the closing of one key, thus centralising the control.

The declaration of war on April 6th, 1917, at once threw a heavy strain on the resources of the Bureau. One of its very first tasks was to provide guns and ammunition for the large fleet of merchantmen under the American flag. During the next half-year contracts were placed for a total of 4550 guns and for nearly 6000 gun mountings, from 1-pounder to 6in. calibre; also for 12,350 machine guns, not to mention millions of rounds of ammunition for these guns, depth charges, mines, and every variety of ordnance equipment. Projectile contracts included 6,000,000 service and 1,162,000 target shells. Orders to the amount of £13,200,000—at par rates of exchange—were placed in advance of the actual credits voted by Congress, this risk being accepted in order to expedite delivery. It is interesting to learn that the Bureau found it desirable to encourage ordnance manufacture by making advance payments to new firms, which otherwise would have been unable to finance the large extensions needed. The cost-plus method of payment had also to be adopted in lieu

* Navy Ordnance Activities, World War, 1917–18. Washington: Government Printing Office.

of the fixed-price which had been the basis of all pre-war contracts. Profits do not appear to have been excessive, the average being as follows:—On gun forgings, 5.8 cents per pound for 3in. guns and 4.5 cents per pound for 4in. guns; £45 for each 3in. anti-aircraft gun, complete with breech mechanism; £80 for each 4in. gun complete, and £97 for each 5in. gun complete. On minor contracts a net profit of 10 to 15 per cent. was allowed. A canvass was made by the Bureau of private plants thought to be capable of manufacturing war material, and eventually a system of control, resembling in broad outline that exercised by our own Ministry of Munitions, was developed. Valuable help was given by the General Munitions Board and the War Industries Board. The total of ordnance appropriations for the financial year 1916, immediately preceding the war, was £6,297,000. The Navy Act of August 29th, 1916, contained ordnance credits of £21,690,000 for the following year, of which £13,300,000 was absorbed by the three-year building programme. The final aggregate of votes for special war work amounted to £194,000,000. After the Armistice £33,000,000 of this was returned to the Treasury, while contracts to the value of £6,200,000 were cancelled, thus leaving a net expenditure of £155,000,000 for the war period appropriations on behalf of the Bureau.

As already mentioned, one of the first problems to be tackled was how to obtain guns for the immense number of merchant vessels representing a total far in excess of any provision allowed for under existing war plans. There was also a very large number of patrol and auxiliary naval craft in urgent need of armament. The gun problem became more complicated as the huge building programme of destroyers and submarine chasers began to materialise. When the order came to provide merchant ships with armaments, the American Navy had only 376 guns, from 6in. to 3in. calibre, that were not actually mounted afloat. The first expedient adopted was the removal of thirty-eight 3in. guns from cruisers and older battleships, these weapons being utilised at once for arming merchantmen. This step was taken with less hesitation owing to the improbability that the guns in question, if left on board the warships, would ever be used in the war. The loss of British armoured cruisers by submarine attack had revealed the desirability of doing away with gun-deck ports, which are a source of danger when a ship assumes a heavy list after being damaged below the water-line. Since the removal of these guns permitted the sealing-up of dangerous openings in the side, the measure involved no loss, but rather a gain, in fighting efficiency. An urgent demand for weapons with which to arm the transports, naval supply ships, and auxiliary cruisers was met by removing 124 3in., twelve 4in., twelve 5in., and thirty-six 6in., or a total of 184 guns and mountings, from the least advantageous positions on battleships and cruisers. Shortly afterwards authority was obtained for the removal of 180 more 3in. guns from vessels of the fleet. But for this expedient it would have been impossible to find one-tenth of the guns needed, for of all war material the manufacture of high-powered naval guns and mountings requires the longest time and necessitates the greatest preliminary preparation. The mounting of the guns thus obtained in merchant ships was a heavy undertaking, strong foundations and extra deck supports being needed, while the positions had to be carefully chosen with a view to the largest possible arc of fire. In the beginning, from three to six guns were supplied to each merchantman, but this system, it was found, not only exhausted the stock of guns too rapidly and necessitated carrying large guns' crews in each vessel, but interfered very seriously with the deck space for handling cargo. Eventually, therefore, it was decided to adhere to a standard armament of two guns—a 3in. gun forward and a heavier gun aft. By November, 11th. 1918, there were 1742 American vessels, other than those of the regular navy, with a gun armament on board, the total number of guns being 4360, of which number 1830 were of 3in. or larger calibre. In addition to these, 132 guns had been supplied to vessels subsequently lost, and 345 guns and mountings delivered to the Allied Governments. In the later stages of the war the allowance of ammunition per gun in armed merchantmen was increased from 90 rounds to 180 rounds per gun. Many depth charge projectors and Y-guns were also issued, and towards the close of the war troop transports were being equipped with an 8in. howitzer, adapted to a 4in. gun mounting, which was capable of discharging a 280 lb. high-explosive shell to a maximum distance of 2900 yards. "It is difficult," states the Bureau, "to measure precisely the extent of gain in safety obtained by arming our merchant marine. From the period of April 1st to December 1st, 1917, during which time the arming of our merchant marine was its chief protection, owing to the fact that the convoy system was as yet in its comparative infancy, and the organisation of the Allies' anti-submarine defence was still unperfected, 80 per cent. of the sinkings of United States merchant vessels were caused by unseen torpedoes or torpedoes observed too late to save the ship. Where the submarine had been sighted before it had a chance to launch a well-aimed torpedo the guns and armed guards of the vessels proved very effective. Excluding sinkings by unseen torpedoes, only 9.1 per cent. of attacks by gun fire, or otherwise, on merchant vessels were successful."

Irrespective of weapons obtained by requisition from the fleet or existing reserves, the following table shows the number and type of guns manufactured and delivered between April 6th, 1917, and the Armistice:—

16in.	1
14in.	29
6in.	11
Y-guns	947
5in.	195
4in.	615
3in. anti-aircraft	323
3in. 50-calibre	376
3in. 23-calibre	532
3in. submarine type	38
3in. Davis non-recoil	150
6-pounder	78
1-pounder	183
Total	3478

Previous to the actual declaration of war large contracts had been placed for explosives, powder, fuses, cartridge cases, and other essentials of ammunition, and options had been obtained on the production of such material. Thanks to this timely action, there was no lack of ammunition at the beginning of hostilities, but it soon became necessary to enlarge very considerably the Government and private plants engaged in work of this description. The Naval Powder Factory at Indian Head, Maryland, was gradually extended, until at the time of signing the Armistice its scale of production was in excess of the immediate needs of the navy. The extension applied equally to the plants for manufacturing nitric and sulphuric acids and ether. The supply of fuses was maintained at a satisfactory level throughout the war. As no rigid specification was laid down for fuses, and any type which conformed to certain dimensions and embodied essential safety features was accepted, the manufacture of these articles could be undertaken by many private firms. American naval fuses are of the following types:—(1) A detonator delay-action fuse for use in high-explosive armour-piercing projectiles; (2) an instantaneous detonator fuse for use in high-explosive projectiles not having armour-piercing properties; (3) a time fuse for shrapnel, star shell, and high-explosive shell intended for use against aircraft; (4) an instantaneous detonator fuse designed for use in flat-nosed projectiles which were loaded with cast T.N.T. and issued for use against submarines; (5) a medium calibre tracer fuse for use in projectiles charged with black powder or a mixed burster. There are three further types of fuse for use in medium and small calibre shell. While the number of firms able to make the detonator fuses was restricted, ability to produce medium and minor calibre fuses was quite general. The supply of cartridge cases and primers was adequate for all demands. In the United States Navy all the smaller sizes of ammunition are "fixed," while the larger sizes are "separate." The former category embraces 1-pounder, 3-pounder, 6-pounder, 3in. landing gun, 3in. 50-calibre, and 4in. Separate ammunition is supplied for everything above 4in. calibre. The table below gives the maximum weight of the propelling charge used in various guns:—

1-pounder	85 grammes
3in. 50-calibre	4.25 lb.
5in. 51-calibre	27 lb.
7in.	62 lb.
12in. 50-calibre	353 lb.
14in. 50-calibre	480 lb.
16in. 45-calibre	600 lb.
16in. 50-calibre	720 lb.

As in the British service, the charges for the heavier calibres are packed in silk bags, each charge for the 12in. and 14in. consisting of four bags, that for the 16in. 45-calibre gun of five bags, and for the 16in. 50-calibre gun six bags. It was formerly the custom to prepare these charges simply by stowing the powder in the silk bag without attempting to regulate the arrangement of the grains. This gave satisfactory results when the charges were comparatively small and the chambers of the guns fairly large, but with the adoption of higher velocities and the consequent increase in the weight of charge, both actually and in relation to the size of the chamber, it was found necessary to pack the powder grains more carefully, particularly in such large calibre ordnance as 12in., 14in., and 16in. The stacking machines now employed for this work arrange each stratum of powder grains on end and then force the layer into the silk envelope. The charge, as prepared by these machines, presents an almost perfect cylinder, rigid and smooth on the sides. By this means the tendency of sharp corners of the powder grains to cut through the silk cloth is eliminated. The prepared charges are placed in air-tight powder tanks, from which they are not removed until the time comes to fire them.

The development of the explosives' industry presented a task of great magnitude and difficulty. It was complicated by the fact that, in this case, certain of the elemental materials had to be provided. The demand for explosives of both kinds, propellants and bursters, was urgent and practically unlimited. The principal elements entering into the manufacture of smokeless powder are cotton, sulphuric acid, and nitric acid, and, in smaller quantities, alcohol, ether, and diphenylamine. Cotton was abundant, sulphur could be mined in Louisiana, and alcohol and ether could be derived from grain. Nor was the relatively small quantity of diphenylamine difficult to obtain. There was, however, an alarming shortage of nitric acid, obtainable only by manufacture from sodium nitrate, which had to be brought from Chile at the cost of employing vessels which were needed for other war duties. There was also a shortage of platinum, used in the manufacture of sulphuric acid. The Bureau decided, therefore, to build a plant for the synthetic production of nitric acid from the nitrogen and oxygen of the air. After studying all the known processes, the de Jahn system—a modification of the original German Haber process—was adopted. A plant was laid down near the Indian Head proving ground, designed to produce 115,000 lb. of nitric acid per day. The system of manufacture belongs to the classification of direct synthesis of ammonia from nitrogen and hydrogen. A mixture of one part nitrogen and three parts hydrogen passes under pressure over a suitable catalyser at a high temperature, causing the hydrogen and nitrogen to unite and form ammonia, $N_2 + 3H_2 = 2NH_3$. A single passage of this mixture through the apparatus causes a transformation of from 2 to 6 per cent. of the nitrogen into ammonia; this ammonia being then recovered by condensation, the remaining and much larger portion of the gases uncombined returning to the cycle. Germany owed her independence of nitrogen imports to the development of this ammonia process. The catalyst used is confidential, but it is stated to be inexpensive as compared with that employed in the Haber process, while the pressures in the cycle of operations are considerably less. The yield of nitric acid from ammonia by oxidation methods is very high, representing 90 to 95 per cent. of the amount theoretically expected. The oxidation process follows the Ostwald method, in which the reaction $NH_3 + 4O = HNO_3 + H_2O$ is produced by passing the mixture of gases over platinum gauze or screen at high temperature—an exothermic reaction—at a velocity of some 2 m. per second. The period of contact between gas and catalyser does not exceed one one-hundredth part of a second. The oxides of nitrogen pass into the acid towers where water absorbs the gases, forming weak nitric acid, which is concentrated by a method of distillation after mixing with sulphuric acid. From this is derived the fortifying acid used in the manufacture of powder. Work on this plant began in the summer of 1918 and proceeded rapidly, but the project was cancelled after the Armistice. It had meant not merely the construction of a plant, but the creation of a new industry, for no large plant for the production of synthetic nitric acid existed outside of Germany, and the development of the Indian Head plant called for the expansion of laboratory processes into full manufacture in far less time than would ordinarily be required.

The situation as regards high explosives was somewhat similar. Since the army and the Allies had a prior claim to the output of existing T.N.T. plants, the Bureau of Ordnance had to evolve a new high explosive and arrange for its supply. After a great deal of experiment it selected trinitroxylol, or T.N.X., as the most suitable for naval purposes. The manufacture of this explosive requires both nitric and sulphuric acids, but not toluol, which was the limiting-factor in the national production of T.N.T. Xylol, the basic element, is the hydro-carbon next to toluol in the so-called benzene series. The explosive properties of T.N.X. resembled those of T.N.T., though it is not so readily moulded into mines and other containers. Blended with a modicum of T.N.T., however, T.N.X. has given very satisfactory results.

NEW METHOD OF BARGE PROPULSION.

On the recommendation of the Special Committee of the new State Barge Canal Conference, the electric launch Dawn and the motor boat New Era, after a series of exhaustive tests, left New York on July 20th, on a demonstration trip *viâ* the Hudson River and Erie Canal to Oswego. In the Dawn a Van Blerc petrol engine had been installed to drive an electric generator. The New Era has only an electric motor, the current for which is supplied by the generator in the Dawn and conveyed by a cable. The two boats demonstrate a system of electric propulsion evolved by Mr. William T. Donnelly, a New York engineer, which is said to be especially applicable on inland waterways and in harbours. The report of the State Barge Canal Conference says: "This system comprises a boat that is also cargo-carrying in which is installed a generating plant with capacity for producing sufficient electric power, not only for its own propulsion, but for transmission through insulated cables to a number of cargo boats or barges proceeding in convoy as in tow. Each of such boats would be equipped with its own motor and propeller, and so operating with power supplied from the power boat. Each being self-propelled, and thus moving as a unit, there is no strain on the transmission cable. There is no inertia or resistance to be overcome by the power boat, and there is a minimum of 'wash' on the banks of the canal. Each boat would have also its own steering apparatus and a storage battery for use as required. The storage battery in each boat supplies it with sufficient electric power to move independently in harbours, for moving it to or from docks, piers or alongside vessels where the cargo is to be received or delivered as required, when detached from the power boat, which, having transported the boats to their destination, is free for other service. Thus the navigation and handling of the boats is facilitated, and danger of collision in transit avoided or lessened. Moreover, harbour towing expense, which is a large item, is eliminated, as the boats move under their own power."

COMBINED ROAD-SWEEPING, GROUTING AND TAR-SPRAYING MACHINE

JOHN FOWLER AND CO. (LEEDS), LTD., ENGINEERS.

Combined Road-Sweeping, Grouting and Tar-Spraying Machine.

The recent developments that have taken place in connection with the making of roads suitable for modern modes of locomotion have led to the introduction of a system of tar grouting, in which the stone is laid and spread in a dry condition on the road and tar is then poured over it, so that it fills up the interstices and makes the whole into a waterproof surface. It is claimed that this method possesses the advantages of dealing with the stone on the same lines as for water-bound roads without the disadvantages appertaining to the handling of tar-macadam.

To meet the needs of road authorities for dealing with this class of work, John Fowler and Co. (Leeds), Limited, have recently introduced a combined steam road rolling, sweeping, tar-spraying, grouting, and gritting apparatus which will perform the several necessary functions satisfactorily and with the minimum of manual labour. The complete apparatus is shown in the view given at the top of this page, while Fig. 1 shows the arrangement of the grit-distributing appliance which is attached to the steam roller, and Fig. 2 the mechanism which actuates the sliding door. The whole forms a complete plant capable of moving from place to place under its own steam.

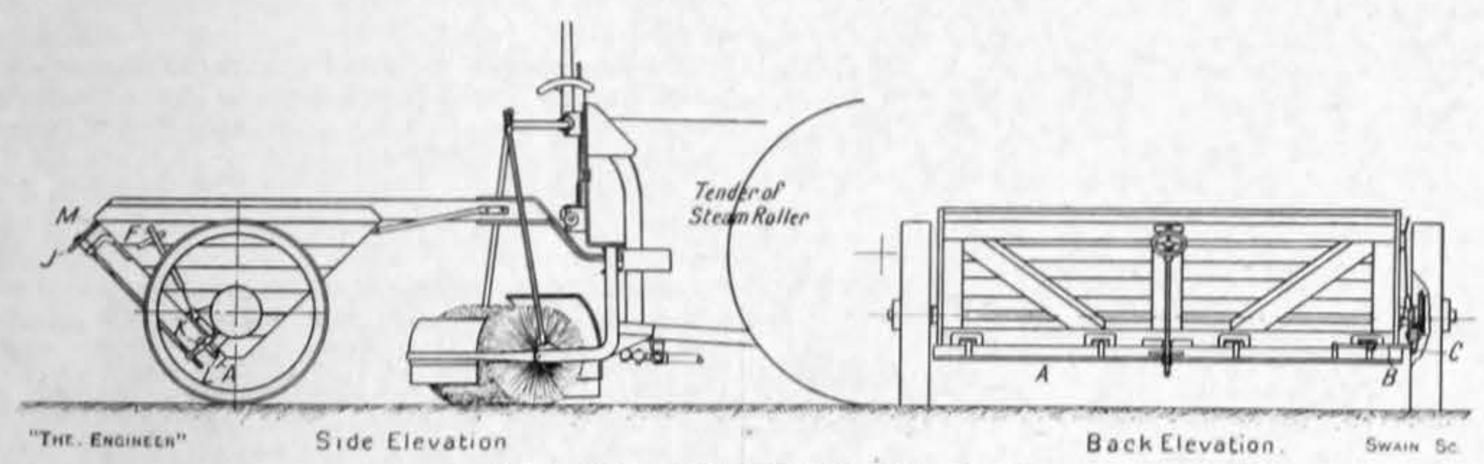


FIG. 1 GRIT DISTRIBUTING APPARATUS

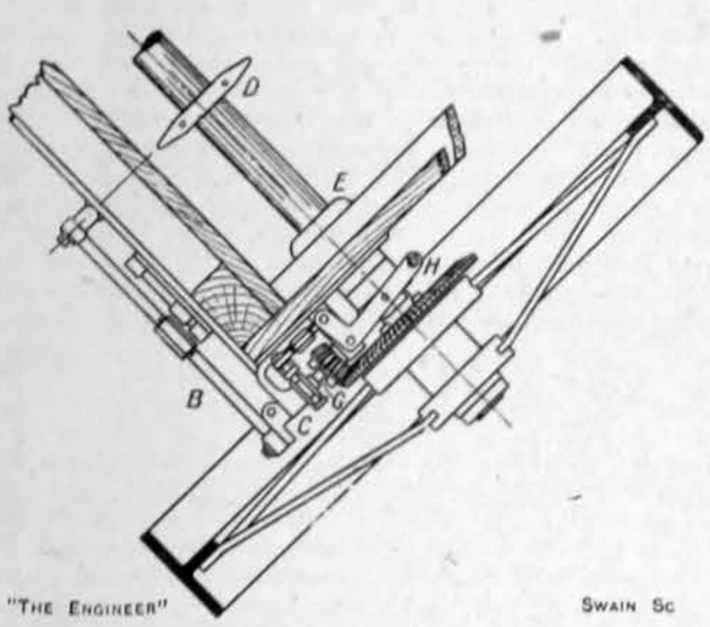


FIG. 2—SLIDING-DOOR ACTUATING MECHANISM

The tar-sprayer has a special tank or container fixed under the boiler barrel which is fitted with a rotary pump driven by a chain off the end of the crank shaft. The pump is used both for filling the tank with tar from the barrel and afterwards pumping the tar under pressure to the nozzles, situated in a cross pipe at the rear of the engine. By this arrangement the hot tar is atomised and sprayed upon the road, and the amount of tar can be regulated by means of a valve on the tank or by altering the nozzles. A steam coil is fitted within the tank for heating the tar to a suitable consistency for spraying, and an extra steam coil attached to a flexible steam pipe is provided for heating the tar in the ordinary barrels if necessary before filling the tank. The chain drive for the rotary pump is fitted with a free wheel device, so that the tar pump is in action only when the engine is running in the direction to give a forward motion to the roller. The chain can be removed when the engine is travelling from place to place. For spraying footpaths and other places inaccessible to the roller itself or for mixing small quantities of tar-macadam for repair work a hand-spraying apparatus is provided.

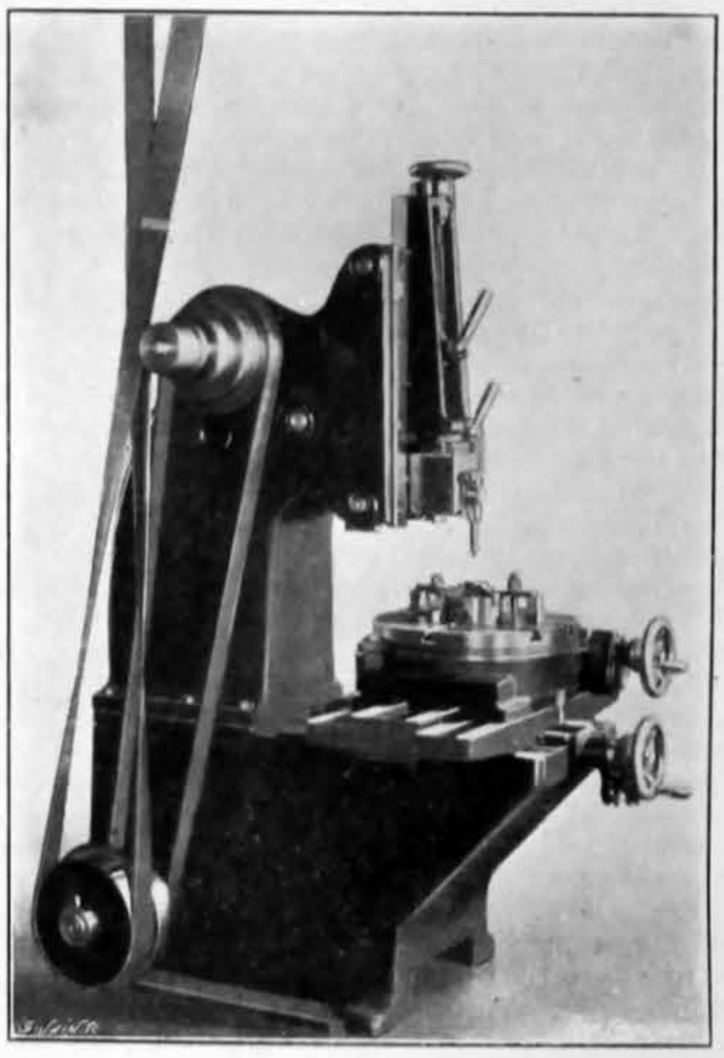
The revolving brush eliminates animal or manual labour. It is used to brush the road surface, and is lifted clear of the ground previous to the application of the tar by means of the lever shown at the back of the tender, and as the brush becomes worn it can be lowered nearer to the ground by the link and arm shown. The brush is caused to revolve by means of pitch chains and sprockets controlled by a clutch operated from the driver's foot-plate.

The gritting machine is attached to the drag bracket behind the hind tank of the roller. It is constructed to hold sufficient shingle or grit to cover, if distributed correctly, the stretch of road normally sprayed by the tar contained in the tank when full. In the illustrations, Figs. 1 and 2, it will be seen that the moving door A actually distributes the shingle or grit and is given a reciprocating movement by the connecting-rod B worked off the crank C, which is driven by bevel gears from one of the road wheels. The shingle or grit in the container is kept in motion and prevented from clogging by means of agitators D equally spaced and fixed on the revolving shaft, which runs the entire width of the machine. This shaft revolves in two bearings, one at each side, protected from dust and grit by felt-lined dust covers E. Both the agitators and the moving door can be thrown out of gear by one movement of the clutch lever F on the right-hand side. The spring of this lever allows of it being placed in the "in gear" position at any period, the dog clutches G and H dropping into their respective positions as the machine starts. The flow of shingle or grit is regulated as required by the operator opening or closing the door A more or less by means of the hand wheel J and bell-crank lever K. A spring catch M on the hand wheel prevents the latter from vibrating round while work is in progress.

One of the results of the eight-hour day on the French railways is that the Paris, Lyons and Mediterranean has had to open four additional engine depôts and another will shortly be opened. Six existing sheds have had to be enlarged.

A Vertical Shaping Machine.

The machine shown in the accompanying engraving, which we recently inspected in the demonstration workshop of Buck and Hickman, Limited, 2 and 4, Whitechapel-road, London, E. 1, is described by the makers, Pratt and Whitney, as a vertical shaper, as it is claimed to have a much wider range of usefulness than the ordinary slotting machine, which at first sight it appears to resemble more closely. The general arrangement of the component parts is, nevertheless, that of a slotting machine, and while it is capable of doing the hard, rough work generally associated with the slotter, the new machine can turn out really fine work. The job for which it was set up when we saw it—shown in the illustration—was a gauging ring of rat



VERTICAL SHAPING MACHINE

intricate design that had to be finished to very close limits. As a matter of fact, the machine is virtually a Pratt and Whitney shaping machine stood up on end, with a milling machine table for carrying the work. The arrangement has the great advantage, as compared with a horizontal shaper, that the pressure of the cut tends to pinch the various slides of the work table together instead of opening them on one side and closing them on the other side, as must be the case when the cut is across the face of the table. As a natural result, the accuracy of the machine should be maintained for a long period of time.

The drive for the tool ram is similar to that of the Pratt and Whitney horizontal shaper, and gives a quick return stroke, while the length of the stroke can be varied by altering the throw of the driving crank. The ram is guided by a set of slides which are attached to the main frame by a pivot at the top. At the bottom, bolts passing through short quadrants hold the guides. If the lower bolts are slacked off the guides and the ram can be swung

out of the vertical to the extent of 5 deg., so that a cut may be taken obliquely to the table This feature is, of course, very convenient in making the clearance in dies and such work. The connection between the ram and its driving lever is made by means of a short link, which accommodates itself to the direction of motion of the ram when the slides are set at an angle. The tool box at the lower end of the ram can be turned into four different positions, at right angles to one another, and is fitted with a clapper action to relieve the tool from dragging over the work during the return stroke.

The table is provided with the usual feeds, at right angles to one another, and is also rotatable. In the larger sizes the rotary feed is automatic, but in the smaller sets it can only be worked by hand. The feed gears are driven off a cam path on the main driving snaft, which is so shaped that the feed only takes place when the tool is at the top of its stroke, and consequently is clear of the work. Variations in the feeds are effected by altering the effective length of one of the driving levers. A long coiled spring is arranged in the length of one of the connecting links, and is of such a strength that it will transmit the force necessary for all ordinary feeds, but will yield if any part of the feed gear is overloaded.

A countershaft is not really required with this machine, as it has its own stepped pulleys, giving three speeds, and there is a friction clutch in the main drive. It is made in two sizes, nominally 6in. and 10in., of which the leading dimensions are as follows :—

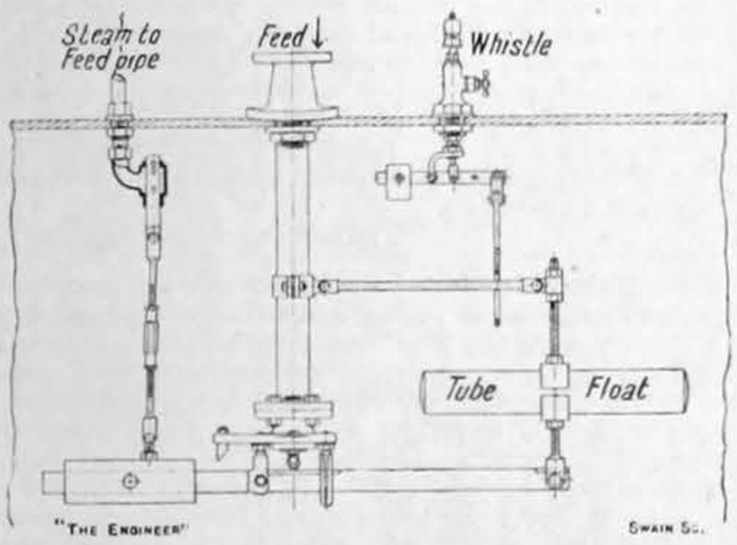
	6in.	10in.
Stroke of ram, inches	0 to 6½	0 to 10½
Table top to end of ram, maximum, inches	13½	22
Rotary table diameter, inches	20	24
Rotary table longitudinal travel, maximum, inches	25	25
Rotary table transverse travel, maximum inches	14	22
Angular adjustment of ram, deg.	0 to 5	0 to 5
Cutting strokes of ram per minute	26 to 77	18 to 70
Longitudinal and transverse feeds to table, inches	.002 to .025	.008 to .12[illegible]
Rotary power feed on 10in. radius, inches	—	.017 to .26[illegible]

The machine shown in the illustration is one of the 6in. size.

An Automatic Boiler Feed Regulator

The automatic boiler feed water regulator shown in the accompanying sketch, which has recently been brought out by James Baldwin and Co., of Devonshire Brass Works, Keighley, Yorks, possesses the merit of simplicity. It comprises, in fact, a valve in the end of the feed pipe, which is directly controlled by a float within the boiler. There is thus no necessity for bringing any moving part through the shell of the boiler, a feature which militates against the continued satisfactory working of some classes of regulator.

A branch is taken out of the main feed pipe just below the usual check valve and is fitted with a screw-down feed valve. A pipe leads from this valve to a second check valve and thence down through the crown of the boiler to just below the water level, where it ends in the feed regulating valve. This valve is of the simple four-feathered type and has an interchangeable renewable seating. It



BALDWIN AUTOMATIC BOILER FEED REGULATOR

is operated by a balanced lever, at the outer end of which there is attached a tube float of the type which the makers have used for many years past in connection with high and low-water alarms. The float can be adjusted on its spindle to suit any water level and is steadied by a radius rod reaching back to the inlet pipe. The valve opens downwards, and it will be easily appreciated that as the water level in the boiler falls the valve will be opened to admit more water. If it is desired to feed the boiler freely when the water is already high and the regulator is consequently closed, the ordinary check valve is opened. Otherwise this valve is kept shut during working hours. This arrangement works quite satisfactorily in installations where several boilers are fed from one pump, and it is not necessary to control the steam supply to the feed pump in accordance with the amount of water it has to deliver. When, however, only one boiler is at work at a time it is generally advisable to control the feed pump. In such cases the control valve for the feed pump is actuated from the feed valve control lever by the means shown in the sketch.

The South African Minister of Railways recently announced in the Union Parliament that when the tenders for electrification were opened after July 3rd, the work for the line between Durban and Pietermaritzburg would be proceeded with unless the prices were prohibitive. The Capetown-Simonstown suburban line would stand over for the present, as the saving on the latter was estimated by the consulting engineers to be only 10 per cent., as compared with 40 per cent. from the former line.

Quarry Spoil Disposer.

The geological formation—that known as the Blue Lias—from which Charles Nelson and Co., Limited, of Stockton, near Rugby, obtain the raw material for making their Portland cement, consists of nearly horizontal strata of alternate limestone and clay. It is well seen in the accompanying illustration, Fig. 2. Saving for the fact that the clay is present in too great proportion, the composition of the stone as it is taken from the quarry is very nearly exactly that required for the manufacture of Portland cement. The problem of how to remove the surplus clay—which forms about 65 per cent. of the whole face—and how to dispose of it when removed has been solved by Mr. Charles E. Blyth, the company's managing director, in the following way.

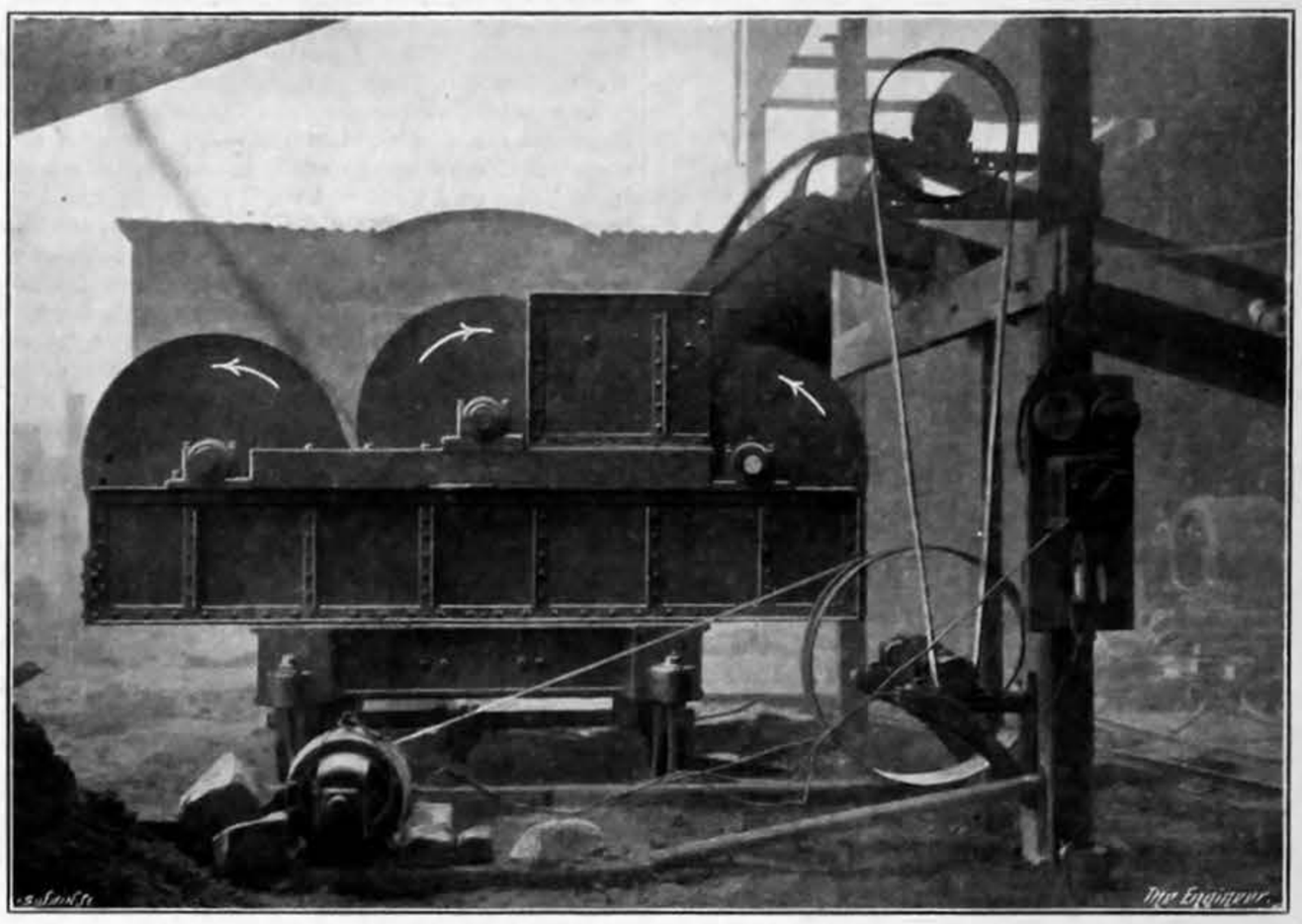


FIG. 1—THE BLYTH SPOIL "TRAJECTOR"

The method of quarrying is to blast down a large portion of the quarry face, say, from 14,000 to 15,000 tons, at a time. The stone as it comes down breaks up into fairly thin slabs of no great size. It, together with the clay, is picked up by the steam navvy seen to the left-hand side in Fig. 2, and deposited into the feeding hopper of a tubular revolving screen or "rumbler." In the latter the stone is separated from the clay, the former being passed on to one conveyor and the latter on to another. The stone is delivered into trucks running on a narrow-gauge railway, by means of which it is taken into the cement factory.

As regards the clay, it occurred to Mr. Blyth that the best way of removing it from the floor of the quarry, which is some 80ft. deep, and of stacking it regularly at the rear as the excavation progressed, was to throw it into the air, for in that way the cost of long conveyors and the laying and operating of railway lines would be avoided. He accordingly designed the machine which can be seen at the right hand in Fig. 2 and to a larger scale in Fig. 1. In construction the machine, to which the name of "Trajector" has been given, is extremely simple. It consists of three flanged wheels or pulleys, which are revolved at high speed by means of an electric motor. It will be observed that, whereas the shafts of the two outer pulleys are at the same level, that of the middle pulley is higher. An endless belt is wrapped round the two outer pulleys and passed under the middle pulley. The pulleys revolve in the directions shown by the arrows. The clay is, as will be seen in the right-hand top corner of Fig. 1, delivered in a stream from its conveyor in between the right-hand outer pulley and the centre pulley. Caught by the rapidly running belt, it is then taken under the centre pulley and is finally shot up into the air and deposited at any desired distance from the machine, the distance depending upon the speed of the belt. We understand that it is easily sent a distance of 70 yards. By changing the speed and slewing the machine the clay can be evenly deposited where it is intended to put it. The horse-power required to work the machine is, when dealing with 60 tons of clay per hour, 20 horse-power, and we are informed that the whole arrangement is found to operate exceedingly well.

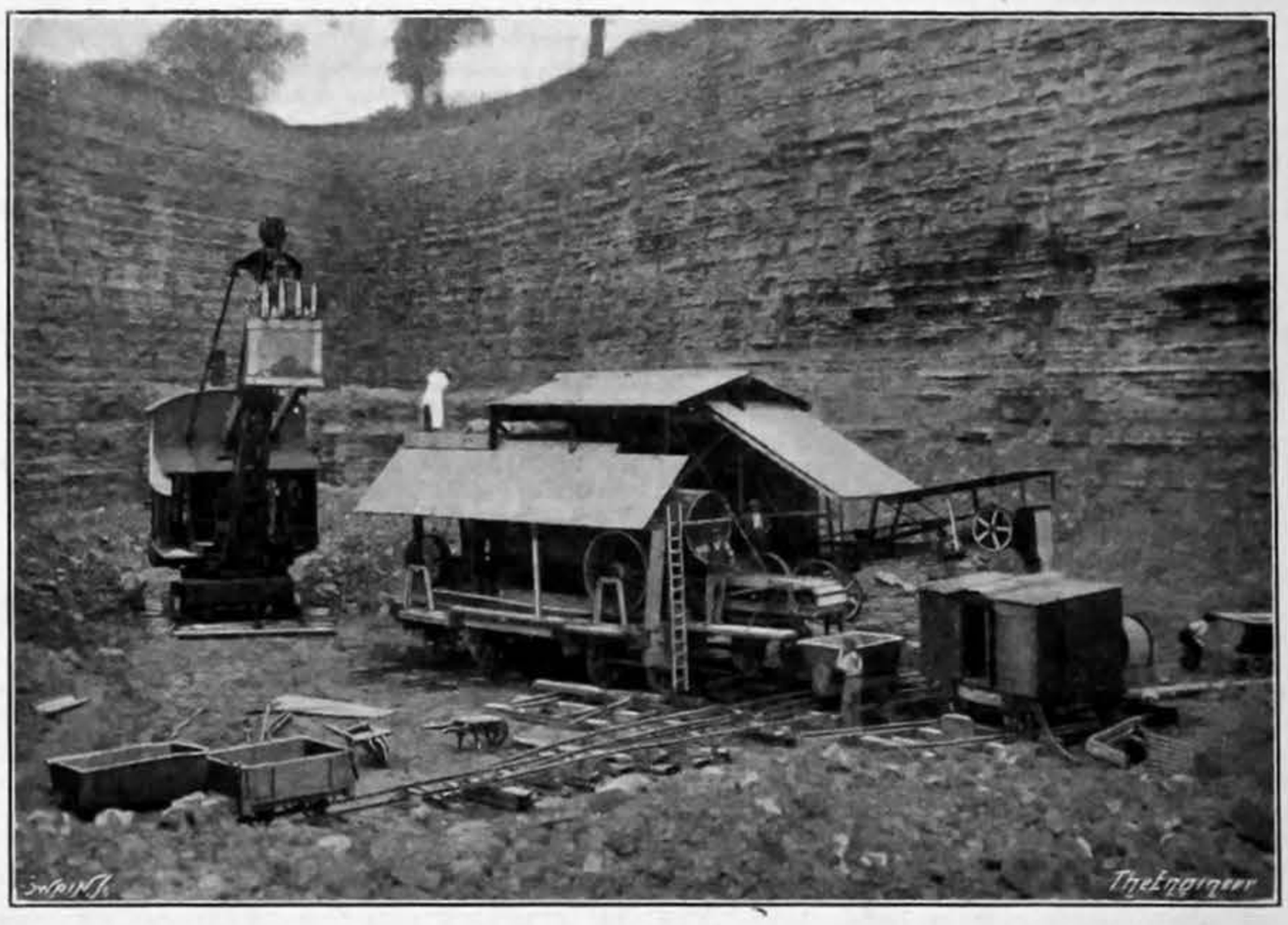


FIG. 2—THE "TRAJECTOR" AT WORK IN QUARRY

Hydro-Electric Power Schemes in Finland.

Some details of the hydro-electric possibilities of the Imatra group of rapids, which constitute of one the most important water powers in Finland and the largest on the river Vucksen between Lakes Saima and Ladoga, have been forwarded to the Department of Overseas Trade by the British Vice-Consul at Wiborg.

The Saima system has a water area of about 60,073 square kilometres. Its waters are collected from numerous lakes and rivers of various sizes, which empty themselves one into another and ultimately reach the Saima Lake. This water system is so large and complex that flood waters of the spring do not reach Lake Ladoga until August. The difference in level between the Saima and Ladoga Lakes exceeds 65 m., and 63.5 m. of that difference is experienced between Niskakoski and Rouhialankoski, a distance of about 24 kiloms. This stretch of the river contains the following rapids :—Niskakoski, the first rapid from Lake Saima, Tainionkoski, Ritikka, Mansikka, Ranankoski, Linnankoski, Imatra, Vallinkoski, Raikkelankoski, and Rouhialankoski. Of these potential powers, only a small fraction is developed. A part of the Tainionkoski water power is being used for a plant producing chemical pulp, sawn timber and bobbins for thread. Another plant, which is also situated at the same rapid, is producing chlorate of potash by electrolysis. Linnankoski has an electric plant, which develops 1300 horse-power,

and produces ferro-alloys and special steel. At Imatra there is only a small power station of about 125 horse-power which furnishes electric light for the "Cascade Hotel" and the village. At Raikkelankoski there is a large plant, which produces mainly chemical pulp. The other powers are undeveloped. Projects have been discussed to develop the entire system of these rapids in the following order :—

The Imatra system, comprising the rapids from Ritikkakoski to Imatra.
Niskakoski and Tainionkoski.
Vallinkoski and Raikkelankoski, together or separately.
Rouhialankoski.

Plans for the Imatra system and Rouhialankoski are said to be complete, and provisional plans exist for some of the other projects.

The Imatra scheme, if fully developed, is calculated to yield 150,000 horse-power. A decision to begin the development was reached at a conference held at Imatra on May 9th last, which was attended by the Ministers of Interior, Industry and Transports, as well as by several prominent engineers. It was decided to expropriate the land that will have to be flooded and to begin work about 1922. In the meantime, however, 20,000,000 Finnish marks have been set aside in the Budget for 1921, and that sum is being expended in connection with preliminary work. It is estimated that the total cost of this project, including the land that has to be purchased, will amount to 267,000,000 Finnish marks, and that it will require eight years for completion.

The rapids of Ritikka, Mansikka, Ranankoski, Linnankoski and the big Imatra falls are included in the project. The rapids are distributed over a distance of 4½ kiloms., and have a fall of 24 m. The Imatra provides a fall of slightly over 18 m. Linnankoski has a fall of about 5 m., and 1 m. will be obtained from the three falls above Linnankoski. It is proposed to build a dam to produce a head of about 6 m. above the Imatra falls, and a power canal, which will necessitate the removal of 700,000 cubic metres of earth and rock. The power-house is to be situated below the Imatra falls, and the effective head of water will be 24 m.—say, 78ft. 9in.

Latin-American Engineering Notes.

The Southern Pacific Railway of Mexico has secured a concession for several new railway constructions in the State of Sonora, where considerable activity is at present proceeding.

The Department of Public Works and Communications of Mexico has under consideration an extensive project for the construction of a railway terminus in the City of Mexico, at an estimated cost of 5,000,000 Mex. dollars (= £500,000).

A concession has been granted by the Mexican Government to a native citizen to cut timber over a tract of about 40,000 acres of land along the Kansas City, Mexico and Orient railway, in the neighbourhood of Bocoyna, State of Chihuahua, the Government receiving a royalty for each tree cut. The opportunity presents itself for the supply of large saw mills with full equipment.

The contract now held by the Electric Light and Power Company in Mexico City is about to expire, and so far nothing has been arranged as to its renewal. It is proposed by the authorities of the Federal District to install a rival plant in order to enter into active competition with the present British (Canadian) company. Under the plans proposed, the municipality would control a majority interest in the enterprise, which, however, would be managed by a private company. It is claimed that a considerable amount of unused power now exists in streams on which the present company holds first option by the contract just expiring, but which, so far, the company has not utilised. It is proposed that these streams be used in the development of the power to be generated by the new plant to an extent of from 20,000 to 30,000 horse-power. The present establishment has a maximum capacity of 80,000 horse-power, but, at this time, not over three-fourths of that amount are supplied.

A plan for the electrification of the Montevideo Northern Tramways, at present horse-drawn, has been discussed in Congress with a view to sanctioning a loan for the purpose. The line covers a very important section of the city and suburbs, and contains the nucleus of a very profitable transportation business. Under the present circumstances, however, the annual loss amounts to 200,000 dollars (£40,000). Anterior to the war, plans had been drawn up regarding these proposed improvements, but they had to be abandoned owing to the lack of foreign capital. It is estimated that at the present prices of materials, a sum of not less than 2,500,000 dollars (£500,000) would be required to carry out the project.

It has been decided to proceed with work on a tunnel extending through La Quiebra Mountain, in the Province of Antióquia, Colombia, in connection with the important railway construction works now in hand there. The tunnel will be 3760 m., or approximately 12,250ft., in length, the cost being estimated by Government engineers at £400,000.

The concession has been granted for the construction of a railway from San Félix, on the Orinoco River, Venezuela, to serve the Guasipati goldfields, which are situated in the south-eastern part of that republic. The railway will be worked by electricity, and the concessionnaire has made arrangements for the use of power supplied by hydro-electric energy taken from the falls of the Caroni River, which is about three miles from the town of San Félix.

Satisfactory progress is being made with the construction of the Durango-Mazatlán (Mexico) Railway, which work was commenced a little over a year ago. This new line is designed to meet the urgent needs of commerce and travel between the central plateau and the west coast of Mexico. For the purpose of effective organisation and operation, the work has been laid out in 10-kilom. sections, and the road bed on the two nearest points to Mazatlán has already been completed and the rails laid for over 25 kiloms. Better progress is being made from the Durango end of the road, as labour conditions there are said to be better. It is expected that the whole line will be completed by the end of 1924.

Proposals for the construction of a railway from Villazón to Atócha, Bolivia, have been accepted by the Bolivian Government, which has given the contract to the Fleming Company and agreed to a loan of 7,000,000 dollars being negotiated to pay for the work.

The engineers of the Argentine State Railways have been instructed by the Government to prepare plans for a railway from Salta (Argentina) to Antofagasta (Chile). The Argentine section of the railway will be 275 kiloms. in length, and will be built to Huatiquina, on the Chilean frontier. The plans ordered by the Chilean Government for their section of the line have only just been completed, and it is understood that work upon them will commence very shortly. But for the delay upon the Chilean side, the undertaking might have already made some progress.

It would also appear that, at last, the gap between the Argentine and Bolivian railways is to be closed by the construction of the much-discussed line from the railhead in Bolivia, at Atócha, to the Argentine frontier. The State line to the Argentine border was constructed several years ago, as was the Bolivian track as far as Atócha ; but since then passengers from Bolivia, Peru and the north, and *vice versâ*, have had to traverse on mule-back, stage coach or motor car the 200 kiloms. of very rough country which separates the two temporary termini of the railway systems. The contract for completing the work has been entrusted to an American corporation, and when the undertaking is completed there will be afforded a further direct transcontinental route between Buenos Aires and Callao.

Several South American railways are changing from coal fuel to oil fuel, and the National Railway Administration of Argentina has ordered the construction of five armoured concrete tanks, with a capacity of 5000 tons each. These tanks are being built at Santa Fé to supply fuel oil to locomotives, and are expected to be finished by the end of the present year.

In connection with the development of petroleum resources in Honduras, a considerable amount of oil plant will be required, and it is hoped that British manufacturers will avail themselves of the opportunity which now presents itself for the introduction of British machinery and equipment in this Central American Republic.

A complete equipment of plant for a new bottle factory to be established in Venezuela will be required. The factory in question is to be built in Caracas, the capital, where already some 12,000 bottles are manufactured monthly. Owing to the increasing demand both in Venezuela and the adjoining states, a large piece of ground has been purchased in one of the suburbs of La Guiara, known as Miaquetia, and here the new factory is being rapidly completed. In all probability, owing to the proximity of the United States, the necessary machinery may be purchased there, more especially as the president of the company is an United States citizen.

The Argentine Government is at length moving in connection with the long-discussed improvement of the port of Rosario. Plans were designed to convert it into a "first-class" port, and included extensive up-river dredging and new construction work. It is proposed to build a concrete river wall, 500 m. in length, and within that zone to construct a series of modern grain elevators connected by rail with the interior, to enable direct and quick-loading of steamers. The estimated cost is £600,000.

The Chilean Government will shortly be requiring three or four steel cranes, of from 20 to 50 tons capacity, to be used in connection with the construction of a new pier at Arica. Similar equipment will be required in connection with the important improvements proceeding at the port of Huasco, where a new pier is being constructed by a Chilean company.

The State Power House Directorate of Uruguay has recently invited tenders for the supply of 10,450 meters for the private installations served by it in Montevideo. The supply comprises a three-phase, 50-cycle system, with 200 volts between phases. The meters required are single-plase and three-phase, while those of the induction type are preferred.

Great inconvenience has been occasioned at Valparaiso, Chile, by the loss of the floating dock in that port some few weeks ago. It is intended at once to replace the lost dock, and the recent reduction in the price of steel now permits of the purchase of a steel structure at a cost that would make the outlay remunerative. It is probable that an order for its construction will be placed very shortly in England, at an estimated total cost of £200,000.

Considerable comment has been aroused in Chile in connection with a concession granted by the Government to two Germans, representing the firm of Krupp, who, by the terms of such grant, will be permitted to occupy uninterruptedly 140,000 hectares of territory in the Province of Llanquihue for the term of thirty years, with the object of establishing an iron and steel factory. The concession is given on condition that the works be initiated within two years from date, and completed and in full operation within five years.

Steaming in Vertical Gas Retorts.

The report of the Fuel Research Board for the years 1918–1919 covered the general policy and programme of the Board and the erection and completion of the East Greenwich Fuel Research Station. Active experimental work now having been in progress for some time, the Board has decided that as a general rule full and specific reports on the leading subjects of inquiry shall be published with as little delay as possible. In accordance with this policy there has just been published an account of the Board's research into steaming in vertical gas retorts. This account forms section one of the Board's report for the years 1920–1921. Other branches of the Board's work will be covered in other sections of the report to be issued later.

For the purpose of the steaming tests there was provided a setting of four Glover-West retorts capable of carbonising 10 tons of coal per day. The equipment as ultimately designed included as special features (*a*) means for firing the setting by washed fuel gas supplied under constant pressure from an outside source and for regulating the gas supplied to each of the seven horizontal combustion chambers of the setting ; (*b*) means for supplying and regulating the air required for combustion under a uniform positive pressure ; (*c*) a steel pipe exchanger whereby the outgoing flue gases could be used to pre-heat the air supply ; and (*d*) a gas-fired independent steam boiler and means for accurately weighing the steam supplied to the retorts.

The results so far obtained in the course of the research are fully set out in the report, and are compared with other experimental results on the same subject obtained elsewhere. The object of the research was to obtain accurate data whereby the economic possibilities of steaming could be determined. The coals used were three widely different types, from Durham, Yorkshire and Lanarkshire, but in view of the great influence on the results obtained with steaming exerted by the physical and chemical characteristics of the particular coal being carbonised, it is recognised that ultimately a much wider range of fuels will have to be examined. As a general result of the inquiry it is now possible within limits to forecast the yield and quality of the gas, tar, coke and ammonia obtained from different types of coal under given conditions of temperature and percentage of steam, and to state how much extra heat must be supplied to the retorts in order to obtain the increased yields of products. It has been known for some years that steaming assures an increase in the number of "therms" in the gas produced from a ton of coal, but it was uncertain as to what was its effect on the tar, coke and ammonia. The Board's investigations have shown that there is not only a very substantial gain in the therms produced, but that there is also a considerably increased yield of tar and ammonia. The coke apparently suffers some loss in quantity and probably also in quality.

As an example of the figures obtained, it may be said that from Mitchell Main coal, with 20 per cent. steam and a retort temperature of 1265 deg., 33 per cent. of the potential heat in the coal was converted into gas of a calorific value of 460 B.Th.U. per cubic foot. The total therms obtained in the form of gas from 1 ton of coal amounted to 104, or 33 more than from the same coal without steaming. The tar yield at the same time rose by 34 lb. and the ammonium sulphate yield by 6 lb. It may be noted that without steaming the gas produced from this coal had a calorific value of 544 B.Th.U. per cubic foot. Nevertheless, the recovery of the potential heat in the coal was more complete with than without steaming, with the result, as stated, that more therms were obtained from 1 ton of coal with steaming than without. To obtain the increased yields the extra heat supplied as fuel and steam to the retorts was 10 therms per ton of coal carbonised.

THE CLOSING OF YARROW'S SCOTSTOUN YARD

The following notice was posted up in Yarrow and Co.'s Scotstoun yard on the 12th inst. :—

NOTICE.

Owing to repeated strikes, reduction of output, and demarcation disputes which have taken place in various industries throughout the country, the cost of shipbuilding has become excessive ; in addition to which, it is impossible to promise dates of delivery.

With the greatest regret we have therefore decided to temporarily close our works, with the exception of our experimental and research department, on or about the 30th of November.

We shall re-open when conditions enable business to be carried on with some chance of success.

We give this early notice of our decision so that our employees may have every opportunity of obtaining work elsewhere.

YARROW AND CO., LIMITED.

After having distributed many millions of pounds in wages and built some of the fastest vessels afloat, it is with great regret, the firm states, that it has arrived at the above decision. Messrs. Yarrow still have great faith in the future of the shipbuilding and engineering industries of this country, and believe that prosperity will return when everyone realises that commercial undertakings can only be carried on with success in accordance with economic laws. So soon as those laws are recognised, it is added, the firm will be enabled to re-open its works, and, as in the past, take some share in future progress. In the meantime, the firm's experimental and research work is to be continued, so that the valuable information to be obtained from this source will be available when it resumes its full activities.

BOOKS RECEIVED.

The Cochran Book of Oil Firing. Cochran and Co., Limited, Annan, Scotland. Price 4s. 6d. net. 1921.

The Journal of the Royal Agricultural Society of England. Vol. 81. London : John Murray, Albemarle-street. 1920. Price 15s. net.

Centrifugal Pumps. By J. W. Cameron. London : Scott, Greenwood and Son, 8, Broadway, Ludgate, E.C. 4. Price 12s. 6d. net.

The Mechanical Principles of the Aeroplane. By S. Brodetsky, M.A., Ph.D. London : J. and A. Churchill, 7, Great Marlborough-street. Price 21s. net.

Electrical Machinery : A Practical Study Course on Installation, Operation, and Maintenance. By F. A. Annett. London : McGraw-Hill Book Company, 6 and 8, Bouverie-street, E.C. 4. Price 18s. net.

Modern Motor Car Practice. Edited by W. H. Berry. Oxford Technical Series. London : Henry Frowde and Hodder and Stoughton, the *Lancet* Building, 1 and 2, Bedford-street, W.C. 2. Price 31s. 6d. net.

Theoretical Mechanics : An Introductory Treatise on the Principles of Dynamics, with Applications and Numerous Examples. By A. E. H. Love, M.A., D.Sc. Third edition. Cambridge : At the University Press. Price 30s. net.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

Pig Iron and Fuel Price Reduction.

Midland pig iron producers say that they do not attach much importance to the announcement by the Blast Furnace Coke Sales Association of a reduction to 30s. per ton in the price of blast-furnace coke, which I was able to announce in the "Latest News" column last week. They point out that the price quoted is for coke on truck at the ovens. Rail freights, truck hire, and terminal charges are estimated to bring the cost of the fuel delivered here to between 38s. and 40s. per ton, and pig iron producers maintain that the delivered cost of coke at the blast-furnaces must not exceed 25s. per ton if native iron is to be placed in an economic competitive position. The offer of coke at 30s. per ton at ovens does not, the smelters say, bring a reopening of the home market within the sphere of practical politics. Before the war they were paying 15s. for coke and getting a much better quality for their money. Negotiations have been going on for some time, as I have previously stated, between the coke people and the pig iron makers. The latter, it is understood, wanted the price of coke fixed at 25s. per ton at ovens. The figure actually decided upon is 30s., which represents roughly a decline of 15s. per ton. Furnaces situated near the ovens will be able to get supplies at about 5s. extra for carriage, but it will cost 10s. before supplies can reach consumers in the Midlands. The reduction is due to the anxiety of the coke makers to get their ovens re-started, partly as a means of getting rid of the small fuel, which has recently reached unmanageable quantities. A number of blast-furnace companies have very carefully considered the situation since this reduction took place. One large maker goes so far as to say that he would re-start on a further concession of 5s. per ton. Unfortunately, railway rates now involve considerably more expenditure than formerly. At the present moment railway rates are at a maximum level. In many cases these rates amount to as much as 20 per cent. of to-day's cost of pig iron, and of steel to 12 per cent. The average for the country is probably 16 to 17 per cent. for pig iron and 10 per cent. for steel. It is interesting to note that one-third of the general merchandise carried on the British railways consists of material for, or the products of, the iron and steel industry. What smelters are most concerned about is the almost complete absence of demand. This feature has a weakening effect upon prices and involves a liability to put in stock possibly one-half of the output of the furnaces, a very serious matter in view of the high labour costs. The very small demand for foundry pig iron has been most conspicuous since the coal strike. The foundry business is quieter than it has been for several years. The engineering trade is dull and calls for very few castings. Foundry iron is consequently neglected, while, to meet the small consumption, there is keen competition from Belgium. In any case the movement is bound to act as a stimulus, though, of course, even were Midland iron on the market to-morrow it would not be possible to compete with Belgian No. 3 iron at £5 15s. a ton, a figure which was recently quoted, and which, on the confession of Belgian exporters themselves, is unremunerative.

The New Pig Iron Prices.

It is not easy to arrive at a conclusion as to what the new prices of pig iron will be. Furnaces which are being re-started are essential to the economy of large steel plants and other related departments of manufacture. Their surplus output will presumably be sold for what it will fetch, for this is not a time to put much into stock. Good foundry numbers are this week offered by Belgian shippers at from 130s. to 135s. In a few cases rather lower figures have been quoted; but the buyer may have to wait a month to get the iron through, and with the market in its present precarious state this is a serious drawback. One quotation for a Derbyshire brand of foundry iron was 155s.; another was nearer 180s. There is no business to standardise prices. It is understood on Birmingham Exchange that only seven furnaces out of fifty-five are operating in Belgium. The British buyer cannot understand how under these circumstances the foreigners have pig iron to offer, and it is assumed that trade must be in a bad way on that side. At least five Derbyshire furnaces are stated to be in the course of re-lighting chiefly for the production of foundry iron required for heavy pipe making. Two or three furnaces in Staffordshire are also reported to be resuming, but these are associated with large concerns owning their own steel works. It does not appear that any definite preparations are being made for the production of pig iron for the open market either in Staffordshire or Northamptonshire.

The Finished Iron Trade.

There are no signs yet of improvement in the finished iron trade. A few firms are partially employed. Those works which are in operation are still unable to buy their coal under £1 10s. per ton, which is about three times the pre-war price. Several trade meetings are pending in the finished iron trade at which the whole position will be considered, taking into account fuel, selling prices, railway rates, &c., and some price readjustments may follow. Particular complaint is made of the railway rates, which in view of the heavy material dealt with, are a special burden on the iron industry. It is likely that a strong agitation for some relief in this direction will be initiated. Demand for iron can hardly continue either at home or abroad at its present exceptionally low ebb, but the possibility must be faced that for some months to come only a fraction of the normal orders may come on to the market. There is a disposition, however, to believe that the worst of the slump is over, and that the autumn will bring a quickened demand. This is not a deduction from the current situation. It is based on the assumption that a large amount of business which has been held up owing to the prevalence of artificial values will be released as prices become stabilised. Those mills and forges which have been re-started are not being at all well supported. It remains to be seen whether such a lowering of production costs can be achieved as to enable native material to be put on the market at prices which will restore the confidence of prospective buyers. A large Wolverhampton ironworks made a re-start last week with some of its plant after many months of idleness. Three rolling mills and the Siemens furnaces are at work again, but the firm states that the present outlook offers no possibility for the re-kindling of its blast-furnaces. Mills engaged in the production of high-grade bars are relatively well off. The individual orders are not large, though in the aggregate they amount to a considerable tonnage. There seems to be no inclination to place any but near business, on the assumption that values will further depreciate as the autumn advances. Marked bars meantime remain at £20. In the common iron branch demand is circumscribed. The nut and bolt and fencing trades are poor customers for the time being. There are big stocks in hand, and even Belgian bars, which are obtainable at something like £5 17s. 6d. below the local price of £16, are not much called for. Though continental producers are taking a large share of such business as is passing in iron, they do not appear to be strengthening their position very much. So keenly are they contending among themselves for orders that prices are being taken which can hardly show a profit. The prices at which Belgium, France, and Germany are putting material on the market are such as to leave our own mills, forges, and furnaces very little chance for competition. Preparations are stated to be in progress for the re-starting of more mills for the production of galvanised sheets, but it cannot be said that trade is developing greatly, though such movement as there is is in the direction of progress. Quotations are between £22 and £24 for 24-gauge sheets in bundles. A certain amount of inquiry is experienced for black sheets at £17 10s. and upwards, according to gauge.

Steel.

The leading steel works in South Staffordshire are partially in operation, being assisted to some extent by quantities of cheap steel scrap, which is rather plentiful, the breaking up of derelict war material being largely responsible for this fact. The outlook for steel, however, is not particularly bright, in view of the stagnation of shipbuilding, the holding up, for the present, of railway renewals, and the almost complete absence of structural engineering demand. The requirements of steel-using trades in Birmingham and district appear to be easily met by the re-rolling steel works, utilising Belgian billets. Lately, however, there have been complaints of poor supplies of this semi-finished material, and the steel mills will be very glad to take advantage of British billets when prices come down. Small steel bars rolled from British billets have been reduced from £14 10s. to £13 10s., and bars rolled from continental billets are down to £12 and even less. Some German steel is being sent here at very low prices, particularly under the head of wire and rivets used for various hollow-ware purposes, supplied at very low rates. But in one case recently a German offer was afterwards withdrawn, the order for sheets sent from this country being refused owing to the improved state of the seller's order book.

Two South Staffordshire Pits Abandoned.

Although the statement was made during the recent coal strike that the withdrawal of the safety men from the pits in the Old Hill and Halesowen districts of South Staffordshire would ultimately result in a number of them being closed, it was not taken seriously. Only now is the actual position realised, for it has been found necessary to abandon, owing to its waterlogged condition, the New Hawne Colliery at Halesowen, one of the largest mines in the district. Furthermore, the Whitley Colliery has been closed down for the same reason. Thus two important mines, containing coal estimated at about 1,000,000 tons, are lost to the country. A number of local industries will be affected, because they relied to a great extent upon the fuel drawn from these pits. Some three hundred miners will be thrown out of employment, and other mines in the district may be affected by the water from these pits. Owing to lack of funds, caused by the coal dispute and the closing of the above pits, the Old Hawne pumping station has ceased operations, the South Staffordshire Mines Drainage Commission refusing to run it at a loss. The custom has been for colliery owners to pay a small sum on each ton of coal drawn to the Commission for working the station. The income has now been considerably reduced, the largest contributors being the proprietors of the two collieries just now closed down.

Coal.

There is an ominous glut of slack, and small fuels are depreciating markedly. If the collieries are to realise the economies of increased production they must find means to facilitate the disposal of their output. Many of the pits will soon become disorganised if they cannot get freer outlets for the large proportion of slack and other industrial fuel which they produce. It is the threat of this possibility which is bringing about the fall in the price of "smalls." The mineowners know that the mining industry can only be profitable in so far as other industries are healthy and vigorous. It is sufficiently apparent that without cheaper coal other departments of trade cannot recover their vitality, and as the coal supply becomes more normal no doubt the easier tendency will increase. The pithead price of screened industrial coal at current quotations in the Wolverhampton area is from 32s. to 32s. 6d. per ton, compared with a pre-war price of 9s. 1½d. per ton, inclusive of all charges. The whole of the metal industry appears to agree that there is no prospect of revival before next month, some, indeed, holding that the real turning point will not be reached until October. Twenty-four pits in Warwickshire, Staffordshire, Worcestershire, and Shropshire have not reopened since the recent coal strike, the number of men remaining out being 5000.

LANCASHIRE.

(*From our own Correspondents.*)

Manchester, Thursday.

Iron, Steel and Metals.

So far as the general condition of the iron and steel trades are concerned, there is very little of importance to note this week. The production of iron and steel is still arrested, and, in spite of that fact, there is no demand and no indication that the consumer cares at all about the arrested development. One can only suppose that the industries which usually consume the British make of iron and steel are all in a comatose condition; otherwise there must certainly be some anxiety amongst consumers when they see the sources of supply stopped. Shipyards are closing or threatening to close; but, on the other hand, some Staffordshire sheet works are reopening, and there is some disposition now to blow in more blast-furnaces.

Metals.

The time for the revival in copper has not yet come, and in spite of the favourable opinion of almost all engaged in the trade, the quotations will not move upwards. Some people throw the blame on bad business and some on the excessive stock of old copper and brass; but whatever may be the cause, consumers of copper hold back and the prices remain at the bottom. The improvement in the American exchange has not yet had much effect on the price of electrolytic ingot, and the difference between this and best select ingot is still far too great. There is, of course, no such difference in the real value, and eventually no doubt the prices will come together; but in the meantime it is absurd to expect the consumer to pay £5 more for one than the other. Up to the time of writing it has not been announced that the arrangements for special credits to facilitate American trade with Germany have been completed; but it is quite likely that Germany will soon be able to buy more freely, and apparently she is already the most important European customer. A reduction of £2 per ton was made in the price of strong copper sheets and flat bottoms, but the £10 difference between these kinds of manufactured copper is maintained. No change in the tube prices was announced at the same time, but one is beginning to hope that some modification of these extravagant prices may be in contemplation. The engineering trade would certainly welcome cheaper locomotive and condenser tubes, whether of brass or copper. There are many other reductions in engineering costs which are overdue, but it is doubtful whether any of them have been so long overdue as that of tube prices. The market for tin has again been weak, and lower prices have been quoted than any current since last March. There has been some speculation for a rise, and in the absence of any improvement in the consumptive demand this may have led to subsequent weakness. The supplies of tin are good and are rather disposed to press upon a reluctant market. It is difficult to form any opinion as to the future; but there is always the possibility that China may attempt to renew sales before the market is ready to absorb them. Tin is now thought to be low, although, of course, it has been very much lower; but it is a little amusing to remember that when the price broke £200 per ton the Eastern producers loudly proclaimed their inability to produce tin at that price. The market for lead is not quite so firm as it has been, but the price is high when compared with that of other metals. Spanish lead is not coming in so well, but in a comparatively short time we must feel the influence of Australian lead, if it be only by means of forward sales anticipatory of the arrival of supplies from Broken Hill. Spelter is a steady market, and the opinion is that it is at the bottom.

Foundry Iron.

The demand in this district for foundry pig iron is not very great, and one assumes that the reason is a lack of orders for castings; but this latter is, of course, a result of the comparatively high price of foundry iron delivered here. There are now three Derbyshire furnaces offering material, but they do not take less than £8 10s. per ton delivered. More furnaces are being blown in in the Cleveland district, and as Durham coke has been put down—although still not so low as Midland coke—and ironstone wages are reduced, it seems quite probable that Cleveland ironmasters will very soon revert to the "official" price of 120s. per ton at the furnaces for No. 3, which price is still nominally in existence. Some Cleveland No. 3 has already been sold at 130s., and when it is freely offered at 120s. the Derbyshire furnaces will no longer be able to sell their No. 3 here at £8 10s. per ton. It is quite probable that they can come down to £7 10s. without actual loss, and that may be low enough for a time. Hematite pig iron also promises soon to be cheaper, for Rubio ore is now offered at 25s. per ton c.i.f. Tees, and with coke at 35s. it ought not to be necessary to charge 160s. per ton for hematite. With foreign basic pig coming in at 85s. per ton it is of the greatest importance for us to get down the cost of our steel-making pig iron.

Finished Material.

There is only a very small demand here for finished iron and steel, and the big gap between British and continental prices still stands in the way of a revival of the industry. Some steel works have orders in hand which will keep them going for a time, but new orders coming in are utterly inadequate. Some lower prices have been taken by makers who have a supply of cheap foreign semi-steel; but what is wanted is a wholesale reduction in the whole list of plates and sectional material.

Scrap.

The market for scrap is quiet here, and no business is being done in wrought or steel scrap. There is a moderate demand for foundry scrap and the prices obtainable are fairly good, although, of course, they do not correspond with the prices at which Derbyshire pig iron

has been sold. Up to £7 5s. is given for the best textile machinery scrap and from £6 to £6 10s. for good broken machinery iron. The nominal price for heavy wrought scrap remains at £3. and the Lancashire iron works are taking in what is offered at this figure, but they do not seem to be at all eager for it, cheap as it is.

Barrow-in-Furness, Thursday.

Hematites.

During the week the position has slightly improved, and the fact that there are now three furnaces in blast is a sign of better conditions obtaining. There is talk of more furnaces going into blast, but the process of recovery will be slow, and one cannot take anything like an optimistic view. There are more inquiries for West Coast pig iron, and as these inquiries increase and the costs of fuel decrease, to say nothing of the heavy goods rates—coke costs 10s. a ton from Durham ovens—so will the trade develop. Coke is down in price already. The local hematite ore mines are preparing to start, in fact the Roanhead Mine has already commenced operations, and others will follow suit as the demand for native ores increases. The stocks of Spanish and North African ores held in Barrow will interfere with any importations for the present.

Steel.

There is little fresh to report in the steel trade, which is quiet in the extreme. Local hoop works are partially employed, but as a sign of the times the importation of French steel billets is to be noted. One gets but little comfort out of the situation, and regrets our inability to manufacture the billets within a few hundred yards of the hoop works.

Shipbuilding and Engineering.

There is a moderate amount of activity in shipbuilding. The decontrol of the railways has practically put an end to the repairing of locomotives for the various trunk lines, and this will naturally rob the engineering trade of a certain amount of briskness, for there is nothing to take its place.

SHEFFIELD.

(From our own Correspondent.)

The Local Situation.

A more confident tone is developing among local manufacturers, many of whom believe that a turn in the tide of depression is in sight, although it may not be very close at hand. Matters are certainly taking such a turn as would seem to justify the optimism, and it is a question, when firms are losing money heavily every week, whether the trade as a whole can hang on until conditions become sufficiently favourable to enable them to work at a profit. So far as business actually in hand is concerned, it is to be feared that the contraction movement has not yet run its course. The depression has lately extended to those branches turning out finished products of steel which are essential to the maintenance of the world's activities, and which contrived to keep fairly employed while other branches were almost stationary. Included in this category are those producing circular and hand saws, edge and joinery tools, and a variety of hand tools. The file industry maintained its ground longer than any other trade of importance, but reports of a sudden lapse into quietude are given out by most of the makers. The present state of things in the city is certainly better than during the coal strike, but it is not so good as it was just before that catastrophe. The unemployment roll is heavy, but more numerous still is the list of men on short time and short earnings, while the paying off of staff officials at the large works is continuous.

The Outlook.

The optimism referred to in the foregoing paragraph is based upon several symptoms in the situation which are distinctly favourable. Additional plant is being put into operation in various centres, including both blast-furnaces and open-hearth furnaces, which indicates that the proprietors can see a certain amount of work ahead. The most important factor in bringing about a revival, however, is the further deflation of prices. Coke for making forge, foundry and basic pig iron has been reduced by from 15s. to 30s. Ironmasters have declared that they cannot run their furnaces at a profit unless coke is procurable at 25s., but they will probably accept the compromise and start up their idle furnaces. The concession will undoubtedly enable them to make a further cut in pig iron and thereby narrow the present wide margin between the cost of foreign and British material. For many reasons and for several purposes users would find it to their advantage to buy British pig iron, and so long as the difference in cost is not unduly great they will not buy much from foreign sources. Any considerable recovery of the German exchange would help the home makers enormously. After the lengthy cessation of buying, stocks of iron and steel material must have become almost exhausted, and the stabilising of prices should bring into the market many people who have been holding off through fears of subsequent reductions. They can be relied upon to change their policy and trade on something like normal conditions when satisfied that the deflation movement of prices has run its course. The next revision may safely be taken to represent the bottom figures.

Crucible Steel.

The outlook in the crucible steel branch does not offer much encouragement, although a partial resumption of buying should soon make itself felt. Overseas trade in this branch has probably never been so bad previously, and unless the unexpected happens in the shape of a downward revision of the proposed new duties, the American market for such material must be written down as lost. The state of the exchanges prohibits buying in Germany, France and Belgium, and France is starting a campaign to sell its home-made crucible steels in this country. It is produced there in the electric furnace for the most part, and the deflated exchange enables the makers greatly to underquote Sheffield firms. We have not yet heard of any considerable importation of French crucible steel. As a matter of fact, such material is not wanted, no matter what its source or price may be. Plans to invade our markets have, however, been completed. A large steel works in Czecho-Slovakia has also opened a branch in London for the sale of best tool steels. Costs of production will be lessened by the recent reduction of 17s. per ton on the special coke used in the crucible furnaces and a wage reduction of 1s. 2d. per day and 17 per cent. on piece work. The saving effected by these decisions, however, will amount to but a trifling sum in relation to the price of a ton of the finished material.

Scrap.

There is no market whatever for steel scrap, and producers cannot dispose of accumulations for which they have no available space for storage. The large steel works have enough scrap to last for a long period, even at a normal rate of consumption, most of it having been bought last year, before the trade slump began, at prices ranging from £11 to £12. Similar material could be bought to-day at 50s. Scrap merchants are almost out of business, and none will buy because of their inability to place their purchases. Turnings and borings cannot be sold just now, as very few electric furnaces are running.

Ferro-alloys.

The market continues stagnant so far as tungsten, molybdenum and vanadium are concerned, and the price of the latter has dropped to the lowest level since the material was first used as an ingredient of special tool steels. Before the war, when supplies were obtained from Germany, the price was 2s. 6d. or 2s. 9d. per pound for tungsten metal powder, and it has reached 5s. and 6s. English-made tungsten of equal quality has been sold recently at 1s. 8d. We believe, however, that this price could not have been accepted but for the use of a big quantity of ore which the Government recently disposed of at about half the market price. There is a limited call for ferro-silicon, but prices are rather easier. Cobalt, molybdenum, vanadium are quite neglected. The price of chrome has lately come down. There is some buying of chrome by makers of armaments and for stainless steel.

The United States Tariff.

Four representative steel manufacturers are on the way to Washington for the purpose of making representations as to the injustice and unwisdom of the Customs duties upon alloy steels proposed in the new United States Tariff Bill. These duties on the best high-speed steel at the current price of 3s. 9d. per pound work out at close upon 2s. per pound, and it is recognised by the local makers that such a tax would shut out their high-speed steel entirely from the American market, as the cost of the material to the buyers would be prohibitive. This trade is in the hands of some fourteen local firms, which have depôts and representatives in America. The Bill is already through the Senate, and the above-mentioned visitors are hopeful of persuading the authorities to modify considerably the new duty before the Senate passes it. The Bill contains duties intended to protect the manufacture of tungsten and various alloys of special steels which was established during the war. It proposes a tax of 1.25 dols. per pound on molybdenum and 72 cents per pound on tungsten. The latter amount is larger than the current price of tungsten metal, which has been sold as low as 2s. per pound lately. The Bill generally is a reversion to highly protective duties, which obtained before the advent of the late Democratic Government to power.

Overseas Trade.

As was only to be expected, the Board of Trade returns of overseas trade in July made a miserable showing, but, bad as they were, they registered rather an improvement upon June. Compared with that month the exports were up and the imports down, and there was a reduction by one-half of the balance of imports over exports. The only cheerful features of the statistics so far as the metal trades are concerned are certain branches of engineering, particularly textile machinery. Upon the year the latter increased from 6721 tons to 10,368 tons, and showed an advance upon the June figures. Prime movers were only 500 tons down on the year, and the value of electric goods and apparatus improved on the year in values from £964,836 to £1,157,591. The export of locomotives was well up, not only upon the month and the year, but it also exceeded the total of July in the last pre-war year. South Africa and India were the principal buyers in this department. Machinery imports totalled 4662 tons, compared with 7771 tons a year ago. The import of iron, steel and manufactures thereof increased from 81,166 tons in July last year and 80,000 tons in June to 103,561 tons, the increase being chiefly in forge and foundry pig iron. Whereas only 2044 tons of that material were imported in July last year, the total last month was no less than 30,308 tons. Basic pig figured at the low total of 2646 tons. Steel billets, girders, bars, rods and sections were about 20,000 tons. We noticed in the import figures 3620 tons of conductor rails for electric traction. A gratifying feature of the statistics was the indication of a substantial recovery in re-exports, known as entrepôt trade.

NORTH OF ENGLAND.

(From our own Correspondent.)

Serious Coal Trade Depression.

Considerable apprehension prevails regarding the outlook in the Northern coal trade. The depression at the moment is very acute, and the hope entertained that collieries would enter a period of prosperity following the miners' strike has not been realised. Optimism has given way to pessimism, and the future is regarded with grave misgivings, both from the mineowners' and miners' point of view. No sooner have many of the mines resumed operations than colliery proprietors find they have no alternative but again to close down their undertakings by reason of the lack of orders in the first place, and, secondly, because they are unable to stand the losses which the present trend of the market imposes upon them. Several pits in Northumberland and Durham are already idle, and it is feared that unless an early improvement takes place in the market position, other collieries will be compelled to take similar action. Owners make no secret of their difficulties, and it is pointed out that the prices obtainable for the coal compared with the cost of production and placing it mean serious loss. These costs are out of all proportion to market value owing to the high rate of hewing, the low rate of output per miner, and the exceptionally high price of mat rials, &c., used to keep the mines in a thorough state of repair. The trade is being handicapped in a variety of ways. Apart from the excessive railway charges, and the abnormal demand for rates from local authorities, the industry has to contend with extraordinary taxation by the Inland Revenue authorities of any new plant introduced to bring about an economical working of the mines. Take, for instance, the substitution of motor haulage underground in place of the use of ponies. A colliery company is in effect charged 6s. for every £1 spent in purchases of such motors, &c., under the heading of income tax, and, again, as a result of making a profit by having expended money in purchasing motors, it is charged a further 6s. under the same heading of income tax. This method of taxation on expenditure and again on income restricts all attempts at reducing costs, with the result that the industry suffers, employees are thrown out of work, local rates and taxes are increased owing to unemployment, and the Inland Revenue is none the richer, and the country is poorer.

Cleveland Iron Trade.

Although business in the Cleveland iron trade is still on the quiet side, the prospects become distinctly brighter as fuel prices and costs of production come tumbling down, and the fact that makers are intending to re-start more furnaces when the race week holidays are over is taken to indicate that an early revival of trade is anticipated. The work of getting the furnace ready is proceeding steadily, and several small firms are making preparations to reopen their works. Thus the outlook in this area is better than it has been for some considerable time past. The Durham coke makers do not appear inclined as yet to follow the lead of the Yorkshire producers who have reduced the quotation for blast-furnace coke to 30s. per ton, but Durham coke is obtainable at 35s. per ton, and the condition of the fuel market is such that further reductions appear almost certain. The price of fuel alone bars the way to a general resumption of activity, and if Durham coke were available at 30s. per ton, the probability is that a fair number of furnaces would be re-lit. This week business on the pig iron market has been disorganised by the annual holidays, with the result that there has been little or nothing transacted. The furnaces in blast have, however, been kept in full operation, the workers having agreed to continue at work on payment of time and a-half for three days. With the August holidays over, it is anticipated that there will be a more active demand for iron from home consumers. The modification in the price of No. 3 Cleveland G.M.B., which is now quoted at 135s. per ton for home and export has been followed by a steadying of the price of No. 4 foundry, and this quality is now available at 130s. per ton, although in most cases sellers prefer to sell equal quantities of No. 3 and No. 4 at 132s. 6d. per ton. No. 4 forge and mottled are still quoted 117s. 6d. per ton, and white iron 115s., but there is no demand, as foreign iron of a better quality is being imported at a cheaper rate.

More Furnaces in Operation.

Now that the price of fuel and costs of production are appreciably falling preparations are being made to put more furnaces in operation on the North-East Coast. The first firm to re-start the manufacture of hematite pig iron is the Normanby Ironworks Company, Middlesbrough. At these works two furnaces have been blown in this week, which, with those already turning out Cleveland pig iron and basic iron, increases the number in operation to 11 out of a total of about 72, which is the normal number.

Hematite Pig Iron.

The position in the East Coast hematite pig iron trade is much firmer. Fairly good sales have been made recently, and the supply of this commodity is now not very plentiful. Makers are no longer pressing cheap parcels on the market for shipment abroad, most of them now asking the same price for export as rules for home consumption, viz., 160s. for mixed numbers, whereas a little over a week ago orders for dispatch of mixed numbers to foreign ports would readily have been accepted at 140s.

Iron-making Materials.

The monotonous inactivity which has characterised the foreign ore trade for some considerable time past still prevails. Sellers' ideas have undergone substantial modification, but the prospect of a resumption of business to any extent appears remote, as consumers have heavy stocks and substantial deliveries yet to take in fulfilment of contracts previously made. The price of coke is falling. Purchases are said to be possible at 35s., but many sellers continue to quote in the neighbourhood of 40s. Consumers, however, consider that circumstances do not justify them in paying more than 30s., and declare that they will not go beyond that figure. Further reductions seem extremely probable in the near future.

Manufactured Iron and Steel.

A quiet feeling prevails in the manufactured iron and steel trade just now, but there are reasonable grounds

for hoping that there will be business expansion before long. No changes in prices are recorded this week.

The Coal Market.

There is no sign of improvement in the Northern coal market, which remains in a state amounting to stagnation in some departments. Altogether, the position is one of increasing despondency. The past week has witnessed a steady decline in values, amounting approximately to about 7s. 6d. per ton all round, and as this reduction followed a week of even greater relapses, it will be seen that the position from a colliery owner's point of view is becoming anxious. The home inquiry leaves much to be desired. Buyers apparently restrict their purchases to the absolute minimum; hence, there are abundant quantities on offer of almost every kind of fuel, with the result that values are anything but steady. There is not the slightest augmentation of the foreign trade. The inquiries are not of any moment, and are in almost every case subject to wiring offers, which nearly always end the business for the present. The collieries for the most part refuse to lower their nominal quotations any further, but as a rule when definite business is under negotiation concessions can be squeezed. The coke market continues to be neglected. In the case of best beehive, the make is small; but even for the little there is, there is next to no inquiry.

SCOTLAND.

(From our own Correspondent.)

Depressing Conditions.

Though there has appeared an occasional ray of hope with regard to the future, conditions generally are of the dullest description. Practically every department of industry is living a hand-to-mouth existence in the struggle to survive until better conditions prevail. Despite the evidences on all hands of the impossibility of maintaining high wages and other costs, the wage-earner continues to demand a return absolutely incompatible with the selling price obtainable. Some months ago a Clyde shipbuilding yard closed its gates, and now another firm has intimated its intention to close within three months. Again, a big pay-off occurred at yet another Clyde yard last week-end. The collieries are in a most unenviable position, and the steel and ironworks are doing next to nothing. The working out of the policy of high wages and restricted output must of necessity be a severe lesson to its followers, while at the same time imposing distressing conditions on trade and the community at large. Inquiries for all classes of products are numerous, but little or no chance is afforded to producers to secure any of the business passing. Markets are more or less idle and are simply carrying on until quotations assume a negotiable level.

The Position on the Clyde.

The serious state of matters on the Clyde has been recognised for a long time back, but recent stoppages have more forcibly brought to light the true position of affairs. With regard to Messrs. Yarrow's yard, the prospects are puzzling. Indications at present point to a universal closing down. Some firms have much work on hand yet. A considerable portion of this, however, is work delayed by sectional strikes and other causes, which otherwise would have been completed long ago. New orders are almost unknown meantime. On the other hand, there seems every probability of the Clyde sharing in new battleship construction. One opinion has it that practically nothing in the way of new orders will be placed for two years. Again, however, it may be said that with cheaper steel in prospect within a week or two, consequent on the reduction in the price of fuel, there seems reason for some hope that shipowners may be induced to place orders for new tonnage. Lower costs and a higher rate of production are the essentials to the re-establishment of the industry.

Pig Iron.

An effort is being made to re-start production of pig iron. Some furnaces have been re-lit, the drop in fuel prices giving smelters some encouragement to restore activities. A few furnaces will be in full blast within a week or two, and as fuel cheapens others will follow. Prices still remain purely nominal, the demand being infinitesimal. Stocks are now low, especially of foundry qualities.

Finished Steel and Iron.

Fair inquiries are coming forward, but current prices prove a barrier to firm orders. There are hopes of business with the Far East, however, a few orders for sheets having been received lately. Deliveries from the Continent are slowing down and home mills may benefit to some extent thereby. Local quotations have still to drop some pounds per ton to ensure a competitive position in the open market. Meantime steel and ironworks are just dragging along. Tube makers, however, have fair home and export orders in hand.

Coal.

Prices of coal continue to fall, and an early improvement in demand is expected. Buyers adhere to their policy of purchasing only immediate requirements, while some are refraining altogether. Collieries are becoming congested with stocks, and still cheaper prices must be established or production reduced meantime. Industrial demands are very light and house coal is little sought after. The latter is selling to-day at 2s. 9d. per hundredweight for medium grade. Export has increased slightly, a fair demand being experienced for bunker sorts. Shipments for the week amounted to 154,652 tons, against 116,406 in the preceding week and 324,349 tons in the same week in 1913.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

Foreign coal exports from South Wales totalled last week over 306,000 tons, which is the highest figure for the current year. This in itself is a very satisfactory position, particularly as the attitude of buyers abroad is to defer operating except for their most pressing requirements, which are kept to the minimum. In such circumstances one would be justified in expecting that before long the foreign coal trade will show considerable expansion. The amount of business done since the strike has been very good, considering all the conditions, but it is questionable whether trade will develop to any marked extent before the end of this year. As previously indicated, prices in the past three weeks have fallen substantially, and as long as the tendency of prices is downward, one cannot expect to see much buying. People abroad have yet to be convinced that the decline in prices is coming to the end, and therefore they are for the most part keeping off. Meanwhile stocks of coal are accumulating, except in the case of some special grades, and the difficulty experienced in clearing wagons promptly is handicapping collieries in maintaining regularity of work at the pits.

Suggested Remedy.

The remedy put forward for finding an outlet abroad for our coals is to cut our prices. Coal exporters, viz., the middlemen, who are not directly concerned in the costs of production are loud in proclaiming that prices must come down. Many people will, no doubt, be somewhat surprised that even at the present price of 35s. for better quality large steams, collieries are not making any profit. Their costs sheets for the past month will not be anything like as satisfactory as expected, and in the face of the fact that collieries in many, if not most, instances are getting down to unprofitable figures, the question arises how can a further material cut be made without seriously prejudicing the financial position of undertakings. The answer in most cases is that a bigger output will reduce the costs of production, but it is useless to make arrangements for a big output if there is not the demand for coal. If prices of South Wales coals were cut 5s. to-morrow, it is doubtful whether the demand would expand appreciably, because buyers would still hold off in the expectation of getting supplies at even lower figures. Furthermore, the fact is overlooked that foreign countries are in most cases worse situated industrially than this country. Everyone knows that industrial undertakings are not progressing to any considerable extent, and it will be months before they get into their stride. Their coal requirements are consequently restricted. The position abroad is similar, if not worse, so that the demand for coals cannot be extensive. In all the circumstances, the wisdom of severely cutting prices is doubtful. The slower and steadier process of reaching stable conditions will probably be more satisfactory than artificial methods of arriving at this end. The point is overlooked that even if production was increased, it is very doubtful whether it could be coped with at the ports. South Wales has not got the facilities for coping with a largely increased output, and if such were obtained collieries would get into a predicament for empty wagons, and intermittent stoppages of work would be brought about on this account alone. Working conditions at the docks would have to be revised, and instead of two eight-hour shifts for trimmers and tippers, labour would have to revert to the old conditions of work being maintained all round the clock.

Colliery Craftsmen.

Colliery craftsmen have definitely decided to revive the old Association, viz., the South Wales and Monmouthshire Enginemen's Stokers' and Craftsmen's Association, and to secede from the South Wales Miners' Federation. Towards the end of last week delegates of members of this old organisation met at Cardiff and agreed unanimously to go ahead with their proposal, and provisional officers were appointed as well as a Committee, and the subscription was fixed at 2s. per month for the time being. The President, Mr. W. J. Rowe, of Hirwain, stated that he had gone to the meeting convinced that no step should be taken until a ballot of the enginemen, craftsmen and stokers had been taken, but the spirit of the meeting and the tone of the letters read had convinced him that the men were determined to regain their own individuality, and therefore he had come to the conclusion that a ballot would be a waste of time and money. The conditions are certainly changing, and many miners are not satisfied with their organisation. The South Wales Miners' Federation has been under fire of late, and its policy severely criticised. A mass meeting of miners at Blaenavon on Tuesday passed a resolution that the agreement by which the Blaenavon lodges became affiliated with the Labour Party should be rescinded, and that in future the efforts and also the funds of the organisation should be devoted purely to industrial matters. This resolution was to be forwarded to the general secretary of the South Wales Miners' Federation with the request that a conference should be immediately called at Cardiff in order that the question of the reorganisation of the South Wales Miners' Federation might be discussed.

Coal Tippers.

The coal tippers of South Wales do not take very kindly to the scheme for the reduction of their wages. Swansea tippers stopped work on Friday in last week to consider grievances, but decided later in the day to continue work. However, the tippers throughout the district have agreed to fall into line. The Cardiff men have protested against the terms, at the same time acquiescing in the reduction provided for in the recent provisional agreement. It was explained that the minimum wage had been reduced by 15s. per week, and that there was a sliding scale reduction amounting to 25 per cent. on tonnage earnings and incidentals. The sliding scale reduction varies from August to December, commencing with 50 per cent. reduction in August, 45 per cent. in September, 40 per cent. in October, 35 per cent. in November, and 25 per cent. in December. The men, who have expressed dissatisfaction with the terms, have emphasised upon their representatives that when negotiations are resumed in the coming months, no settlement should be effected without first submitting the terms to them.

Colliery Developments.

Two new pit shafts are being sunk in the Treherbert district of the Upper Rhondda. That which is being sunk by the Glenavon Colliery Company is to reach the bottom measures, where there is a very substantial quantity of steam coal which is untapped. In the other case, the Fernhill collieries, of Blaencwm, are sinking the shaft in a district where the area of coal is very considerable. After completion of the sinking operations, it is expected that employment will be provided for between 1400 and 1800 men.

Works Restarting.

News is forthcoming almost every day of different works making a restart in South Wales. Work is likely to be recommenced at the big mill at Dowlais towards the end of this week, and providing that arrangements can be arrived at regarding wage costs, there is a probability of the English Crown Spelter Company restarting operations at Port Tennant, Swansea. This undertaking employed about 700 men before the slump in the spelter trade. The company has a quantity of ore on the spot, should work be possible. The works closed down in June, 1920, being one of the first to feel the effects of the decline in industry.

Cuts in Steel Bars.

The South Wales Siemens Steel Manufacturers' Association, in order to endeavour to meet foreign competition, has reduced steel bars by another £1 per ton, making the price £8 10s.

Current Business.

There is not a great deal of fresh business being done in Welsh coals except in the way of cargoes for fairly early delivery and for which prices have to be cut very fine. People abroad will do practically next to nothing for shipment very far ahead, as they are afraid of the market showing easier conditions. The French State Railways are reported to have contracted for some supplies on the basis of a little over 30s. per ton for Monmouthshire large, but the figures have not yet become known, and it is doubted whether the business is for shipment over the next month or two. Prices have not sagged during the past week. Dry coals are quiet in demand, but highly bituminous coals are firm and in great demand. In fact, highly bituminous smalls can command as much as superior large coals for this month's shipment. Patent fuel makers are experiencing a better inquiry, while pitwood is very steady at 39s. to 40s. Anthracite coals, particularly sized qualities, continue firm.

Latest News from the Provinces.

SHEFFIELD.

Rolling and Forging.

The proprietors of local rolling mills have reduced their charges for hire work by 7½ per cent., and the charges for forging and tilting 10 per cent. This movement is a sequel to the recent reduction of steel workers' wages.

WALES AND ADJOINING COUNTIES.

Swansea Metal Exchange.

The market continues very quiet, and business is scanty in proportion; while here and there works are re-starting, it is to be feared that others which resumed operations recently will come to a standstill again on account of the shortage of orders.

Coal Contracts.

It is now reported that French railways have purchased 20,000 tons of Admiralty and leading Monmouthshire large coals for delivery up to the middle of October at the price of 90f. c.i.f. This is approximately 38s. 6d., and taking the freight at 8s. for Rouen, the price left is a shade over 30s. for the coal. A contract for 20,000 tons of smalls, for delivery over the next two months, has also been arranged at round about 25s. c.i.f. A contract for British coaling stations is also reported to have been fixed up on the basis of 31s. per ton, f.o.b. for shipment up to the end of June next, for superior large steams.

In the August issue of the *Great Western Railway Magazine* appears an excellent article suggesting that the "Safety First" movement, initiated in this country by that company, should be followed by "another form of 'Safety' propaganda among railwaymen; another crusade or movement—one to preach clear thinking, to teach facts, and to combat discontent." The writer claims that this can best be done through railwaymen, because they "are an intelligent body of men. They are among the more respectable and more responsible sections of the community, because of the permanent nature of their employment, and because they are, to so great an extent, custodians of the public safety. They are also engaged in a public service, responsible not only to their employers, but also to the public. Workers in other industries look to railwaymen for a lead in important issues where clear thinking and sound judgment are required. It is because of that fact, and because of the inherent sound judgment and common sense of our men, that this article is written by an ordinary representative Great Western man to his fellow-railwaymen."

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	—
[1] Spanish	28/-
[1] N. African	30/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	37/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—[3]		
Hematite	9 0 0	—
No. 1 Foundry	8 15 0	—
No. 3 ,,	8 10 0	—
N.E. Coast—		
Hematite Mixed Nos.	8 0 0	—
No. 1	8 2 6	7 12 6
Cleveland—		
No. 1	—	—
Silicious Iron	—	—
No. 3 G.M.B.	6 15 0	6 15 0
No. 4 Foundry	6 10 0	6 10 0
No. 4 Forge	5 17 6	5 17 6
Mottled	5 17 6	5 17 6
White	5 15 0	5 15 0
Midlands.		
Staffs. *(All nominal, waiting early reduction).*—		
All-mine (Cold Blast)	17 0 0 to 17 7 6	
Part Mine Forge	8 0 0	
,, Foundry No. 3	9 0 0 to 9 5 0	
Northampton [3] *(All nominal, waiting early reduction).*—		
Foundry Nos. 2 and 1	8 10 0	
,, No. 3	8 0 0 to 8 5 0	
,, Forge	6 17 6	
Derbyshire [3] *(All nominal).*—		
No. 3 Foundry	8 0 0 to 8 5 0	
Forge	7 0 0	
Lincolnshire [3]—		
Basic	*Uncertain.*	
Foundry	,,	
Forge	,,	
N.W. Coast— [3]		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	8 0 0	
Special	9 0 0 to 11 0 0	

MANUFACTURED IRON

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	16 0 0	—
Best ,,	17 0 0	—
N.E. Coast—		
Crown Bars	16 0 0	19 0 0
Best ,,	17 0 0	20 0 0
Tees	15 10 0	15 10 0
Lancs.—		
Crown Bars	16 0 0	—
Hoops	20 5 0	20 0 0
S. Yorks.—		
Crown Bars	16 0 0	—
Best ,,	17 0 0	—
Hoops	20 5 0	—
Midlands—		
Marked Bars (Staffs.)	20 0 0	—
Crown Bars	16 0 0	—
Nut and Bolt Bars	16 0 0	—
Black Sheets (dbls. nom.)	18 0 0	—
Galv. Sheets, 24 W.G. (f.o.b. L'pool, or equal)	22 10 0 to 25 0 0	
Gas Tube Strip	20 0 0	—

STEEL.

	Home.[5] £ s. d.	Export.[6] £ s. d.
Scotland—[4]		
Boiler Plates	20 0 0	—
Ship Plates ⅜in. and up	15 0 0	—
Sections	14 10 0	—
Steel Sheets 1/16in. to ⅜in.	16 5 0	—
Sheets (Gal. Cor. 24 B.G.)	—	24 0 0

STEEL (*continued*)

N.E. Coast—	Home. £ s. d.	Export. £ s. d.
Ship Plates	15 0 0	14 0 0
Angles	14 10 0	13 10 0
Boiler Plates	21 0 0	21 0 0
Joists	14 10 0	13 10 0
Heavy Rails	14 0 0	—
Fish-plates	19 0 0	—
Channels	14 10 0	—
Hard Billets	13 0 0	—
Soft Billets	11 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	14 0 0	—
Light ,,	17 0 0 to 19 0 0	
Billets	13 0 0	—
Ship Plates	15 0 0	—
Boiler ,,	21 0 0	—
Manchester *(Prices irregular and uncertain, unchanged)*—		
[7] Bars (Round)	14 0 0 to 16 0 0	
[7] ,, (others)	15 0 0 to 16 10 0	
Hoops (Best)	20 5 0	20 0 0
,, (Soft Steel)	17 5 0	17 0 0
Plates	15 0 0	—
,, (Lancs. Boiler)	21 0 0	—
Sheffield *(Prices irregular and uncertain)*—		
Siemens Acid Billets	16 0 0	—
Bessemer Billets	15 10 0	—
Hard Basic	13 0 0	—
Soft ,,	12 0 0	—
Hoops	17 5 0	—
Soft Wire Rods	13 15 0	—
Midlands—		
Small Rolled Bars	12 10 0 to 14 10 0	
Soft Billets and Bars	12 0 0	—
[2] Hoops	17 0 0	—
Tube Strip	12 10 0 to 13 10 0	
Angles and Joists	14 10 0	—
Tees	15 10 0	—
Bridge and Tank Plates	15 0 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	24/- to 25/-
Block Tin (cash)	154 15 0
,, (three months)	156 0 0
Copper (cash)	69 10 0
,, (three months)	69 17 6
Spanish Lead (cash)	23 12 6
,, (three months)	23 5 0
Spelter (cash)	25 2 6
,, (three months)	25 15 0
Manchester—	
[8] Copper, Best Selected Ingots	70 10 0
[8] ,, Electrolytic	74 10 0
[9] ,, Strong Sheets	103 0 0
,, Loco Tubes	0 1 3½
Brass Loco Tubes	0 1 1½
,, Condenser	0 1 5½
Lead, English	24 15 0
,, Foreign	23 10 0

(*Metal prices practically unchanged*).

FERRO ALLOYS,

(*All prices now nominal*).

	Per Ton.	Per Unit
Tungsten Metal Powder	2/- per lb.	
Ferro Tungsten	1/6 to 1/8 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£36	12/-
,, 6 p.c. to 8 p.c. ,,	£34	12/-
,, 8 p.c. to 10 p.c. ,,	£34	12/-
,, Specially Refined		
Max. 2 p.c. carbon	£80	28/-
,, 1 p.c. ,,	£95	32/-
,, 0·75 p.c. carbon	£110	41/-
,, carbon free	2/8 per lb.	
Metallic Chromium	5/6 per lb.	
Ferro Manganese	(per ton) £18 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£14 10 0 scale 6/- per unit	
,, ,, 75 p.c.	£21, scale 6/- per unit	
,, Vanadium	22/- per lb.	
,, Molybdenum	9/- per lb.	
,, Titanium (carbon free)	1/6 per lb.	
Nickel (per ton)	£190	
Cobalt	15/- per lb.	
Aluminium (per ton)	£110 to £120	

(British Official).

FUELS.

	Export.
Scotland.	
Lanarkshire—	
(f.o.b. Glasgow)—Steam	29/-
,, ,, Ell	31/6
,, ,, Splint	30/- to 33/6
,, ,, Trebles	29/6
,, ,, Doubles	27/6
,, ,, Singles	26/-
Ayrshire—	
(f.o.b. Ports)—Steam	29/-
,, ,, Splint	30/-
,, ,, Trebles	29/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	26/- to 30/-
Screened Navigation	35/-
Trebles	30/-
Doubles	29/-
Singles	25/-
Lothians—	
(f.o.b. Leith)—Best Steam	29/-
Secondary Steam	27/6
Trebles	29/-
Doubles	27/-
Singles	25/-
England.	
[10] N.W. Coast—	
Steams	44/-
Household	56/8 to 60/-
Coke	45/- to 48/-
Northumberland—	
Best Steams	30/- to 32/6
Second Steams	27/6 to 30/-
Steam Smalls	13/- to 15/-
Unscreened	22/6 to 27/-
Household	35/- to 40/-
Durham—	
Best Gas	35/- to 37/6
Second	27/6 to 30/-
Household	35/- to 40/-
Foundry Coke	45/- to 55/-
Sheffield— [11]	
S. Yorks. Best Steam Hards	33/2 to 33/8
Derbyshire Hards	32/8 to 33/2
Seconds	31/8 to 32/2
Cobbles	31/8 to 32/2
Nuts	31/2 to 32/2
Washed Smalls	28/8 to 30/2
Best Hard Slacks	20/- to 25/-
Seconds ,,	20/- to 23/-
Soft Nutty ,,	20/- to 25/-
Pea ,,	18/- to 22/-
Small ,,	15/- to 18/-
House, Branch	40/2 to 40/8
,, Best Silkstone	36/8 to 37/2
Blast Furnace Coke	(45/-, 55/- export)
[12] South Wales.	
Cardiff—	
Steam Coals:	
Best Smokeless Large	36/6 to 37/6
Second ,, ,,	35/- to 36/-
Best Dry Large	35/- to 37/-
Ordinary Dry Large	33/- to 34/-
Best Black Vein Large	34/- to 35/-
Western Valley ,,	34/- to 35/-
Best Eastern Valley Large	32,6 to 35/-
Ordinary ,, ,,	30/- to 32,6
Best Steam Smalls	19/- to 20/-
Ordinary ,,	12/6 to 17/6
Washed Nuts	36,6 to 38,6
No. 3 Rhondda Large	45/- to 47/6
,, ,, Smalls	32,6 to 35/-
No. 2 ,, Large	32,6 to 35/-
,, ,, Through	25/- to 26/-
,, ,, Smalls	16,6 to 17/6
Coke (export)	60/- to 65/-
Patent Fuel	37/6 to 40/-
Pitwood (ex ship)	39/- to 40/-
Swansea—	
Anthracite Coals:	
Best Large	55/- to 57/6
Seconds	55/- to 57/6
Red Vein	55/- to 57/6
Big Vein	55/- to 57/6
Machine-made Cobbles	70/- to 72/6
Nuts	72/6 to 75/-
Beans	60/- to 65/-
Peas	42/6 to 45/-
Breaker Duff	15/- to 17/6
Rubbly Culm	21/- to 24/6
Steam Coals:	
Large	38/- to 40/-
Seconds	36/- to 38/-
Smalls	17/6 to 20/-
Cargo Through	29/- to 30/-

[1] Delivered. [2] Net Makers' works. [3] At furnaces. [4] Glasgow, Lanarkshire and Ayrshire

[5] Home Prices—All delivered Glasgow Station. [6] Export Prices—F.O.B. Glasgow.

[7] Prices represent the real market before the *official* change was made. [8] These prices are practically alike now.

[9] Sheets reduced while other prices are advancing. [10] Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export.

[11] For inland sales. [12] Per ton f.o.b.

French Engineering Notes.

(*From our Correspondent in Paris.*)

Export Facilities.

THE stagnation of the iron and steel trades is due partly to the large increase in the country's production through the addition of the manufacturing resources of Alsace-Lorraine and the Saar. The production now so far exceeds the home requirements that the surplus can only be disposed of on foreign markets, and the situation is complicated by the fact that it is almost impossible to compete with Belgium and Germany, in which countries the productive costs are very much less. For some time past the Government has been considering the ways and means of coming to the assistance of the metallurgical industries, and negotiations are now being carried out whereby the prices of coke will be appreciably reduced and much greater rebates will be allowed on the railway charges for export. While Germany has been required to deliver large quantities of coke the prices delivered at the frontier are so much below those paid for French coke that the Government imposed a tax on the German fuel as a protection for the French ovens. It is now intended to reduce that tax to permit of ironfounders being supplied with cheaper coke. At the same time the rebate of 25 per cent. on the railway rates as applied to goods for export is to be increased, although to what extent is not yet known. It is probable that effect will be given before long to other proposals for reducing the prices of French metallurgical products on foreign markets.

Locomotives.

The statement that the P.L.M. and the Orleans railway companies were on the point of giving out orders for locomotives was particularly welcome to builders, who were finding themselves very short of work, but although the railway companies are in need of locomotives, it appears that there is little prospect of contracts being given out for some time, on account of there being insufficient funds available for the purpose. What gave rise to the rumour was the intention of the P.L.M. and the Orleans companies to purchase a number of electric locomotives required for the electrification scheme, which is being actively proceeded with and is helping to provide satiafactory employment for the electrical engineering firms. Steam locomotive builders have been promised large orders from Poland, but the financial situation which prevents the distribution of contracts in this country is considerably worse in Poland, where the requirements are being met for the time being with locomotives surrendered by the Germans after the Armistice.

Tidal Power.

The Commission appointed at the Ministry of Public Works to examine proposals for the laying down of experimental tidal power installations has given particular attention to the preliminary schemes for utilising the tides at Aber-Vrac'h, near Brest, where the difference between high and low water levels is about 8 m. Complete plans have now been prepared and presented to the Commission, which has transmitted them to the Minister of Public Works, and the usual public inquiry is to be carried out as rapidly as possible, so that the work can be put in hand with the least delay. The concession is being applied for by a financial group, which will constitute a company of which the share capital of 15 million francs will be subscribed by the State and an additional 13 million francs will be raised by an issue of debentures. From a technical point of view the most serious obstacle was the construction of turbines which would resist the action of the sea water. That difficulty has, it is now stated, been satisfactorily overcome, and turbines will be supplied by Messrs. Escher Wyss et Cie., of Zurich. The scheme provides for the construction of a barrage 150 m. long, the height being 4 m. above high water level. It will be formed of ferro-concrete caissons. In the central caisson will be installed four turbines, each of 1200 horse-power, and two alternators which will generate current under a tension of 1500 volts. The barrage will have a hold up from two to three million cubic metres of water, according to the height of the tide. The turbines will be reversible, so as to operate on the rising and falling tides, and to prevent any interruption between the tides, a barrage 30 m. high will be constructed across the Diouris.

Morocco Railways.

By the completion of the section of railway between Fez and Taza there is now direct communication between Algeria and Casablanca and Marakech. Begun ten years ago, the 60 cm. gauge railway in the Protectorate has a length of 1300 kiloms., and although the work of construction has not been rapid, it was continued without serious interruption throughout the war, often under very serious difficulties. The building of the Fez-Taza section was a particularly arduous undertaking, passing as it does through a mountainous region where fifteen bridges had to be constructed of from 20 m. to 100 m. in length, while embankments more than 20 m. high had to be made, as well as numerous deep cuttings through rocks.

Aviation.

In a communication on the future of aviation, presented at the Congress of the Advancement of Science at Rouen, M. Louis Breguet pointed to remarkable achievements in the future as regards the speed of aeroplanes, which, he was convinced, would eventually be able to travel from Paris to Buenos Ayres in five stages in less than two and a-half days. Such a machine would have a wing surface of 250 square metres, and would be propelled by engines of 2000 horse-power. Travelling at speeds from 200 to 250 kiloms. an hour, it would carry twenty passengers, a crew of seven, a ton of luggage, and about 4 tons of fuel. M. Louis Breguet claims that these predictions are based upon results already obtained. He states that aeroplanes are now under construction with engines of 4000 and even 5000 horse-power.

British Patent Specifications.

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

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

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

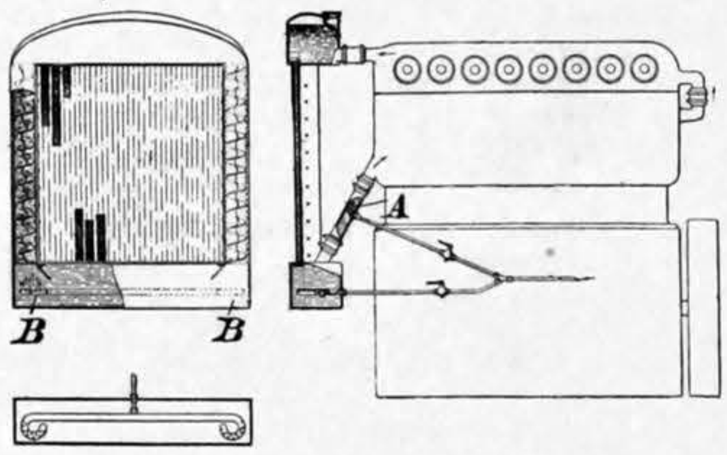
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of th complete Specification.

INTERNAL COMBUSTION ENGINES.

165,556. April 9th, 1920.—COOLING WATER SYSTEMS, R. M. Alexander, 1, St. Luke's-road, Maidstone.

The inventor proposes to increase the speed of circulation of the cooling water by introducing a jet of compressed air A in

Nº165,556



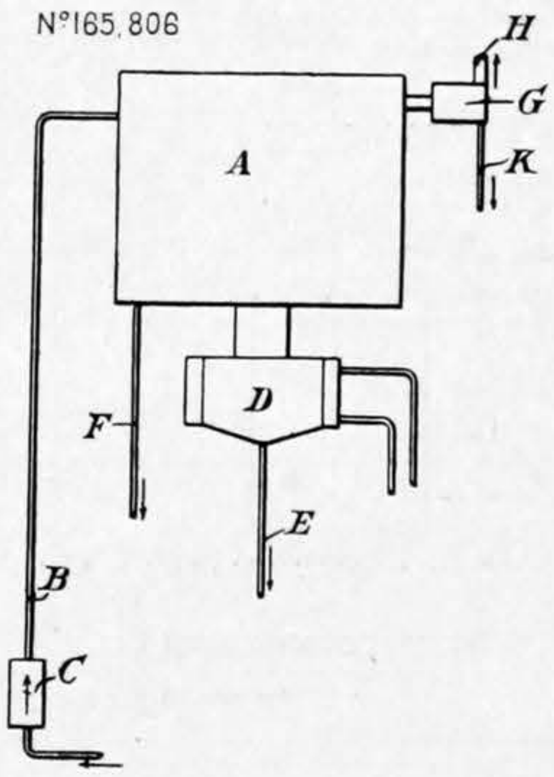
the riser connecting the radiator with the cylinder jacket. For the purpose of reducing the temperature of the water he bubbles air up through the water from perforated pipes B B, and allows it to escape at the top. Spiral baffles are arranged in the radiator to check the ascent of the bubbles.—*July 7th*, 1921.

DYNAMOS AND MOTORS.

165,806. July 11th, 1921.—IMPROVEMENTS IN OR RELATING TO THE COOLING OF DYNAMO ELECTRIC MACHINES, Vickers, Limited, of Vickers House, Broadway, Westminster, and Allan Bertram Field, of the same address.

This specification, which is a long one, deals with a method of cooling which involves the evaporation of a cooling medium, which, at a favourable pressure, has a boiling point somewhat below the temperature at which the insulation of the machine is liable to injury. This medium is circulated through passages in the rotor or stator, or both, thus converting the greater part of the liquid into vapour. The mixture is then withdrawn from the machine and passed through a cooling apparatus, which

Nº165,806

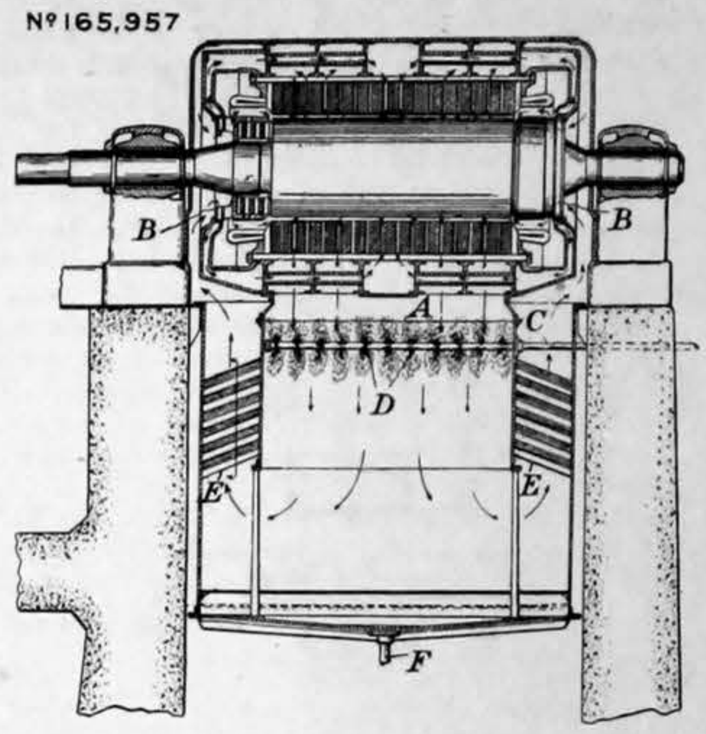


condenses the vapour and cools the resultant liquid, which is then delivered to the pumps, which again circulate the medium through the machine. In the diagram A is the turbo-generator, B a pipe leading to the generator from a sump containing the evaporable cooling medium. C is a pump, D a surface condenser with inlet and outlet pipes on the right for the circulating water. E is a pipe through which the medium, after condensation, leaves the condenser on its way to the sump. F is a pipe also communicating with the sump for drawing off the surplus or unvolatilised part of the medium from the generator A. G is an air pump for use when a sub-atmospheric pressure is maintained within the generator, the pump having an air discharge pipe H and a connection K leading to the sump.—*July 11th*, 1921.

165,957. April 8th, 1920.—IMPROVEMENTS IN AND RELATING TO VENTILATING SYSTEMS FOR DYNAMO ELECTRIC MACHINES, The British Thomson-Houston Company, of 83, Cannon-street, E.C. 4.

This specification describes an improved ventilating system of the closed circuit type, that is, a system in which the same air is used continuously. The machine is provided with air circulating passages designed to direct the current of air toward and around the parts tending to be heated, and finally outward through exhaust port A. The rotating member of the machine is provided with fan members B at either end, which are adapted to maintain a circulation of the cooling medium. Extending across the central chamber is the air washer, which comprises a pipe C or a number of pipes connected to a fresh water supply and having a plurality of spray nozzles D. The heated air, after passing through the exhaust port of the machine, passes through the air washer. The supply ducts are fitted with corrugated metal plates E which collect any particles of moisture carried over by the air, and the particles are drained to the bottom of

Nº165,957

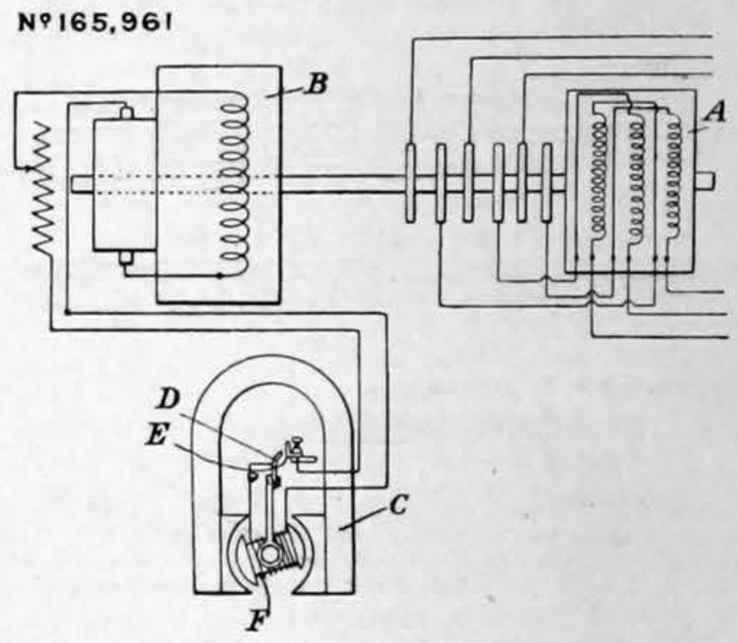


the tank, where this water and that from the spray nozzles is collected by a drain pipe F.—*July 8th*, 1921.

165,961. April 9th, 1921.—IMPROVEMENTS IN AND RELATING TO DYNAMO ELECTRIC MACHINES, The British Thomson-Houston Company, 83, Cannon-street, London, E.C. 4, and Frank Percy Whitaker, of 237, Clifton-road, Rugby.

This invention relates to rotary converters which are started with an induction motor connected in series with the slip rings, and the object is to prevent the reversal of polarity when starting. A is the starting motor, and B the rotary converter. If the polarity of the rotary converter is correct, current will flow

Nº165,961



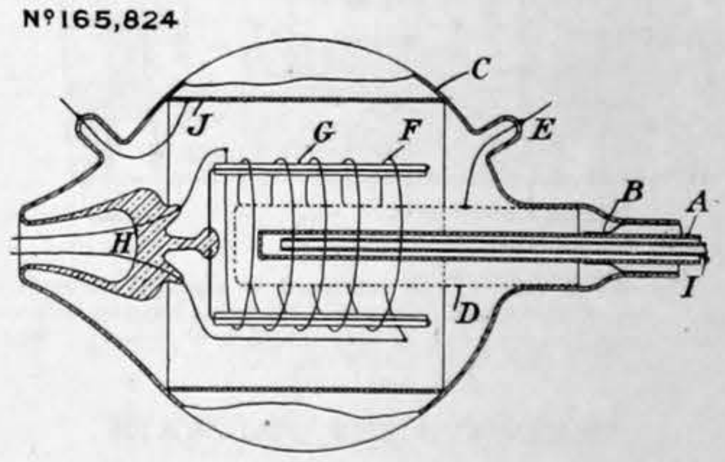
through the armature of the relay C so as to hold the field circuit closed at contacts D, E. If, however, the field tends to build up in the wrong direction, the armature F will be moved so as to open the field circuit at contacts D, E, or reverse it with respect to the armature of the rotary converter, and so prevent the converter from building up with the wrong polarity. Even if the field poles of the converter have accidentally acquired a residual magnetism in the wrong direction, the action of the electro-magnetic relay is such that the rotary converter will eventually build up in the correct direction.—*July 11th*, 1921.

WIRELESS TELEGRAPHY.

165,824. May 5th, 1919.—IMPROVEMENTS IN THERMIONIC TRANSMITTING DEVICES FOR WIRELESS TELEGRAPHY AND TELEPHONY, Henry Joseph Round, of 9, Woodberry-crescent, Muswell Hill, London, N.

The thermionic valve described in this specification has the anode inside the grid, and the filament outside, and the anode is made hollow, so that it may be cooled with oil or water. A is a hollow metal tube closed at its inner end and sealed at B into

Nº165,824



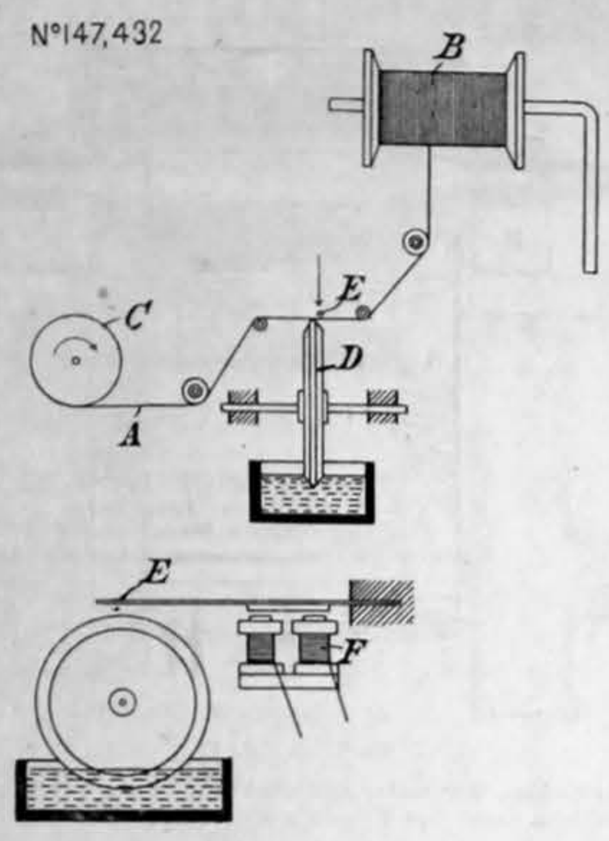
the glass of the bulb C and acting as the anode. It is surrounded by a grid D the lead from which passes out through the glass at E. F is a filament which is arranged preferably as a coil around the grid and is maintained in position by supports G, the leads from the grid being sealed through the glass at H. I is a tube which is arranged along the axis of the anode A and through which cooling fluid may be introduced. J is a cage or sheath of metal surrounding the filament for the purpose of preventing the emission from reaching the glass.—*July 11th*, 1921.

TELEGRAPHS AND TELEPHONES.

147,432. July 14th, 1921.—IMPROVEMENTS IN TELEGRAPHY, Gesellschaft fur Drahtlose Telegraphie, m.b.H., of 9, Tempelhofer Ufer, Berlin, Germany.

The object of this invention is to provide a substitute for the paper tape commonly employed for the transmission of Morse signals. A is the thread which is drawn from a reel B on to a reel C, and passes around guide rollers between which is a wheel D dipping in a trough of coloured ink.

The thread is intermittently pressed against the surface of the wheel by a blade E attached to the armature of an

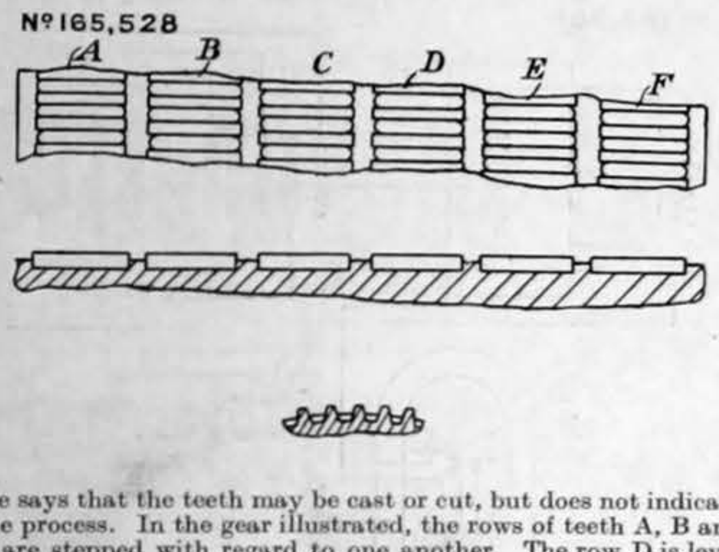


electro-magnet F. The specification also describes a transmitter which operates on a similar principle.—*July 14th*, 1921.

TRANSMISSION OF POWER.

165,528. March 27th, 1920.—TOOTHED GEARING, J. Pollock, 91, Victoria-gardens, Chichester Park, Belfast.

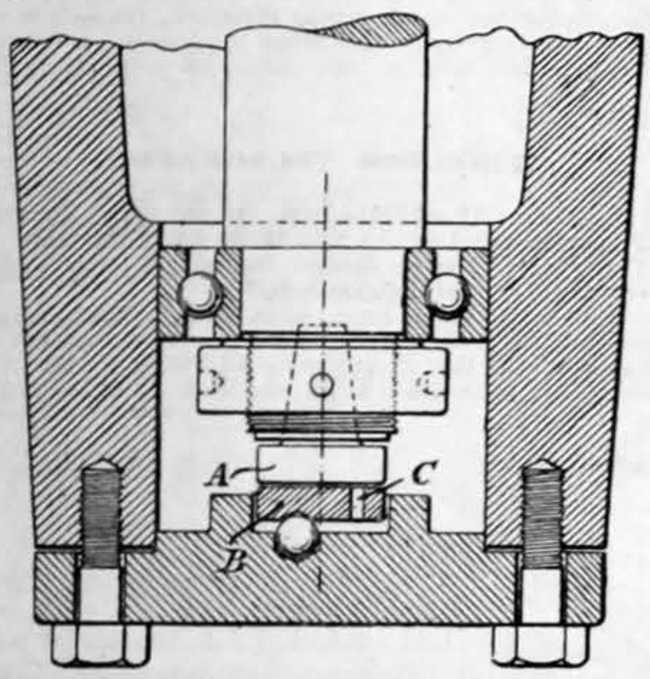
The inventor proposes to step, or stagger, the teeth of gear wheels, and to provide shrouding between each of the steps.



He says that the teeth may be cast or cut, but does not indicate the process. In the gear illustrated, the rows of teeth A, B and C are stepped with regard to one another. The row D is level with row C, and then another set of steps is introduced.—*June 27th*, 1921.

165,715. January 12th, 1921.—FOOTSTEP BEARINGS, *B. E. D. Kilburn, 31–33, High Holborn, London, W.C. 1.*

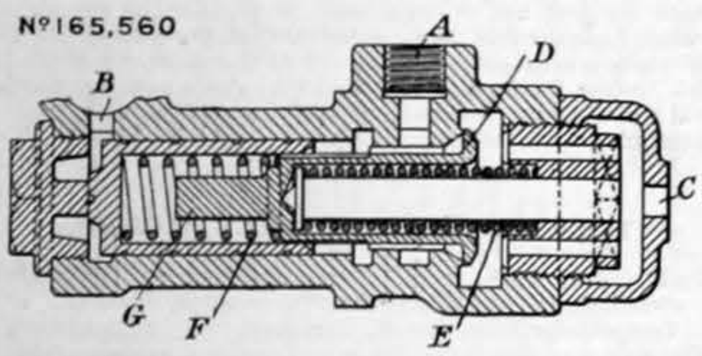
In this footstep bearing the load is supported by a pin A bearing in a flat plate B. The plate rests on a ball which is



excentric to the shaft, and lubricant is supplied through the hole C, opposite the ball. It is said that this bearing will carry greater loads, irrespective of the direction of rotation, than is possible with other types.—*July 7th*, 1921.

TRAMWAYS AND RAILWAYS.

165,560. April 12th, 1920.—VALVES FOR AIR BRAKES, The Westinghouse Brake Company, Limited, and K. H. Leech, 82, York-road, King's Cross, London, N. 1.

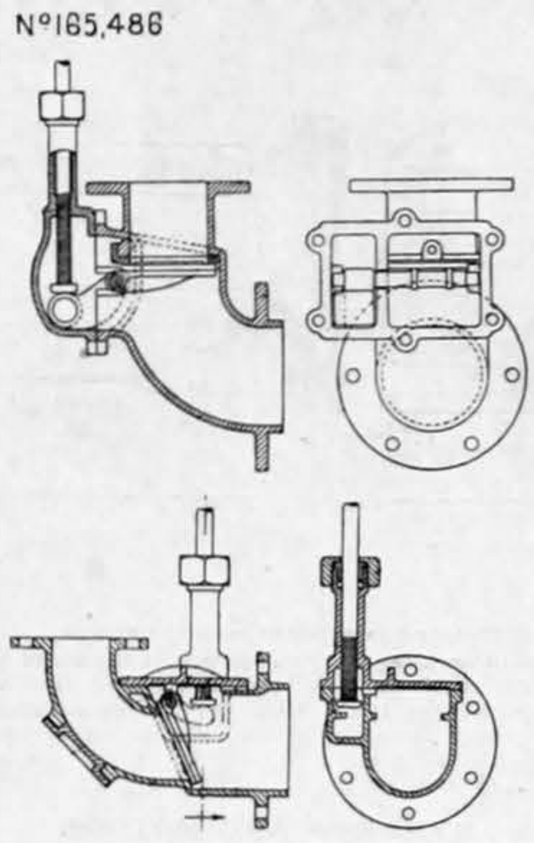


This release valve is fitted in the usual manner to control communication between the exhaust port of the triple valve of the braking apparatus and the atmosphere. The branch A connects with the triple valve, and the port B communicates with the train pipe, while C is open to the atmosphere. The valve itself is shown at D, and is kept on its seat by the spring E. Another spring F, bearing against a sliding plunger, tends to open the valve, but in the position shown is not sufficiently strong to oppose the spring E effectively. If, however, the pressure in the train pipe is increased, the plunger is pushed forward and compresses the spring F until it can overcome the spring E, when the valve D is opened and establishes communication between A and C. If the spring F fails, the plunger comes into contact with the projection G on the valve and ensures the valve being opened.—*July 7th*, 1921.

SHIPS AND BOATS.

165,486. January 21st, 1920.—STORM VALVES FOR SHIPS' SCUPPERS, Cammell Laird and Co., Limited, Sir G. J. Carter, J. D. Murray, and N. B. J. Peacock, Birkenhead.

This valve, for ships' scuppers or soil pipes, is intended to be closed in cases of emergency, when it is necessary to prevent sea water coming in and flooding the ship. Its chief peculiarity

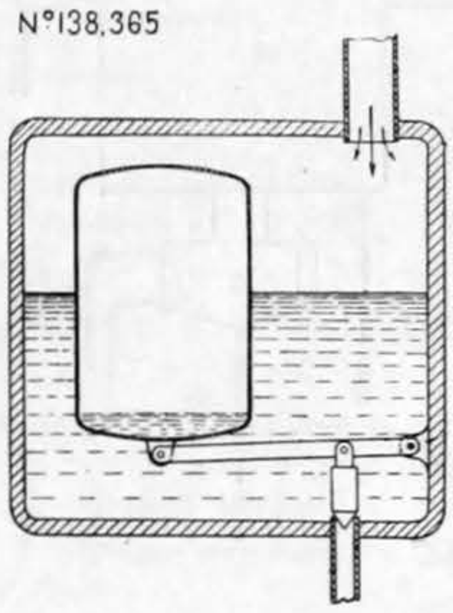


lies in the method of actuation, which is said to prevent the valve being distorted by improper use. The valve, it will be seen, is of the flap type, and has its spindle extended at one end. On this extension there is a lever, against which a threaded spindle is screwed down. Two types of valve are illustrated.—*June 21st*, 1921.

MISCELLANEOUS.

138,365. January 29th, 1920.—FLOAT VALVES FOR REFRIGERATORS, E. Ruegger, Hardturmstrasse, 19, Zurich, Switzerland.

It is necessary that the floats of valves used to control refrigerating machines should be light in comparison with their displacement. At the same time, however, they have to with-



stand an external pressure. The inventor thus makes the float as light as possible, and puts inside a small quantity of liquid ammonia, or sulphur dioxide, or a mixture of liquids which will have a vapour pressure above that of the atmosphere at a temperature of 20 deg. Cent. The pressure of the vapour inside the float then helps to balance the external pressure and relieve the walls of the float.—*June 29th*, 1921.

Forthcoming Engagements.

MONDAY, AUGUST 22ND.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Through the courtesy of the Gofa Tire Company, Limited, Gargrave, arrangements have been made to visit their works. Motor vehicles will leave Town Hall Square 1.30 p.m. prompt.

MONDAY TO SATURDAY, SEPTEMBER 5TH TO 10TH.

IRON AND STEEL INSTITUTE.—Autumn meeting in France.

WEDNESDAY TO WEDNESDAY, SEPTEMBER 7TH TO 14TH.

BRITISH ASSOCIATION.—Annual meeting in Edinburgh. For programme see page 154.

WEDNESDAY, THURSDAY AND FRIDAY, SEPTEMBER 21ST, 22ND, AND 23RD.

THE INSTITUTE OF METALS.—Autumn meeting in Birmingham. For programme see page 151.

CATALOGUES.

T. L. REED COOPER, 11, Tothill-street, Westminster, London, S.W. 1.—New illustrated list of immersible electric pumps.

SUFFOLK IRON FOUNDRY (1920), Limited, of Gipping Works, Stowmarket.—Pamphlet giving particulars of Super-Silicon welding rods for cast iron.

MARRYATT AND SCOTT, Limited, Hatton-garden, London, E.C.—Exceedingly well got up and illustrated catalogue of various types of lifts, including those with automatic control, with their accessories.

ALFRED HERBERT, Limited, Coventry.—Catalogue Section E6, fourth edition, devoted to turret lathe tools and containing a series of excellent illustrations of numerous accessories designed for use with such tools.

SIR W. H. BAILEY AND CO., Limited, Albion Works, Salford, Manchester.—Catalogue Section 6, No. 221, giving illustrations and particulars of numerous types of power pumps designed for a great variety of purposes.

MAVOR AND COULSON, Limited, 47, Broad-street, Mile End, Glasgow.—First issue of a monthly journal entitled *M. and C. Machine Mining*, which contains several articles of interest, including a description of the firm's "Universal" coal cutter.

JOHN H. WILSON AND CO., Limited, Dock-road, Birkenhead.—Illustrated catalogue 55 W/1921, giving particulars of ships' deck machinery, including electric cargo and lifeboat winches and windlasses, steam-driven cargo winches, steam windlasses and capstans, &c.

THE CITY ELECTRICAL COMPANY, Limited, of 1, Emerald-street, London, W.C. 1.—Revised catalogue of direct-current motor starters, speed regulators and shunt resistances. New features are the firm's improved combined starter regulators and a new form of inching starters.

BARIMAR, Limited, 10, Poland-street, Oxford-street, London, W. 1.—Well illustrated and got up brochure entitled "The Welding Test," which contains a large amount of information regarding the Barimar system of welding and numerous engravings of broken articles repaired by it.

WATTS BROTHERS (SHEFFIELD), Limited, Triumph Works Keetons'-hill, Sheffield.—Well got up and illustrated catalogue of woodworking machines, including circular saw benches of various types, fretsawing machines, plane iron grinding machines, tenoning machines, mortising machines, wood trimmers, vises, &c.

J. PARKINSON AND SON, of Shipley, Yorks., have sent us a copy of their publication AA 3, which is entitled "What Others Say of the 'Sunderland' Gear Planers," and which comprises a series of copies of letters written by satisfied users of those machines. At the end of the little book there are several photographs showing various sizes of machines and gears produced.

SIMPLEX CONDUITS, Limited, Garrison-lane, Birmingham.—Copy of the July issue of "Installation News," containing, among other items, articles on "Earthing of Factory and Works Installations" and on "Wiring in Modern Concrete Buildings," and descriptions of the firm's standard pattern hand lamp, colliery lighting system and lanterns for industrial and street lighting.

EDUCATIONAL INTELLIGENCE.

MR. H. P. PHILPOT, B.Sc., A.M. Inst. C.E., Assistant Professor at University College, has been appointed to the Professorship of Civil and Mechanical Engineering at the Finsbury Technical College; and Mr. A. J. Hale, B.Sc., F.I.C., Chief Assistant in the Department of Applied Chemistry, to the Professorship in that Department. The entrance examination of the College will be held on Tuesday, September 20th.

BRITISH INDUSTRIES FAIR AT BIRMINGHAM.—In connection with the British Industries Fair, which is to be held from February 27th to March 10th next year, in addition to the classification under which exhibits have hitherto been invited for the Birmingham section, the Board of Trade has now included the following:—Engineering in general; all metals, ferrous and non-ferrous, excluding precious metals; agricultural implements and appliances; mining, colliery and quarrying; brewing, distilling, and catering plant; and construction, building, and decorating.

"ARMSTRONG WHITWORTH SHIPS."—A very handsome and interesting souvenir bearing the above-named title has been sent to us by Sir W. G. Armstrong, Whitworth and Co., Limited, in commemoration of the fact that with the launch of the Cunard liner Ausonia the firm has now produced a total of three million tons of shipping. Since the first keel was laid in the Walker Yard in 1852 the firm has built 1000 vessels, of which 800 were passenger and merchant ships. The Elswick Yard was some time ago, as is well known, found inadequate to meet the demand for larger vessels, and in 1913 the company opened its new Armstrong Yard adjoining the Walker Yard. This new yard has ten slips, is capable of accommodating larger vessels than any yet projected, and has a capacity by itself for 100,000 tons of shipping per annum. The souvenir takes the form of a list of the vessels which the firm has produced and a selection of excellently reproduced photographs of some typical examples of Armstrong warships, passenger vessels, train ferries, oil tankers, ice-breakers, &c. At the present moment the company is building Cunard and P. and O. liners and many cargo vessels. The souvenir is a most interesting production, and is well worthy of the great enterprises of a great firm.

UTILISATION OF WASTE TIMBER AND COTTON STALKS.—An enormous amount of wood is wasted in the process of converting the felled tree into merchantable timber. It has been estimated that in the United States alone the quantity of wood waste produced annually in the saw mill amounts to 4000 million cubic feet. Much of the wood at present wasted could be utilised for such purposes as the manufacture of paper pulp, and the production of turpentine, acetic acid and other products. The question has recently received consideration in New Zealand, and it has been suggested that the waste in some instances might be used for papermaking in place of imported wood pulp. In order to ascertain the suitability of certain New Zealand timbers for this purpose, an investigation has been conducted at the Imperial Institute, the results of which are recorded in the current number of its quarterly *Bulletin*. It was found that the timbers examined could all be used for the manufacture of paper pulp, but whether such an industry would be profitable in New Zealand would depend on purely economic factors, such as the quantity of waste wood available, its cost at the pulp mill and the price of fuel and chemicals, &c. Another article in the same *Bulletin* deals with the problem of the commercial utilisation in cotton-growing countries of the vast quantities of cotton stalks which are produced each year, and have to be removed from the fields after the cotton crop has been gathered. Investigation at the Imperial Institute has shown that the stalks form a promising material for paper-making, and that they might also be used for obtaining acetic acid, tar and charcoal by a process of dry distillation.