Literature.

Die Zwei Weissen Völker. Georg von Hase. Koehler, Leipzig.

[CONCLUDING NOTICE.*]

THE BATTLE OF JUTLAND.

AT this period, says Commander von Hase, shell upon shell came crashing into the Derfflinger. "The enemy was shooting splendidly. My heart stood still as I thought of what must be happening inside the ship. . . . My thoughts were rudely interrupted. Suddenly it was for us as if the world had come to an end. A tremendous roar, a mighty detonation, and then darkness fell upon us. We felt a terrific blow; the whole conning-tower, which reeled as if shaken in a giant's grip, was thrown upwards, and then settled down vibrating on its base. A heavy projectile had struck the G.C.T. some 20in. from where I was standing. The shell exploded without, however, piercing the armour, which it had struck at a sharp angle. But huge pieces of armour were torn away, and noxious greenish yellow gas poured into the tower through the look-out slits. 'On gas masks!' I shouted; and continued to control the fire with my own mask on, which made my orders difficult to understand." The gas soon dispersed, and an examination of the control instruments showed everything to be in working order. Splinters entering through the look-out slits of the conning-tower wounded several people, including the navigating officer. The explosion had burst open and jambed the armoured door, and two men vainly strove to close it. A moment later another 15in. shell exploded beneath the bridge, ripping up the deck plating and blowing overboard everything that was not firmly riveted down. The chart-house disappeared bodily, and the blast of air slammed the armoured door of the conning-tower to. "A polite fellow, the Englishman. Having opened the door, he kindly closed it for us!" Practically nothing of the British ships could be seen from the Derfflinger, though their position was revealed by great, golden-red flashes from the guns.

Commander von Hase states that without much hope of hitting anything he ordered salvo after salvo to be fired from the forward turrets—the only two that remained serviceable. "I could feel how our fire was soothing the nerves of our crew. If we had not fired at this moment the entire company of the ship would have given way to profound despair, for they all realised that if things went on like this much longer we should be lost. But so long as we were firing there must be hope. The secondary armament also joined in, though only two of the six guns on this side were still in action. In 'B' turret the training pointer broke down, so that only one turret could now be accurately controlled from the G.C.T." At 9.18 p.m. the German battle-cruisers were ordered by the Commander-in Chief to turn from S. to W. by S. This brought the British line almost dead astern, where they could no longer be seen from the fore G.C.T., and the guns had therefore to be controlled from the after tower. But the reversal of the switches could only be effected from the T.S., which had been temporarily abandoned. In consequence, the two remaining turrets could not be controlled, and were ordered to fire independently. As, however, their arc of training was only 220 deg., they could not fire on a target which bore on the quarter. For a time, therefore, the Derfflinger, with both after turrets disabled, could not fire a shot. During the turn to W. by S. she discharged a torpedo at 8750 yards, no result being claimed. The change of course was masked by destroyer attacks, which appear to have been as unsuccessful as all the preceding German attacks of the kind had proved during the battle. Whatever the case may have been with other German weapons, it cannot be said that the German destroyers gained any laurels at Jutland. At 9.23 p.m. the T.S. was again in occupation. It appears that the poisonous gases had poured into the room through the voice pipes leading to "C" and "D" turrets, where the burning cartridges were still giving off dense fumes. When these pipes had been plugged and the fans set in motion, the atmosphere was soon cleared and the T.S. became habitable once more. At 9.37 p.m., no enemy then being visible, the men were released from action stations. "A pause in the action was urgently needed. All guns' crews had to be mustered on deck to put out fires. The conning-tower was enveloped in flames and smoke. Although everything inflammable had as far as possible been removed from the ship, the flames were continually fed by linoleum, wooden deck planking, articles of clothing, and paint. Towards 10 p.m. the worst fires had been mastered, though conflagrations were still proceeding in various parts of the ship. Both the after 12in. magazines had to be flooded to get rid of the fumes that poured out of the turrets. "No one would have believed," says Commander von Hase, "that a ship could withstand so many severe hits. We found after the action traces of about twenty 15in. shell, and as many more from projectiles of smaller calibre. . . . The Lützow was no longer in sight. Heavily ablaze, she had vanished into the mist at 9.20.* Our other consorts, Seydlitz, Moltke, and Von der Tann, were still with us. They also had been punished severely, the Seydlitz worst of all. From one of her turrets flames were shooting up to the height of a house. All the other ships were burning. The bows of the Seydlitz were deep in the water. When Admiral Hipper in his destroyer had proceeded alongside the Seydlitz he found that her W/T gear had been shot away, and that several thousand tons of water were in the ship. He had accordingly prepared to board the Moltke, but at that instant such a heavy fire was opened on the vessel that it was too dangerous to stop.

The Admiral then inquired what damage the Derfflinger had suffered, and was informed that the only guns left in action were two 12in. and two 5.9in., that all signalling gear with the exception of a W/T receiver had been shot away, and that 3400 tons of water had entered the ship. He thereupon gave up his intention of boarding us, and transferred his flag to the Moltke as soon as the circumstances of the action permitted. In this way it had fallen to the Derfflinger to lead the battle-cruisers throughout the fourth phase of the action. Each of our battle-cruisers," continues the author, "had sustained a great number of casualties." The Derfflinger had 200 killed, while the death-roll of the Seydlitz and Lützow must have been considerably longer. Commander von Hase appends a diagram to explain the German movements during this fourth phase. He points out that only the best units of the High Sea Fleet had come under fire in the day action, viz., the Third Squadron, comprising the "König" and "Kaiser" classes. The First Squadron—older Dreadnoughts of the "Nassau-Helgoland" classes—was not in action during daylight, but, on the other hand, it bore the brunt of the destroyer attacks after dark. The Second Squadron—the "Deutschland-Braunschweig" pre-Dreadnoughts—had fired on British light cruisers, but was not seriously engaged until after nightfall, when the Pommern was sunk and other vessels damaged by torpedo. The Lützow was abandoned by her crew in the early hours of June 1st, and then sunk by torpedoes. Commander von Hase gives a vivid account of the retreat by night. The Derfflinger was in no condition to repel attack of any sort, and fortunately for her she was not molested. Shortly after 10 p.m. she and the other battle-cruisers took station ahead of the First Battle Squadron. "While this manœuvre was proceeding we and the First Battle Squadron suddenly came under a heavy fire from the S.E. . . . A large projectile glanced off 'A' turret, buckling part of the turntable, but the damage was soon repaired. Ranging was possible only at infrequent intervals, and our salvos could not be spotted. Once more we were in a most critical situation." Of this phase Admiral Beatty wrote in his despatch: ". . . At 8.20 p.m. (10.20 German time) we altered course to west in support. We soon located two battle-cruisers and battleships, and were heavily engaged at a short range of about 10,000 yards. The leading ship was hit repeatedly by Lion and turned away eight points, emitting very high flames and with a heavy list to port. Princess Royal set fire to a three-funnelled battleship; New Zealand and Indomitable report that the third ship, which they both engaged, hauled out of the line, heeling over and on fire. The mist which now came down enveloped them, and . . . they were last seen at 8.38 p.m. steaming to the westward." Commander von Hase, however, attributes their escape to the timely arrival of the German Second Battle Squadron—pre-Dreadnoughts—which on their way to take station for the night passed between the British line and the hard-pressed German van. "The enemy," he says, "suddenly observed seven large ships approaching at high speed. At the same moment he was again attacked by our destroyers. This was too much for him; he turned away and disappeared in the gloom. *Auf Nimmerwiedersehen!* (May we never seen him again!) Had he known that the seven vessels were only the famous German pre-Dreadnoughts, the 'five-minute' ships—which the British reckoned could be sunk in five minutes—I do not believe he would have turned away." At 10.31 p.m. the recorder in the T.S. noted the firing of the Derfflinger's last salvo—bearing 244 deg., range 75 hm. (8200 yards). The Derfflinger and Von der Tann now took station astern of the main body and maintained that position through the night.

The author saw nothing of the Moltke or Seydlitz, which were too badly injured to keep station. He learned afterwards that the Seydlitz was kept afloat only by the greatest exertions; she reached Wilhelmshaven two days after the battle. As the penultimate vessel in the line, the Derfflinger was in no great danger of destroyer attacks, which were almost invariably made from a position ahead. Actually only one destroyer found her. "Firing went on all through the night. One must acknowledge that the British destroyers, with admirable pluck, attacked time after time." During these hours the light cruiser Frauenlob was engaged by British cruisers and sunk by torpedo. At the first glimmer of dawn the battleship Pommern was sunk by a torpedo discharged at long range. The author saw several British destroyers set on fire by shells. "Glowing red-hot, the boats resembled fine filigree-work in red and gold. The fact that these British boats were so swiftly wrapped in flames was due to their oil. Once this fuel had been ignited, it quickly spread all over the heavily rolling boat." As is well known, the German destroyers made no attacks during the night, although according to the author, they "searched for the British Fleet" all through the hours of darkness. At one period those on board the Derfflinger heard a destroyer nearing them at high speed, and she was soon sighted four points to starboard. It was decided not to switch on lights, a course followed also by the Von der Tann, the result being that the destroyer vanished without firing torpedoes. It is possible that by suppressing their searchlights the two German battle-cruisers escaped a torpedo attack which, in their damaged state, might well have proved fatal. "At 2.15 a.m. we passed a ship on fire—the British armoured cruiser Black Prince. The whole ship was glowing with heat, and all on board must long since have perished." Soon after nightfall this vessel had suddenly found herself in close proximity to the German Third Battle Squadron. The Thüringen and other ships promptly opened on her at almost point-blank range, and she was at once disabled and set on fire. She apparently drifted about for some time before foundering. At 3.10 a.m. two heavy explosions were heard to port of the Derfflinger—obviously torpedo hits on some ship or ships. The whole German line, it is confessed, was repeatedly thrown into confusion by the British destroyer attacks. As an instance of this it is mentioned that the Nassau, from being in the van, eventually found herself astern of the battle fleet line. Everyone believed that the action would be renewed at dawn. "At 3.50 a.m. we heard a loud explosion, and directly ahead of us a huge pillar of fire shot up to the sky. We saw our next ahead turn hard a-port. What catastrophe had happened? We held on our course and so passed over the scene of the explosion. We looked eagerly for *débris* or men in the water, but nothing was to be seen. At the time we were in ignorance of what had occurred; and yet, only a few minutes beforehand, the battleship Pommern had been steaming over this spot. A British destroyer had torpedoed her at extreme range, and the ship must have been blown literally to atoms. Not a trace of her was left, and not a man was saved. The torpedo had manifestly exploded her magazines. . . . Meanwhile the sun had risen. Hundreds of glasses swept the horizon, but nothing could be seen of the foe. The fleet pursued its course to the South, reaching Wilhelmshaven at 1 p.m. on June 1st. Our ship was very heavily damaged by shell fire. In many places entire compartments had been reduced to mere heaps of rubble. But the vitals were not hit—thanks to our strong armour, the engines, boilers, steering gear, propeller shafts, and practically all auxiliary engines were undamaged. For a long period the engine-rooms had been filled with poisonous fumes, but by wearing their gas masks the engineers had been able to carry on, though not without casualties. The entire ship was littered with thousands of shell splinters, large and small. Two 15in. shell caps were picked up almost uninjured. *The belt armour had been pierced in several places,** but in every case the leaks had closed up or the inrush of water been localised in small compartments. . . . The Derfflinger took six months to repair. Fitted with many ordnance and other improvements, she was recommissioned in December, 1916." But fate—and the German *personnel*—denied her another meeting with her enemies until the final humiliation of November, 1918, when, in company with her fellow-captives, she was delivered into custody of the British Navy. She now rests many fathoms deep on the bed of Scapa Flow.

The chapter which Commander von Hase devotes to reflections on the Battle of Jutland is not the least interesting in the book. He makes one admission that ought finally to dispose of the legend that the German ships were eager to resume battle on the following day. "As the sun rose on June 1st, and far and wide no trace of the enemy could be seen, I freely confess that a great load was lifted from my mind. For with our battered ship, and its decimated armament, we could not have fought a victorious artillery duel with an undamaged Dreadnought. Nearly all the ammunition for 'A' and 'B' turrets had been expended, while that remaining for 'C' and 'D' was not available, as those turrets were still full of gas and the magazines had been flooded." The author attempts, not very convincingly, to qualify this significant admission by observing that for the German navy and the Fatherland it was a great misfortune that the action could not be fought to a finish. "Judging from our experience on the previous day, more British ships would have been destroyed, and it would have needed a tremendous expenditure of ammunition to place the German Dreadnoughts *hors de combat*. If on June 1st Admiral Jellicoe had sought a decision near Horn's Reef, the British Fleet would undoubtedly have had to resign to America its premier rank." This assumption is not borne out by the author's own evidence. On his own showing, the entire German battle-cruiser force was practically disabled, and could have taken no effective part in a new action. Furthermore, the rapid deterioration of German gunnery towards evening on May 31st—that is, immediately after our Battle Fleet came into

* The third notice appeared March 5th.

* H.M.S. Colossus is credited with having finally disabled the Lützow at this time.

* Our italics.

action—made it most improbable that the British Fleet would have suffered serious loss had the battle been resumed at dawn. The nerves of the German gunners cannot have been improved by the incessant night attacks delivered by our destroyers. We feel sure that Commander von Hase, in common with all other intelligent Germans, knows that swift and certain annihilation would have been the doom of the High Sea Fleet had it failed to evade the British pursuit on the night following the action. Admiral Jellicoe, the author considers, acted wisely in declining a night engagement with his main body. In such a combat, he declares, "the enemy would have forfeited all his advantages of numbers, superior speed, and longer range guns." It is acknowledged that the Battle of Jutland—acclaimed by German propaganda at the time as a victory—did not for a single moment relax the crushing grip of British sea power. Among its secondary results was "the frustration of our plan to prey upon British and neutral shipping in the Skagerrak and Cattegat."

Valuable as is this book, it does not pretend to give a comprehensive description of the Battle of Jutland. It was manifestly impossible for any individual to see more than a small part of an action which from beginning to end lasted twelve hours, and in which the contending fleets, numbering hundreds of vessels of every type, were continuously moving at high speeds. The author has wisely devoted most of his space to the battle-cruiser action, the events of which came more especially under his personal observation. Nothing that he says lends colour to the view that there was any German superiority in manœuvring or gunnery. Our fire was no less accurate than theirs—in fact, judging from the large number of hits on the Derfflinger and other ships—it was superior both in accuracy and volume. That only one German battle-cruiser was actually sunk by this terrible fire is attributable to the extraordinary defensive qualities for which the vessels in question were famous. But to gain this relative invulnerability their designers had been compelled to sacrifice speed and long-range guns, two factors which in this country are held to be of supreme importance to the battle-cruiser. Unable, as Commander von Hase tells us, to steam faster than 25 knots, the Derfflinger and her sisters were more akin to fast battleships than battle-cruisers. That their 12in. and 11in. guns were, nevertheless, effective against our ships of this type is explicable only on the ground that insufficient provision had been made to protect the vitals of our earlier battle-cruisers from "lucky" hits. The destruction of the Queen Mary, Indefatigable, and Invincible was in each case ascribed to a magazine explosion caused by the flash of a shell which had burst inside a turret, penetrating right down to the magazine. Hits of precisely this kind were common in the German battle-cruisers, as Commander von Hase has told us. Both after turrets of the Derfflinger were pierced by 15in. shell, the explosions of which set fire to all the charges in turret, working chamber, and handing-room; and two, if not three, turrets of the Seydlitz were disabled in the same way. There can be no reasonable doubt that had these ships been fitted with hoists of the direct communication system, both would have been lost in exactly the same way as were the British ships. As it was, their two-stage ammunition hoists saved them from instantaneous destruction.

For the rest, there cannot have been any further serious defects in our battle-cruisers, seeing that after enduring for several hours a heavy bombardment they were still able to steam at 28 knots and to fight their guns with great effect. On the other hand, the German battle-cruisers had all been virtually disabled before the end of the day. Another proof of the failure of the Krupp 11in. and 12in. guns against well-protected ships is furnished by the escape from serious damage of our "Queen Elizabeth" class. Four vessels of this class present at Jutland were frequently under heavy fire, at one period from at least ten German capital ships; while the Warspite, owing to damaged steering gear, approached to within 6000 yards of the enemy's line and became the target of every gun that would bear. Yet none of these ships sustained grave injury. Armour undoubtedly proved its great value in this action, the experience of which, as Lord Jellicoe subsequently said, "convinced naval officers afloat, even if it did not convince others less intimately associated with the Fleet during the war, that ships with inadequate defensive qualities are not a match for those which possess them to a considerably greater degree, even if the former are superior in gun power." On the question of naval ordnance Commander von Hase's book supplies us with some valuable testimony. Assuming his observations to have been correct—and as a gunnery officer he was not likely to be mistaken—our heavy guns, notably the 15in., proved themselves capable of accurate practice at ranges beyond 20,000 yards, while the destructive effect of their huge projectiles was immense. Furthermore, the author's notes corroborate an assertion which has been frequently made in these columns—namely, that with the latest type of mountings, hoists, &c., the heaviest naval guns can now be worked almost, if not quite, as rapidly as the 12in. For example, he speaks of the Queen Mary as having fired broadsides at "fabulous" speed, yet her 13.5in. projectiles weighed 500 lb. more than the German 12in. In time, no doubt, the 15in., 16in., and perhaps still heavier guns, will become capable of firing three rounds per minute. It need hardly be said that this growing rapidity of fire will be a strong inducement to increase the size of naval ordnance, since in the past the main justification for keeping to guns of medium calibre has been their supposed higher rate of fire. Heavier guns, thicker and more extensive armour, higher speed—each of these *desiderata* entails increased displacement, and since all three are now being demanded in the light of war experience, a large increase in the dimensions of the capital ship would seem to be inevitable. Jutland was primarily an affair of mastodons to which the operations of light cruisers and destroyers were merely incidental. Although the torpedo claimed several victims, it proved to be far less deadly or decisive than the big gun. In view of the large number of destroyers present—at least 150 in the aggregate—the percentage of torpedo hits was astonishingly small. Submarines are said to have been present with the German fleet, but, if so, their influence on the action was negligible. Whatever future there may be for the submarine, destroyers appear to have lost their value as torpedo-carriers, and henceforth will be used principally for anti-submarine purposes.

The Swiss Rhone-Rhine Navigation.

By A. WHARTON METCALFE, B.Sc.

No. II.*—THE ENGINEERING ASPECT.

Introductory.

AMONG the lectures on "The Theory and Practice of Hydro-mechanics" delivered at the Institution of Civil Engineers in 1885, that on "Water Motors," by Professor W. C. Unwin, immediately preceded Sir C. E. Hartley's on "The Inland Navigations of Europe," but the subjects were not interdependent, their sequence being merely one of date. The case is different, however, when they are considered in relation to the economic and industrial needs of Switzerland. As regards the internal navigation—future—of that country in general, and the Rhone-Rhine proposal in particular, success is absolutely dependent upon the antecedent completion of large schemes destined to provide hydraulic power for turbine installations. This is most economically effected by water storage created and maintained by means of dams constructed across the rivers and streams that are a feature of the country.

On this question, Dr. Léon W. Collet, Director of Waterways of the Swiss Department of the Interior, in an article on "Le Réseau Fluvial Suisse" ("The River Network of Switzerland"), observes: "The problem of river navigation in Switzerland should not be separated from that of the utilisation of hydraulic forces." This, though true of Switzerland and of countries similarly situated physiographically, would not be so of level lands.

Scope of Rhone-Rhine Project.

Among Swiss internal navigation proposals, the Rhone-Rhine project is at once the most comprehensive and the most important, and must not be confounded with the existent French Rhone-Rhine Canal. It is well to remember a point previously mentioned, that the present scheme is very strongly supported officially in France—notably by the Minister of Public Works, M. Sénateur Herriot—by the commercial world, and the French public; were it not, the scheme would lack one of its principal alternative determining factors.

The project will give Switzerland access to the sea in two directions, south-westwards, *viâ* the Rhone, to the Mediterranean, and north-westward, *viâ* the Rhine, to the North Sea. The scheme postulates, in the first instance, a Rhone rendered navigable from the point where at present it ceases to be up to the Swiss frontier, thus linking Geneva and south-west Switzerland with the sea. It further takes full account of the present navigability of the Rhine from Amsterdam to Basle, giving north-east Switzerland direct access to the sea. Given this double through communication seawards from Geneva and Basle, it is intended to unite the Rhone below Geneva with the Rhine below Basle by the construction of a junction waterway available for barges of 600 tons. As the line crosses watersheds, provision of one kind or another for "lifting" must be made. Incidentally, this inland waterway will unite the North Sea and Mediterranean. The size—600 tons—for the barges appears small when compared with the great barges in use on German internal waterways, but the size has been determined as being the most suitable after exhaustive technical inquiry.

A brief glance at the great strides made in the two branches of hydro-mechanics referred to at the beginning may prove of interest. The use of water motors, and especially of turbines, has nowhere progressed more than in Switzerland, though as yet only one-eighth of the available supply of hydraulic power from natural sources has been tapped; while as regards the extension of inland waterways, the most notable advance in Europe has been made in Germany and Austria-Hungary, especially if canals,* which unite two seas and achieve the designedly double purpose of serving commerce and also certain aims of military and naval strategy, are included.

The rapid developments proceeding in the solution of the problem of providing a convenient and plentiful supply of hydraulic motive power is due in Switzerland to the cheapness and accessibility of water with a fall of suitable "head," on the one hand, and to the dearness of coal and the difficulty of getting it on the other. In Switzerland, as in France and Italy, imaginative speakers refer to water power as "white coal"—*houille blanche* (and now they talk of the future canals as "green coal"—*houille verte*) by way of pointing the contrast with "black coal," that other source of stored energy which costs so much.

The great progress of inland navigation in Germany and other parts of Europe owes its advance to a realisation of its economy for the transit of certain classes of goods in bulk. It is also due to a growing belief that in the near future railways will, unaided, be incapable of dealing with the traffic problem. An acquisitive bent, encouraged by a penetrative and competitive commercial policy, is also accountable for the development of internal navigation, as it was for the Berlin-Baghdad Railway.

Swiss Commercial Aims, &c.

The Swiss commercial aims embrace, *inter alia*:—(1) Access to four seas—the Mediterranean, the North Sea, the Adriatic, *viâ* Lago Maggiore, and the Black Sea, *viâ* the Danube; (2) the cheapening of raw materials, the increase and development of trade, and the removal of restrictions that have hampered it; (3) the obviation, by internationalisation, in case of future wars of the state of quasi-blockade experienced during the late war. To promote these aims, leaving aside the questions of port improvements at Basle and of railway facilities and equipment, the following works, external and internal, will have to be carried out:—

(*a*) *External Works.*—The rendering of the Rhone easily navigable throughout its course, and especially the regulation and rectification of the river section, known as the Haut-Rhone.

(*b*) *Internal Works.*—The construction of the Rhone-Rhine junction waterway, with its accessory ports, basins and railway connections with the P.L.M. and C.F.F. railway systems. By "external" is meant outside Swiss territory.

(*a*) The Rhone: Its Condition and Remedies.†

On its course between the lower of the city of Geneva's hydro-electric stations—Chèvres—at about 189 kiloms. above Lyons, and Génissiat (153 kiloms.), the Rhone flows through the gorge of Bellegarde, its fall in 26 kiloms. above Génissiat being about 70 m. Its current is at all times rapid, and it is subject to great variations of level in times of floods or when the snows are melting on the Alps. At such times the river in the defile of Bellegarde resembles a millrace. Between Chèvres (189 kiloms.) and Seyssel (142 kiloms.), that is, over and beyond the aforesaid length, the Rhone is only considered as navigable for rafts and loose timber, but such traffic of the kind as there was has entirely ceased. As Mons eur G. Autran, one of the engineers to the R.R. scheme, observes: "The Upper Rhone is dead."

Formerly, the Rhone was navigable from Seyssel (142 kiloms.) to Lyons, and the stone quay walls still flank the river at Seyssel. To-day, the river is only navigable from Sault-Brenaz (58 kiloms.) above Lyons to that city for barges and small craft. From Lyons southward to the sea the Rhone is navigable for moderate-sized vessels, but the navigation is impeded by shifting sandbanks, and on account of the rapidity of the current, upstream navigation is particularly difficult. Through navigation from points north of Lyons to points south will be possible when the city has been turned by a junction canal.

The outlook for the navigability of the Rhone from Geneva to the sea would not appear to be hopeful were it not for the drastic remedies contemplated.

Remedies Proposed: Applicable to (a) and (b).—These proposed remedies comprise palliative and radical measures, such as:—(*a*) "Regulation," deepening, straightening, local corrections and attention to the river banks, in order to retain them and prevent slips and obstruction of the course. (*b*) The formation of single or successive stepped reaches of still water suitable for navigation, formed either by constructing special barrages with locks, or, more usually, by utilising barrages designed for hydro-electric stations and adapting them by providing locks to their new purpose. All barrages on the Rhone are now designed for that purpose. There is a constant demand for hydro-electric stations. (*c*) The construction of lateral canals or of branches with locks, either independently or in conjunction with barrages, by which means rapids or difficult stretches of river, or in some cases towns, may be avoided.

Application to case of Rhone: Geneva to Génissiat.—On the length between Geneva and Génissiat, which includes the Bellegarde gorge, and in connection with the hydro-electric works at Génissiat, the

* No. I. appeared February 27th.

* See THE ENGINEER, July 15th, 1915.

† In dealing with the French Rhone, the distances given are from Lyons.

scheme finally adopted and authorised—after various technical inquiries, reports and a reference—and the execution of which was begun in July, 1918, provides for the erection of a dam 69 m. (230ft.) high at the lower end of the gorge. The effect of this bold and imposing work, of which MM. Blondel, Harlé and Mähl are the engineers, will be to dam back the water as far as the Franco-Swiss frontier, a distance of about 25 kiloms., thus submerging the rapids of Bellegarde, and providing a reach suitable for navigation. The difference of level between the surface of the water held up by the dam and that of the Rhone at Génissiat—70 m.—will be overcome by means of a stairway of locks provided with twin entrances.

The water stored by the Génissiat dam will actuate an installation of turbines at that station, driving electric generators which will, it is estimated, supply 250,000 horse-power of electrical energy to consumers in Lyons and Paris.

Génissiat to Lyons.—A succession of minor barrages, with their resulting reaches of deep and quiet navigable water, together with local corrections, &c., will provide for the requisite regulation on the length between Génissiat and Lyons. The city of Lyons itself is to be "turned" and alterations of existing works—which would prove very costly—obviated, the Rhone north and south of the city joined, and a new industrial area created by the war served by a loop canal.

Rhone-Marseilles.—A great canal uniting the Rhone with the Marseilles dock basins is in course of construction *viâ* Arles.

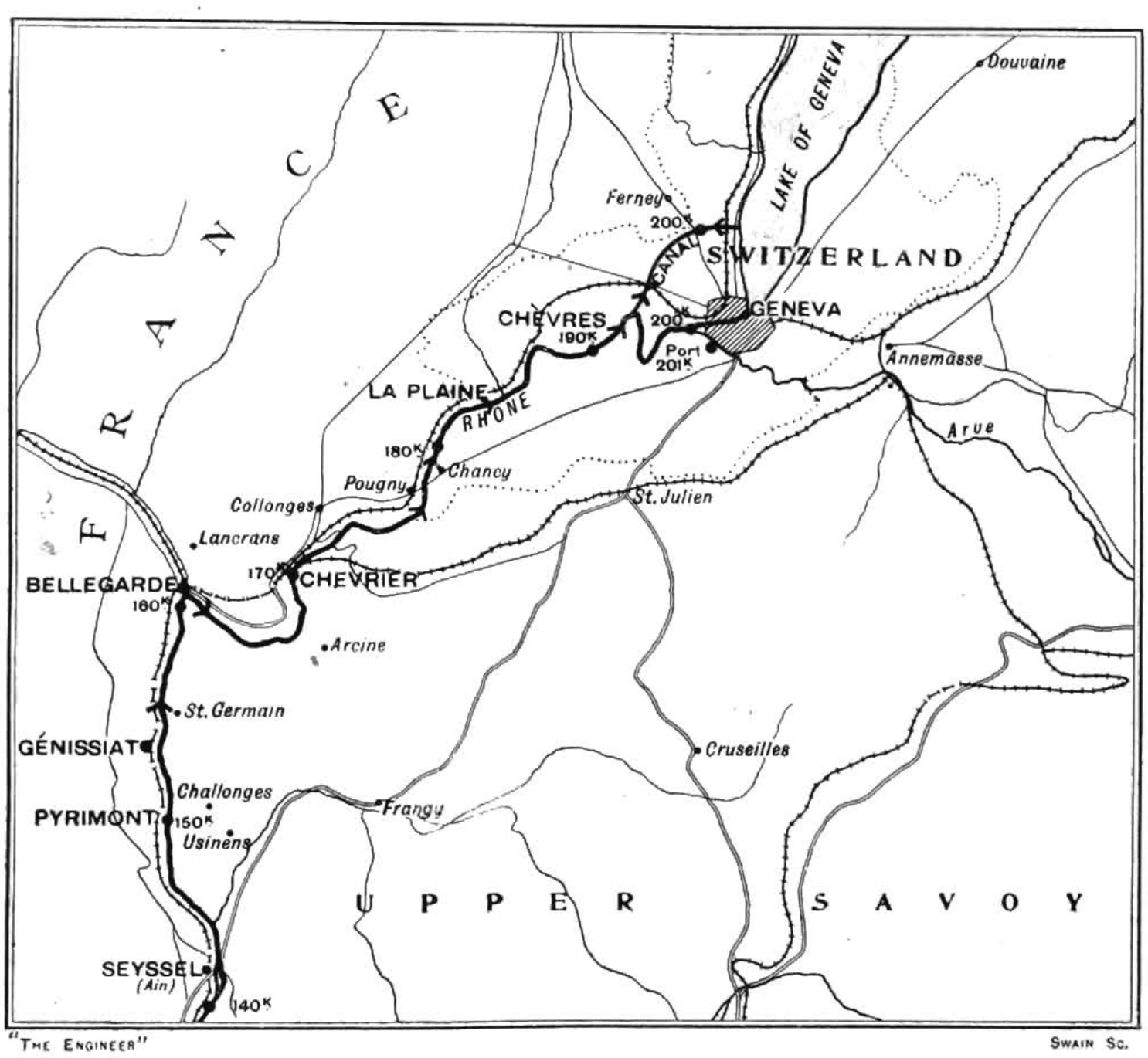


FIG. 4 MAP SHOWING SUGGESTED WORKS BETWEEN GENEVA AND SEYSSEL

A survey, of necessity the very briefest, of the French Rhone was demanded, because the "To be or not to be" of the Swiss Rhone-Rhine navigation turns upon its navigability and condition, circumstances dependent upon the views and attitude of the French commercial world and French Government, as also upon the policy towards the Rhone those views inspire—a policy now very wide awake. Finally, no scheme of river improvements intended to meet the requirements of an existent and growing trade can be deemed complete that does not provide for:—(*a*) An adequate supply of suitable tugs or some alternative system of traction, or of both; (*b*) the reconstruction of former quays and wharves, so as to bring them into a state fulfilling modern requirements, and the construction of new ones and of commercial basins in some cases; (*c*) ample and suitable wharf equipment; (*d*) connections with the nearest railway serving the river valley drained.

(*b*) THE SWISS RHONE-RHINE NAVIGATION.

The Swiss Rhone-Rhine comprises four sections, viz.:—(1) The Rhone section, from Geneva past the Franco-Swiss frontier—right bank—over the international portion of the Rhone to the Franco-Swiss frontier—left bank; (2) the Rhone and Lake of Geneva junction section; (3) the Lake of Geneva and Lake of Neuchâtel section; (4) the Lake of Neuchâtel and Rhine junction section.

Sites and Categories of Works.—The sites where alterations or new construction are involved, embraced by the above four sections, are many, the number of new works required being large, though the number of different categories—exclusive of machinery and plant—to which they may conveniently be referred, are only seven. The present position of the projected scheme, and what it comprises, may perhaps best be gauged by means of a summary which should at least prove helpful—the first seven items follow the traverse:—

*1. *Rhone*, river improvements, correcting, deepening, widening and in places canalising;

*2. The construction of barrages—with locks where necessary—and furnished with "Stoney" sluices;

*3. The provision of branch or loop canals, derivations and laterals;

*4. Rhone and Lake of Geneva junction—including branch across canals from the Rhone and lake to 600-ton barge elevators on inclined planes, and summit level canal between them;

*5. *Lakes of Geneva* and Neuchâtel junction—central summit level canal with stairway lock gradient to both lakes;

6. *Thiele*, river improvements—similar to those of the Rhone—between lakes of Neuchâtel and Bienne, and between its exit from the latter and junction with the Aar at Soleure;

7. *Aar*, river improvements—regulation, training, erection of barrages in conjunction with hydro-electric stations—between Soleure and its junction with the Rhine at Koblenz, Switzerland, not Coblenz in Germany;

8. *Rhine* river improvements—regulation, training and erection of H.E. barrages—and submersion of the rapids of Schwaderloch;

*9. The provision of commercial facilities—river, canal and lake ports and basins, quays, wharves, warehouses, transit sheds, sidings, railway connections, hydraulic power and light, cranes, &c.

*10. Alterations and diversions—road and railway bridges, &c.;

11. Miscellaneous works, additional and extra not specified.

Items with an asterisk denote different categories. The recurrence of the item "barrages"—hydro-electric—among "river improvements," proves the inseparable nature of the internal navigation and the power supply problems in Switzerland.

1. *Rhone Section.*—Between Geneva and Chancy, approximately 19 kiloms. below Geneva, the inclination of the Rhone and the configuration of its banks prohibit navigation pending regulation of the river. In order to adapt it for that purpose, the whole length between these two points must be completely corrected by canalisation, effected by forming reaches by barrages with locks, at Chèvres, 6 kiloms., La Plaine, 17 kiloms., and Chancy, 19 kiloms., approximately from Geneva—see map, Fig. 4.

The "head" for the turbines at Chèvres varies between 4.15 m., summer, and 8.25 m., winter, and at La Plaine between 7.55 m., summer, and 11.92 m., winter. Here the considerable difference of levels will be overcome by a lock with two divisions stepped.

At Chèvres a barrage has for many years been in existence, having been built in connection with the second of the city of Geneva's hydro-electric stations. Another concession has been granted to Geneva for a station at La Plaine, and another hydro-electric station is under consideration at Chancy.

The barrages at the points mentioned are those necessary to the turbine installations of the hydro-electric stations there; but they are to have locks, with the cost of which the Rhone-Rhine scheme will be debited. Federal law provides for this. The estimated cost of these three locks is 3,000,000f. Their dimensions are 110 m. by 9 m., with a minimum depth of 3 m. on the sills.

Between Chancy—19 kiloms.—and Pougny—23 kiloms.—the foundation is bad, and the banks inclined to slip, and the length is unsuitable for big heavy engineering structures, such as a barrage. Further, the inclination of the river and the risk of obstruction from slips impose separate canalisation as the solution of the navigation difficulty, necessitating a barrage with sluices at the end of the doubtful portion.

This barrage is to be constructed opposite Pougny, from which a lateral canal will be carried to rejoin the Rhone on the French frontier—left bank—600 m. further down stream. This work is estimated to cost 1,220,000f. All four barrages are to be fitted with Stoney or other sluices for the regulation of flood waters.

The No. 1 Rhone section of the Swiss Rhone-Rhine navigation ends at the French frontier which is within the sphere of influence of the navigable reach made possible by the Génissiat dam.

Electric Traction on Swedish Railways.

IT is a comprehensive proposition for the directors of any large railway system to come forward with a scheme for the substitution of electric for steam locomotion throughout the network; it is even more comprehensive still when the question applies to State-owned railways, because the same measure of initiative and flexibility, as a rule, is not shown by Government officials as in the case of railways in private ownership. The law of necessity—and necessity in the present case is the scarcity and costliness of coal—is, however, making exceptions even of State railway authorities in many countries in Europe, and the Government officials concerned are almost tumbling over each other in their investigation of the question of electric traction. This is specially the case, for instance, in Italy, Holland, Belgium, Germany, Denmark, and Sweden. During the war the Swedish State Railways, like the railways in most other countries, were unprofitable notwithstanding various increases in passenger fares and rates for the transport of merchandise, and although equilibrium between working expenses and revenue has now been practically re-established in that country, the difficulties experienced in obtaining supplies of coal from England and the United States and the dearness of the coal when delivered in Sweden, have had the effect of directing greater attention to the problem of making further use of the abundant water powers existing in the country for the working of the State railways. The question has been under consideration for a long time past, and the directors of the State railways have now issued a report, which was published in Stockholm on February 28th, giving the results of their investigation into the problem of the electrification of the entire network of the State railways.

The report states that besides the indirect advantages which result from electrical working, a direct reduction in the working expenses also takes place when the prices of coal are relatively moderate. But with the present high prices of coal the prospective economy from the introduction of electric traction is considered to be so great that the conversion of the State railways is fully justified for that reason alone. The directors therefore do not hesitate to express the definite opinion that it is both appropriate and desirable to begin the work of generally electrifying the State railways as soon as possible. Owing, however, to the great capital expenditure which would be rendered necessary by the adoption of a complete scheme of conversion for the entire network, it is thought to be advisable that the transformation should be carried out successively in certain districts and with certain pre-determined periods of execution. Nevertheless, this circumstance has not deterred the directors from examining the question as to whether the requisite electrical energy could be rendered available for a complete scheme of electrification based upon double the train miles and gross ton miles which prevailed in 1913. It is assumed that the State railways would receive a supply of energy from eight power stations which are enumerated in the report, and each of which would supply a separate district. It is calculated that the State railways would require 412,851,000 kilowatt-hours per annum, the private railways 294,852,000 kilowatt-hours, and the Svartön railway to the frontier a further 90,000,000 kilowatt-hours per annum. No technical difficulties stand in the way of the delivery of these quantities of energy,

and it is mentioned that the existing hydro-electric works at Trollhätte alone furnished in 1917 slightly more energy than is needed for the operation of the State railways, excluding the Svartön line. As the proposal is to proceed with the suggested general conversion in a gradual manner, a somewhat novel method has been adopted for deciding the order in which the work, divided into certain large and connected units, should be undertaken. The method consists in selecting as the first section to be carried out the particular line which has the greatest annual coal consumption per route kilometre. On this basis the Stockholm-Gothenborg railway occupies the first place with 384 tons of coal, the Jarna-Norrköping and Katrincholm-Malmo-Trällborg lines rank second with 322 tons, and the Stockholm-Bräcke railway takes the third place with an annual consumption of 290 tons of coal per route kilometre.

The directors of the State railways, in the circumstances already explained, recommend the Government to proceed with the electrification of the line between Stockholm and Gothenborg in the first place at an estimated cost of £5,768,000, which sum, however, would be reduced to £4,120,000 if the line were credited with the value of the steam locomotives to be removed from it and transferred to other lines. We have omitted to mention that one of the State railways has been operated by electric traction for some years past, namely, the iron ore railway from Kiruna to the Norwegian frontier, or, as the Swedes prefer to put it, the boundary of the kingdom. In this case the single-phase system is in use, and although an examination has been made by experts of the direct-current system at 3000 volts for the working pressure as introduced in the United States in recent years, the directors quote the experts' opinion that the same system as used on the Kiruna line should be introduced for the further scheme of electrification, beginning with the Stockholm-Gothenborg line. The current from the two power stations which come into consideration for this section will supply single-phase current at $16\frac{2}{3}$ periods and a pressure of 100,000 volts, which will be reduced at sixteen sub-stations to the working conductor tension of 16,000 volts, and the whole length of the railway is to be brought into operation gradually, the final section in 1925. It is of particular interest to note what the directors have to say regarding the influence which the high prices for coal may have on the redemption of the expenditure proposed to be incurred on the railway in question, and it is for this reason that they urge it to be of the greatest importance for the work to be carried out while these high prices continue and very considerable economies are obtainable. Thus with a coal price of 150 kronor per ton in Sweden the annual profits through electrification of the Stockholm-Gothenborg railway are estimated at 21 per cent. of the actual cost of conversion for the traffic calculated for 1925, and at 11 per cent. with a coal price of 100 kronor per ton, whilst no profits are expected if the coal fell to 50 kronor per ton. Should, however, the present high prices of coal continue after the electrification has been completed it is computed that the entire expenditure on the transformation would be redeemed in a period of four years. It will be obvious that the directors are exceedingly sanguine concerning the financial results of the projected conversion. No doubt considerable economies would be obtained from the substitution of electric for steam locomotion, particularly in a country having plenty of water powers but no coal. It will certainly require, however, a great stretch of the imagination to conceive the actual possibility, on which the four years term of redemption is based, of the export prices for coal remaining on the present level until 1928 or 1929.

The B.S.A. Small Tools Works.

THE announcement recently made that the Birmingham Small Arms Company, Limited, had decided to organise its small tools department as a separate concern under the title of B.S.A. Tools, Limited, covers a development of considerable interest and significance to engineers and to manufacturers whose business involves the use of special tools and machinery.

For many years, of course, the Birmingham Small Arms Company has been noted not only for its military rifles and sporting guns, its bicycle components, and its motor cycles, but also for its twist drills, milling cutters, taps, and similar small tools. It continues to make all these things and, in addition, is now linked up with the Daimler Company at Coventry and with the Aircraft Manufacturing Company and other well-known firms. The developments in its small tools department do not, however, simply begin and end with the provision of increased facilities for the production of small tools of the description we have named. As we understand it, the organisation of this department as a separate concern is primarily intended to meet the requirements of engineers and other manufacturers who may desire assistance in designing, constructing, and laying down special machine tool or machinery equipment.

It is possible that what we commonly understand as machine tools of standard type—such as lathes, drilling, milling, and other machines—will be manufactured by the company, at least in the smaller sizes; but, generally speaking, it is primarily the intention of the directors that B.S.A. Tools, Limited, shall devote a large, if not the chief, part of its attention to the manufacture of special machine tools or machinery equipment to suit the individual needs of each special client. The items to be manufactured may be needles, penknives, aero-engines, motor car parts, or anything else of similar light kind. The object of the Birmingham Small Arms Company's new department is to advise the manufacturer as to the best method of working and to design and make the machinery, jigs, gauges, and other equipment necessary to give it effect.

The company is, of course, well fitted to undertake this work, for during its own existence it has specialised in the manufacture of small parts on a very large scale and has consequently equipped itself with a specialised staff and with specialised plant for the production of the machinery required for such class of manufacture. During the war period its resources in this direction were freely taken advantage of by the Government and by firms taking up the manufacture of munitions and components. A striking instance of its success in fulfilling the demands of this nature which were made upon it is to be found in the equipment which it designed and made for machining the cylinder heads of the Bentley rotary aero-engine. These heads, it may be remarked, are machined from the solid out of steel drop forgings. The heads are so irregular in shape, so complicated with fins, bosses, ports, and valve seats that no one, we are certain, until a few years ago, would have thought of making them elsewhere than in the foundry. Even now, while the heads no doubt admirably fulfil the function for which they were designed, their design cannot, we think, be very heartily commended from the production point of view. The question of producing the heads in large numbers was referred by the Government to the Birmingham Small Arms Company, and within eight weeks we understand the company's small tool department had designed, made, and put into service plant for the machining of the heads. The key to the problem was the machining of the radiating fins round the periphery of the head. These fins, being interrupted by four bosses for holding-down bolts, could not be formed in a lathe. The three-spindle milling machine illustrated in Fig. 1 was especially made for the work, and so successfully did this machine and the rest of the plant operate that the total labour charges for the machining of the head were reduced to a very low figure. A group of the three-spindle milling machines is shown in the left-hand bottom corner of page 274.

During a recent visit to the company's Sparkbrook Works at Birmingham we were afforded an opportunity of studying the workshop organisation which is behind B.S.A. Tools, Limited. The Sparkbrook Works are not new—they are by no means the youngest of the several establishments in Birmingham and elsewhere controlled by the company—but they have recently been extended and are equipped in every respect with the most modern machinery and equipment. The works are laid out entirely on one floor and are heated and lighted in a manner which would put many a hotel or private dwelling-house to shame. We were particularly struck with the cleanliness manifest throughout the entire factory, even in the hardening and heat treatment department. Throughout the machine shop—views of which are given on page 274—the floors are of wood planking and are not only swept but scrubbed daily by four women employed solely for the work. Indeed, looking at the floor, one might well have imagined oneself on a battleship's deck; anywhere rather than

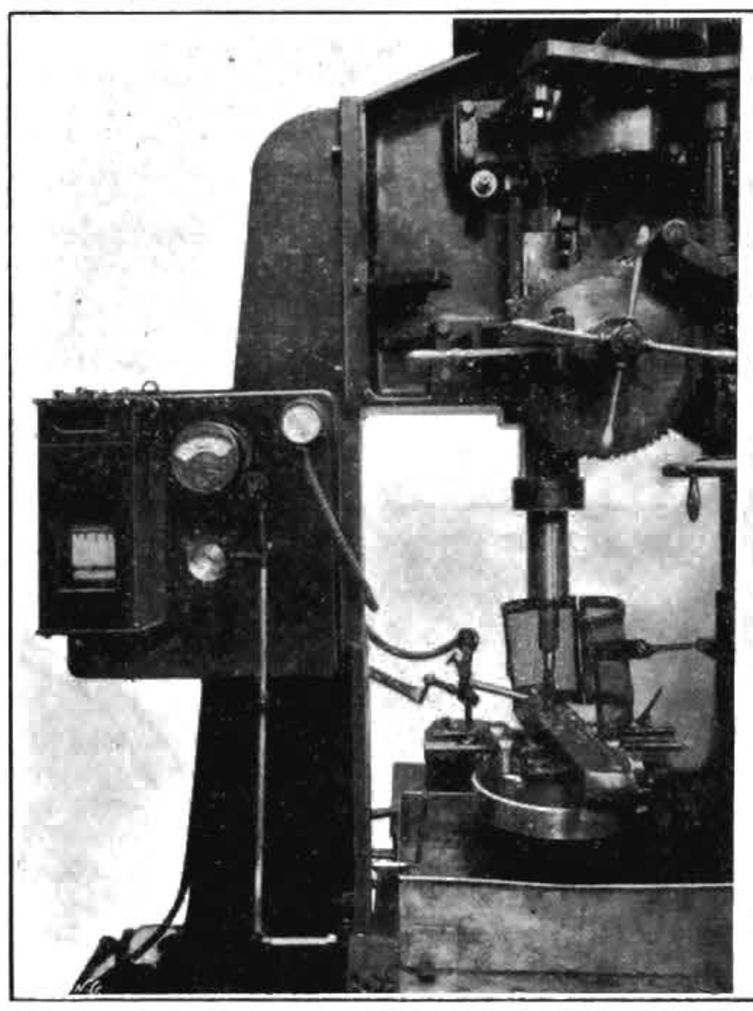


FIG. 2—TESTING MACHINE FOR LARGE DRILLS

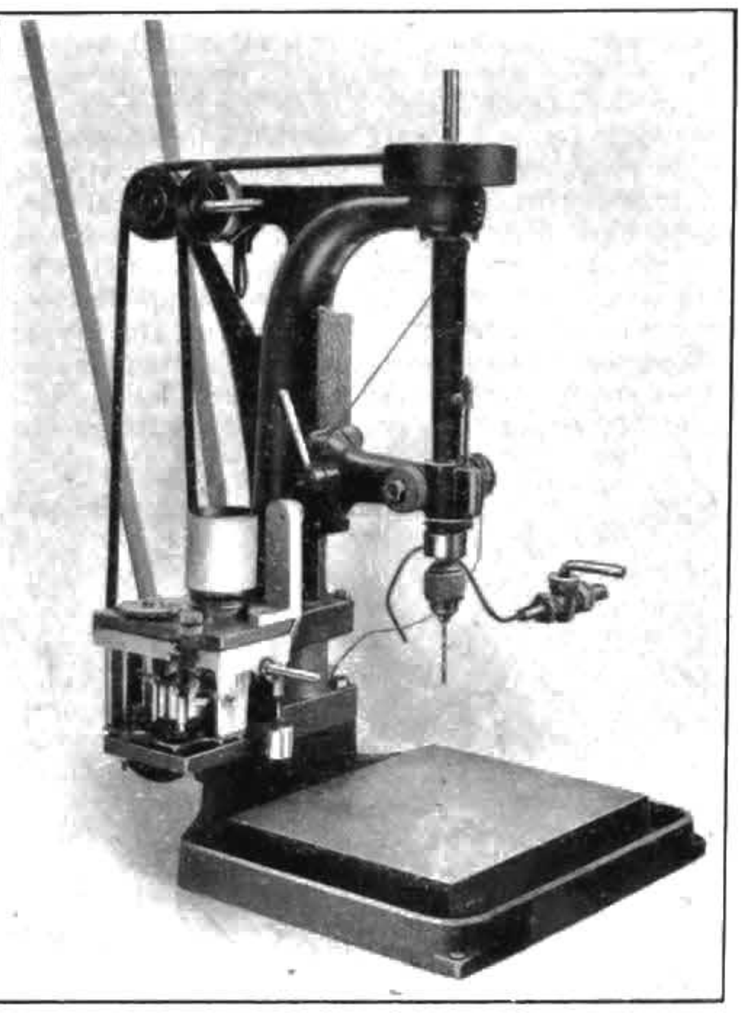


FIG. 3—TESTING MACHINE FOR SMALL DRILLS

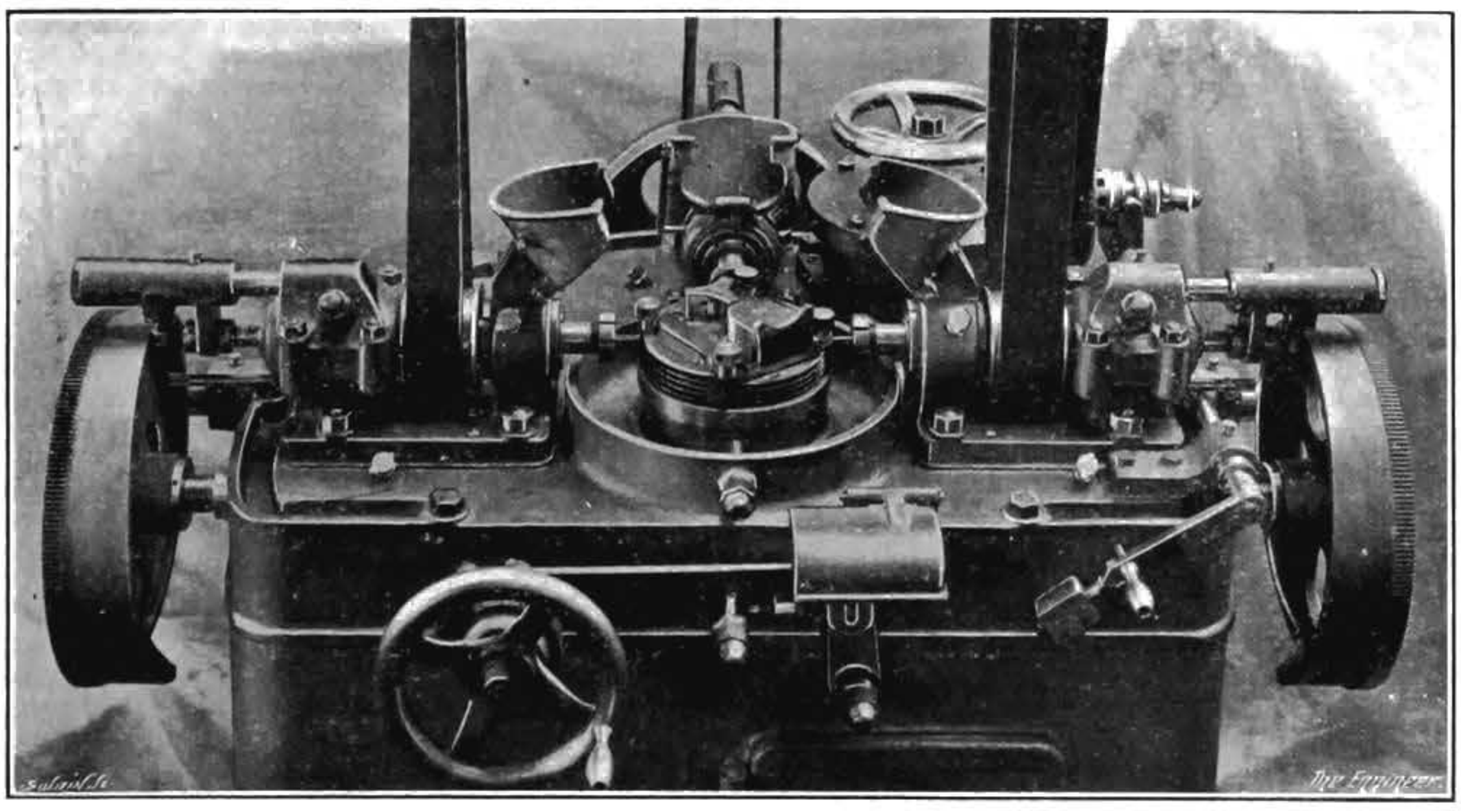


FIG. 1—THREE-SPINDLE MACHINE FOR MILLING CYLINDER HEADS FOR AERO-ENGINES

in an engineering workshop. We were assured that the shops had in no way been tidied up especially for the occasion.

Does it pay to go to all this obvious expense to keep the workshops tidy ? Does it pay to provide, as the company does at its various works, canteens, surgeries, gymnasium, apprentices' school, dentistry department, football and cricket pitches, hard tennis courts, and other facilities for the workpeople's health and recreation ? The answer is that the company does not do these things out of charity or for philanthropy, but because it is a clearly established fact that it is commercially profitable in a variety of ways to look after the workers' health and happiness and education. If the company carried this policy to excess the fact would speedily be revealed in the excessive prices it would have to demand for its products. It is significant, therefore, that, in spite of the present undoubtedly high labour and material charges, the company is placing on the market a double-barrelled sporting gun of very fine design and construction, which is to be sold retail to the public at a price not exceeding seven guineas under a penalty. We have examined the weapon and can safely say that in the cheapest period of pre-war times the gun would have been accounted a bargain at this figure. That it can be produced at such a price under present conditions is a remarkable and enlightening fact. The company explains it by saying that it is the result of modern mass production methods, but we cannot help thinking that its kindliness towards its workers and its interest in their general welfare is also an important item in the count.

The gun and rifle portion of the company's works is, however, outside our present field, although our visit was extended to the Small Heath Factory. Returning to the Sparkbrook Works, the home of the small tools department, we would especially notice among other subjects the methods adopted in the manufacture of twist drills. The drills are fluted as usual in milling machines provided with spirally grooved formers for giving the work the requisite rotary feed as it advances. Following what is now the general practice, the two flutes on each drill are machined successively and not simultaneously, as was one time the custom. The flutes are formed with an increasing twist from the point towards the shank. This feature not only improves the efficiency of the drill in use, but economises the number of spirally grooved formers required to produce a given range of drill diameters. The formers are made considerably longer than would be necessary if each had to be used only for one size of drill, and by working on different portions of the spiral groove each former can be made applicable to at least three different diameters of drill.

The drills are hardened and tempered in the heat treatment department, a section of the works which, in the matter of scientific equipment and orderliness, is certainly not surpassed by any similar department with which we are acquainted. The furnaces are in some cases gas fired, but those which we saw in use for hardening and tempering twist drills are electrically heated. The drills, two dozen or so at a time, are fixed by their shank ends in a holder carried at the end of a balanced arm, and in the first instance are heated to bright redness in an electric furnace, the bath of which is composed of molten barium chloride. After insertion in this bath for a given number of seconds, which varies with the diameter and size of the drills, they are quenched in whale oil. They are then tempered by being heated to dull redness in a second electric furnace containing a bath which consists of a mixture of the chlorides of sodium, calcium, and potassium. Quenching in whale oil follows, and thereafter the drills, still in the holder, are set aside to cool and drain. The whole process is very speedy and accurate. In the case of the smallest sizes of drills, round about one-sixteenth inch in diameter, the tempering process is apt to develop a bend in the drills. All the smaller drills are therefore examined individually for straightness. The examination apparatus consists of a horizontal flat plate surrounded by a hood, the back of which is a ground glass plate through which a green light shines. The examiners are girls, and work by placing the drills on the flat plate and observing how closely they lie to it. If a drill is found to be bent the examiner corrects it with a light blow from a mallet.

The drills after manufacture are sampled and tested, the larger sizes in a special drill testing machine —Fig. 2—made by Messrs. Archdale, of Birmingham, and the fine sizes in a sensitive drilling machine—Fig. 3—equipped with suitable adjuncts. The large machine is provided with means for measuring or recording the power consumption, the speed, penetration, and other important factors. The small machine is equipped with a clock-driven drum, whereon the penetration is recorded. At frequent intervals samples of the drills made are tested to destruction on one or other of these machines.

Elsewhere in the shops we noticed in various stages of manufacture a large variety of special gauges and jigs, some of the former devices being very complicated and more of the nature of micrometers, while some of the latter, such as the truck jigs used in the mass production of motor car engines, were almost as elaborate as the machine tools with which they would be used. In Fig. 4 we illustrate a fixture for use when boring the twin cylinders of a motor car engine. This jig is arranged to hold four cylinder blocks. Of these blocks one is being rough bored and another finish bored, while a third is being put into position, and the fourth is being removed from the jig. The blocks are located and clamped relatively to the rotatable base of the jig by means of the plungers on the base. A boring fixture for the large and small ends of motor car connecting-rods is shown in Fig. 5. The two main parts of the jig are shown separately towards the front of the illustration and assembled in the working position towards the rear.

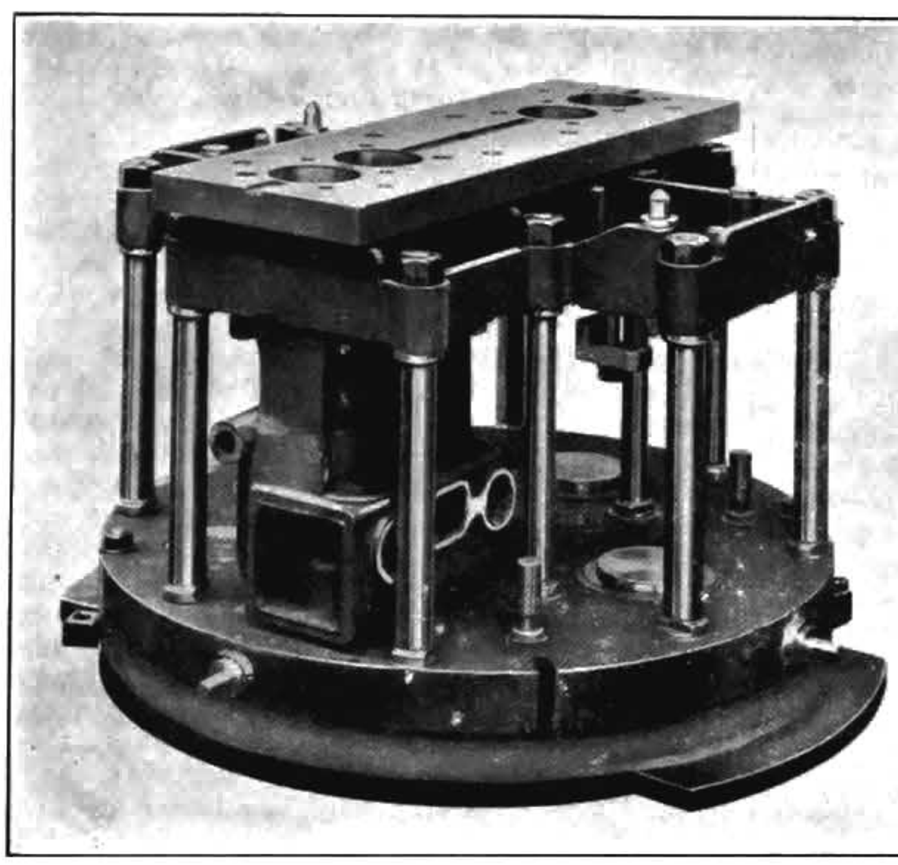


FIG. 4—BORING FIXTURE FOR MOTOR CAR CYLINDER BLOCKS

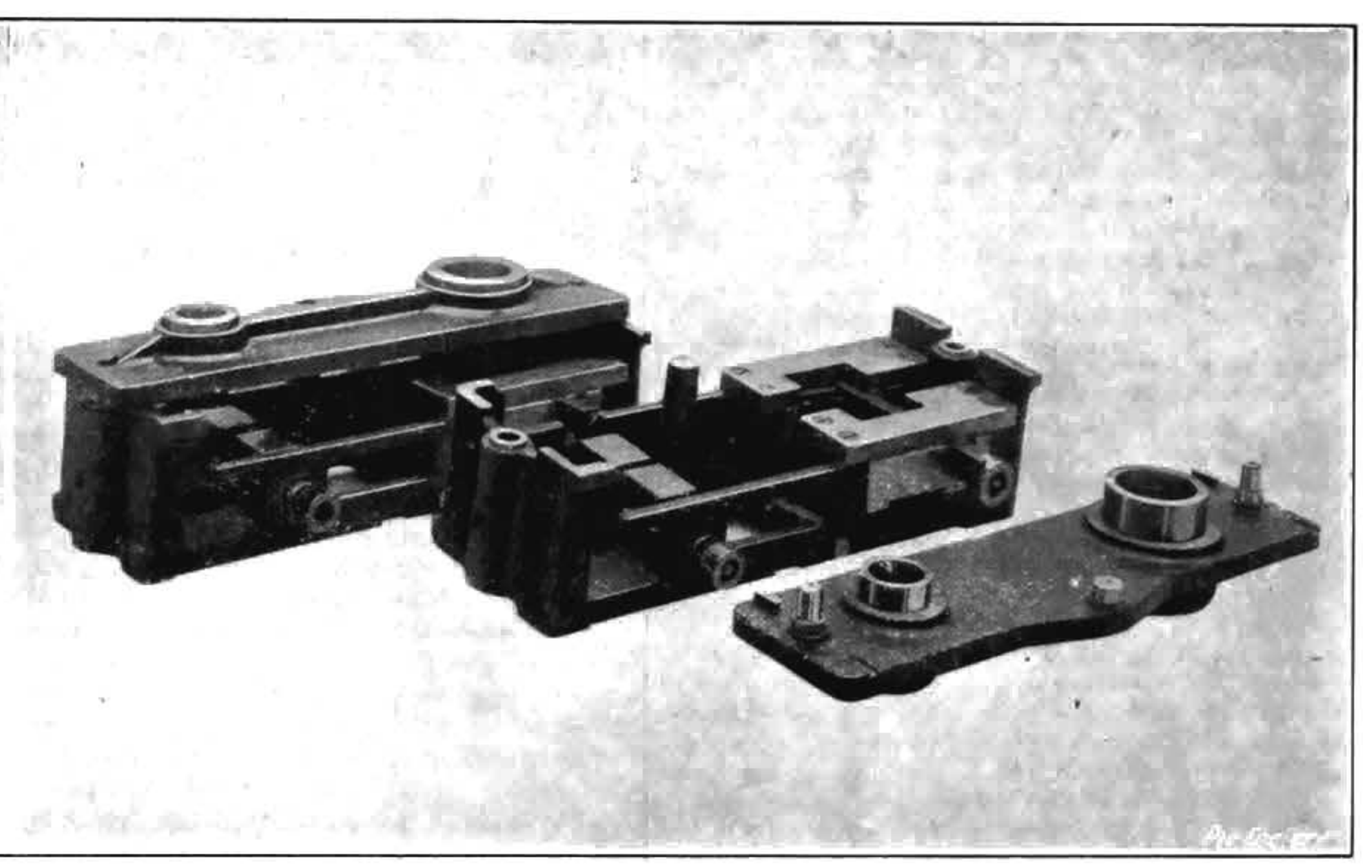


FIG. 5—BORING FIXTURE FOR LARGE AND SMALL ENDS OF CONNECTING RODS

The Corrosion of Condenser Tubes.*

THE present report is confined to the corrosion of condenser tubes—mainly 70 : 30 brass—and is a study of the practical problems of corrosion in condensers under service conditions, employing either sea water or fresh water. It is divided into four sections.

The first section deals with what has been called the diagnosis of condenser tube corrosion. The procedure to be followed in withdrawing and preparing a tube for examination is described, also the symptoms or appearances within the tube which correspond to each of the five main types into which the practical problems of corrosion under fresh-water or sea-water conditions have been classified. The importance of additional information concerning (*a*) the water supply and (*b*) the corroded tubes towards elucidating the cause of corrosion is shown and emphasised. This information, which is specified, has rarely been obtainable in the past, particularly as regards the water supply, and this may partly account for the lack of appreciation of the importance in corrosion troubles of the conditions existing within the plant. These conditions frequently vary very much from time to time, and it is shown that although the conditions which favour accelerated corrosion may be present for but short periods at irregular intervals, and consequently may not be easily detected, the effect on the tubes may still be very serious. Also in certain cases it is shown that accelerated, localised corrosion may persist after the initiating conditions have disappeared.

The second section is devoted to a consideration of certain features in the structure of condenser tubes, since an appreciation of these is of great value in following the mechanism of the types of corrosion studied later. Attention is principally directed to the presence on the tubes of a surface layer consisting of structureless and highly distorted metal. This layer has undoubtedly a greater resistance to corrosion by saline and fresh waters than the underlying crystalline metal, so that whenever this layer is penetrated corrosion will proceed at an increased rate. The layer has been stripped from a number of tubes of different composition. Its thickness is usually of the order of 0.01 mm., and indications have been obtained that its composition may be somewhat different from that of the underlying metal.

In the third section the five main types of brass condenser tube corrosion are considered separately in detail.

Type I.: General Thinning.—This type may be considered as an accelerated form of the complete corrosion which normally occurs in saline solutions, in so far as the tube is gradually and uniformly reduced in thickness. The rate of ordinary complete corrosion is too slow to be of any serious consequence in practice. Laboratory experiments with running sea water have shown that a period of fifteen to twenty years may elapse—even presuming that the rate of corrosion is uniform and does not decrease with time—before a tube is reduced 50 per cent. in thickness from this cause. Tubes almost always fail in practice by local action of some kind long before ordinary complete corrosion has seriously reduced the thickness of the tube. Rapid general thinning, however, is essentially a fresh-water phenomenon, and is usually associated with the presence of free acid in the water supply. The results of tests on ten samples of tube of widely different composition in hydrochloric acid of concentration 3 parts in 100,000 at ordinary temperature show that in six weeks all tubes had lost from 2 to 4 per cent. in thickness. That such a very dilute acid should reduce the thickness of a tube so much in such a short time at ordinary temperature is ample evidence of the serious effect of acid in the water supply upon the life of condenser tubes. Proper neutralisation, preferably at the source of contamination, is an effective remedy for this trouble, but considerable difficulty may be experienced in detecting the acid, especially if, as is generally the case, it enters the water supply only intermittently. Regular and frequent tests of the water must be made whenever this type of trouble occurs.

Type II.: Deposit Attack.—The principal cause of pitting which is the most frequent source of trouble in condensers is ascribed to what is termed "deposit attack." In the presence of sodium chloride solutions, the cuprous oxide formed on a brass surface gradually changes to cuprous chloride. The latter is usually swept out of a condenser tube by the circulating water, but under various conditions may adhere at different parts of the tube surface. When such adherence has occurred, conditions now allow of the further gradual change of the insoluble cuprous chloride under the influence of oxygen to soluble cupric chloride and cuprous oxide. The action of cupric chloride solution on brass is very rapid, as may be gathered from the fact that a piece of brass tube, 2in. long, placed in a strong cupric chloride solution at ordinary temperature, was completely disintegrated and partially replaced by a pseudomorph in copper in two days. The action involves the oxidation of the copper and reduction of cupric chloride to cuprous chloride. Redeposition of copper from solution by the zinc also occurs. In the presence of air cuprous chloride will again be converted to cupric chloride and the attack on the brass continued. Thus the action is both recurrent and local. Foreign bodies, and particularly colloidal bodies, lying in the tube have an injurious effect by serving as loci for the adhesion of cuprous chloride and by preventing the diffusion of cupric chloride. Observations on the incidence and distribution of pits in condenser tubes are shown to agree with the results which would be expected to follow from the above explanation of the mechanism of pitting. Attention is drawn to the importance of keeping tubes clean and as free as possible from foreign bodies as a means of preventing deposit attack.

Type III.: Layer Dezincification.—An account is given, preliminary to the consideration of this type of corrosion, of the mechanism of so-called dezincification. The conclusion is reached that true parting of zinc and copper in a 70 : 30 brass does not occur, but that the so-called residual copper is always redeposited copper. Dezinci-

* Fifth Report to the Corrosion Committee of the Institute of Metals. Official abstract.

fication is therefore only apparent and not real, and the term is always subsequently employed by the authors in this sense.

The layer type of dezincification, which is characterised by disintegration of the brass tube and redeposition of copper over large areas, has been found to occur under both marine and fresh-water conditions. Several ways in which such action may occur are indicated. Under fresh-water conditions, it is often associated with acid water, particularly if the acid is not too dilute and the access of oxygen is not very easy.

Type IV.: Plug or Local Dezincification.—This type of local corrosion may be regarded as a form of deposit attack, as it always proceeds beneath a deposit, and is stimulated by the presence of foreign bodies. It differs, however, in many ways from Type II. So far as is known, it occurs only in sea water—or diluted sea water—and is always associated with adhering white salt, consisting of colloidal zinc oxychloride—also containing some carbonate. It is readily reproducible in the laboratory, as it occurs spontaneously on the surface of 70 : 30 brass tubes after immersion in sea water at elevated temperatures—40 deg. to 50 deg. Cent.—for a few days; and is hence rather more amenable to experimental study than the previous types of corrosion. It is shown that the production of the right concentration of zinc in the liquid layer adjacent to the corroding brass surface plays a large part in the formation of the characteristic white oxysalt, and that interference with the production of this condition, *e.g.*, by lowering the zinc content of the brass or by raising the zinc content of the sea water, is sufficient to prevent its occurrence. The dezincifying action is thought to be due to a small concentration of hydrochloric acid contained within the colloidal white salt. The difference in behaviour of different batches of 70 : 30 tube—some always showing local dezincification, others never—persists after annealing or pickling, or both, and the reason for the difference in behaviour is still not clear.

Type V.: Water-line Attack.—In the case of a brass tube only partially immersed in sea water, increased corrosion—compared to that of the immersed portion—takes place, not at the water line as is commonly supposed, but above it, and sometimes as much as 2 cm. above the air-sea-water surface. Further, the attack is not uniform, but is concentrated at areas where salt deposits have formed and is coterminous with the area covered by the deposits. Narrow bands of salt connect the sea water with the deposits. This type of corrosion is obviously a special form of deposit attack, taking place under the most favourable conditions, inasmuch as the attack beneath the deposits is much more severe than in any of the previous types of corrosion. This type of attack may occur at the inlet end of condenser tubes when entangled air clings to the surface of the tube and is prevented by eddying effects from being swept away by the water flow.

The fourth section of the report contains an account of preliminary work on the electrolytic protection of condenser tubes. The particular question investigated was that of the efficiency of electrolytic protection in preventing deposit attack, *i.e.*, attack by cupric chloride solution. A piece of 70 : 30 brass tube made cathode to strip iron in a normal cupric chloride solution is very distinctly attacked despite the small current passing from the solution to the brass. It is considered that an electric current slows down, but does not necessarily inhibit corrosion of a cathode. By raising the current density sufficiently it is possible that all corrosion, even in a cupric chloride solution, may be prevented. Experiments have shown, however, that a current as large as 20 to 25 ampères per 1000 square feet is insufficient to prevent a 70 : 30 brass tube from being rapidly corroded by such a dilute solution of cupric chloride as a one-twenty-fifth normal solution. Some suggestions are made whereby the usefulness of the electrolytic protection process may be extended by special manipulation of it in the early part of the life of a tube, with the object of forming a thin continuous layer of calcium carbonate over the surface of the tube.

EXAMINATION FOR AVIATION GROUND ENGINEERS.

ARRANGEMENTS have been made to hold examinations for candidates desiring to become certified ground engineers—aircraft or engines—under Section 4 of the Air Navigation Directions, 1919, at the following centres during March and April :—London, March 17th and 31st, April 14th and 28th ; Bristol, March 24th ; Birmingham, March 25th ; Manchester, March 26th ; Leeds, April 21st ; Newcastle, April 22nd ; and Glasgow, April 23rd.

A candidate may apply to be examined as a ground engineer to overhaul and inspect all flying machines and/or engines, or for examination of any named type or types of flying machine or engine.

The examinations, which may be partly written, partly oral, and partly practical, will be based on the following syllabi :—

(*a*) *For Engines.*—General principles of internal combustion engines applied to aircraft, including the general principles of ignition, carburation, lubrication and cooling ; knowledge of the inspection, testing, and adjustments necessary for the installation and functioning of the complete power unit in the aircraft ; and the capacity to supervise or inspect running repairs and/or overhaul of particular engines.

(*b*) *For Flying Machines.*—General principles of construction, rigging, trueing-up, and adjustment of flying machines ; a detailed knowledge of construction, adjustments, maintenance, and final inspection of the flying machine's components ; and the capacity to supervise, or inspect running repairs, and/or the overhaul of specified types of flying machines.

Candidates before examination will be required to show (*a*) that they are not less than twenty-one years of age, and (*b*) that they have served at least two years as a mechanic or engineer on internal combustion engines or like period on aircraft construction or maintenance, or a period of not less than three years on joint areo-engines and aircraft construction or maintenance.

Candidates desiring to be examined can secure application forms from the Secretary, Air Ministry, London, W.C. 2.

The Use of Non-ferrous Metals in Warships.*

THE standards set by the Admiralty for most of the metals required by it have always been high. It has sometimes been suggested that it is somewhat arrogant for the Admiralty to insist on such high standards, that it is, to say the least, extravagant to decree that the best and the best only is good enough for the Navy ; but I can assure you that, although we do not always require the best, when we do ask for the best it is because the best is absolutely necessary, and, further, that if still better materials were available we should require them.

In warship design, offensive and defensive powers, speed and radius of action are all tactical factors which must be taken into account. Their relative importance varies according to the type of vessel and her intended service ; but in all designs, once the separate values are allocated to these features, it is essential that the weight and space required for the propelling machinery should be as small as possible, consistent with the maintaining of the desired power and the desired degree of reliability and durability.

The standing problem that has been before naval designing engineers for many years—thirty or more—has therefore been the reduction of machinery weight, coupled with the reduction of fuel consumption and increased durability and reliability. The never-ceasing demand for higher speeds, and yet higher speeds, has resulted not only in the enormously increased power of machinery for the fast-steaming war vessel which we now possess, but in a greatly reduced weight of machinery and in a high degree of reliability which could scarcely have been dreamed of in distant days.

The position at present reached as a result of the cumulative endeavour during the last few decades is that in our latest battle cruiser we hope to obtain 144,000 shaft horse-power on a total machinery weight, including water, of 4750 tons, that is, at the rate of 74 lb. per shaft horse-power, and our most recent destroyers have over and over again developed over 28,000 shaft horse-power on a weight of 32 lb. per shaft horse-power.

* * * * *

The successive steps that have led to the position of British naval engineering may be briefly reviewed.

It was, I think, in 1881 that forced draught was first applied to naval boilers, and the results of its application and the limitations of the boiler designs in use led by stages to trials of the locomotive boiler in its several forms, and later to the water-tube boiler. This was a time of trial indeed, with worries and troubles that have rarely had an equal. This phase had perforce to be endured and passed through ; but the difficulties were very bravely faced, and their solution yielded invaluable experience to our *personnel*, and played an important part in equipping them for their onerous duties during the war.

Simultaneously with this development in boilers, we passed through a stage of intense reduction in engine weight, by increasing the speed of revolution of the reciprocating engine. I think this was brought to its utmost perfection in the light destroyer engines running at over 400 revolutions per minute, and in the engines of our cruisers of the "Good Hope" class, developing some 15,000 indicated horse-power on a single shaft. A grander sight than these engines running at full power it is difficult to conceive, and it was with some pangs of regret that engineers saw such engines pass away. But the sentimental must always give way to the utilitarian, and the splendid realisation of Sir Charles Parsons' laborious endeavours for many years in the production of the steam turbine marked an epoch in naval engineering which, seized upon very quickly, was turned to account and gave us a lead which has been maintained to the present time.

As far as our information goes, there was hesitation elsewhere to adopt the steam turbine for some years after we had fully accepted it. Throughout we have maintained our lead, both in type and in performance.

For many years the thoughts of naval engineers had been directed to the advantages of oil as fuel in connection with naval machinery. It was for some time used only as an auxiliary to coal, but the experience thus obtained and the progress made in burning appliances was such that it was early demonstrated that it could be used as the sole fuel when the security of supply could be relied upon. As soon as this matured, the combination of the water-tube boiler with oil fuel and the turbine became our definite policy for the Navy, and finally determined the superiority which we obtained. We were first in this field, and the designs developed by us have been adopted in principle by other navies.

Without steam turbines and oil-fired water-tube boilers we could not have had the steaming performances to our credit that we have recently had.

The mercantile marine is largely adopting the steam turbine, and although water-tube boilers, or at least most types, are not likely to be popular just yet in that service, some thought is being devoted to their possible advantages in certain circumstances, and any information or experience we possess which may be useful will readily be made available for such purposes.

It is gratifying to notice that the large sums spent on naval engineering, in preparation for the destructive work of war, will probably be fully repaid to the nation by the great advances in general engineering which the peculiar problems of naval design have stimulated.

Although war-time does not afford good opportunities for development in naval engineering designs, production being at such time the paramount consideration, yet it must be remembered that the geared turbine with its great advantages so established itself in favour in the early days of the war that it was definitely adopted for all types of warships, and was fitted in a very considerable number of vessels during the war, the direct driving turbine being thenceforth abandoned for new ships. For the inception of this type we have again to thank Sir Charles Parsons. For the success of the material and the excellence of workmanship which made the adoption of gearing possible, our thanks are due to the metallurgists and the machine tool makers who were closely associated with us in the early stages of its introduction.

* * * * *

The factor of safety to a considerable degree measures not only unknown and uncalculable stresses, but also the degree of suspicion or doubt of the material. In other words, if a large factor of safety is used, it often indicates that the designer does not know all that he would wish to know about the material. It often suggests also that the metallurgist cannot sufficiently relieve his mind of the doubts.

It is in this field that our three sections—the metallurgist, manufacturer, and engineer—can well work together, if each knows as fully as possible the needs of the others.

The more that can be brought into full light as to the structure, the stability of the structure, and other essential properties of the materials, the lower that factor of safety can be, with consequent reduction of scantlings and lighter machinery.

It must, however, be realised that the problems are never ending ; as soon as a particular object is reached new demands arise, and very often the job has to be tackled afresh.

Our most important use of non-ferrous metals is in condenser tubes, and as we have these tubes at present in the Navy, we are, I think, fully satisfied with what our manufacturers, after years of patient endeavour, have given us, except that we want just a little more freedom from sea-water corrosion. The investigators working for the Corrosion Research Committee of the Institute are doing great work in this connection. They have already shown us how improvements may be expected, and the results of their labours are being turned to practical account. When they have succeeded in enabling us to remove from our minds doubts as to the freedom from corrosion of our condenser tubes, we engineers will assuredly be under an everlasting debt of gratitude to them.

Following their suggestion, a set of tubes, pre-oxidised under their system, was fitted in one condenser of a patrol vessel for comparison with a similarly manufactured set fitted in the other condenser without having been so treated. Unfortunately for the comparison, both sets of tubes have behaved themselves quite satisfactorily so far, so that the comparison is of little positive value. As far as our opinion is of interest, I may say that we believe in, and are strongly predisposed towards, the pre-oxidised tubes.

This trouble from corrosion of condenser tubes is the most annoying one experienced in the Service ; it is annoying because we feel we have got so near success, and also because of the serious consequences of even small leakages.

It has recently been recorded that the Grand Fleet was very much inconvenienced at times owing to leaky condenser tubes ; but it must be remembered that this cuts both ways, and that ships of all navies suffered from this evil. There is sufficient evidence to justify the belief that proportionately others had to put up with more inconvenience than we experienced.

We have recently obtained specimens of tubes from some of the ships of the German Navy. Dr. Hudson has examined some of them and has given a very interesting report, from which I have extracted some details for the information of the Institute.

A very noticeable feature of the samples examined is that most of the tubes are either tinned or lead lined. The tinning of tubes was a common Admiralty practice years ago when the circulating water was outside the tubes, and it was of material assistance in prolonging the life of the tubes. The external surface could be easily completely coated with tin, but such a complete covering is more difficult to obtain on the interior surface of a long tube of small diameter, even with the greatest care ; apparently should a small spot be left uncovered an intense action is set up, greatly reducing the life of the tube. I suppose the same sort of thing would occur with lead-lined tubes and other troubles at the tube ends might reasonably be anticipated. For this reason, such tubes have not had much use in our Service, and have been totally abandoned for many years.

* Institute of Metals. Excerpts from the presidential address by Engineer Vice-Admiral Sir George Goodwin, K.C.B., LL.D.

We, however, have great faith in a suitable covering of homogeneous quality, provided it is complete, such as the pre-oxidising method promises to be, and provided it will stand the erosive effects of circulating water under conditions of normal service.

In the latest sample we obtained, from one of the newest light cruisers, there is no such lining or coating, and the tubes are practically of the British Admiralty composition with a very small quantity of iron.

The possibility of using tubes of composition different from those in general British practice has occupied the attention of many workers, and it is quite a legitimate field. It is well known to us that materials can be used which will be practically free from corrosion; but to all such workers a word of warning may be useful, and that is that freedom from corrosion is not the only requirement in a condenser tube. The tubes must not be too expensive. The manufacturers must be able to draw them practically and commercially, and they must comply with several other conditions which are fully laid out, I think, in the Admiralty specification, with which members are fairly well acquainted.

The second example I will quote is turbine blading. For many years turbine blades were made of brass, which was convenient in manufacture. The peripheral speeds and consequently the stresses were comparatively low, and, on the whole, this material has given, and is continuing to give, good results in designs suitable for its use.

With the introduction of impulse turbines, difficulties became apparent. They may have been due to the increase in the steam temperature attending the employment of a small amount of superheat or to increased stresses on the blades of turbines of this type beyond the ordinary centrifugal stresses, or to a combination of the two. The higher stresses can be met to some extent by increased scantlings, but, as is well known, the ordinary brasses fall off rapidly in strength as they are exposed to higher temperatures.

Phosphor-bronze blading was therefore introduced for the high-pressure end of such turbines, and with the higher peripheral speeds of impulse turbines of the geared types, the use of blades in which the root and blade are combined has been much extended for these designs.

Tests of phosphor bronze as used for this blading have shown an ultimate strength of 23 tons per square inch at ordinary temperature, and 20.7 tons at 440 deg. Fah. This is satisfactory as far as it goes, but a material is sought which, while yielding nothing to phosphor bronze in its other qualities, will give a higher tensile strength and safely permit of high peripheral speeds where this would be of advantage, or, alternatively, reduced blade scantlings with its attendant advantages in respect to the turbine weight.

Steel has been considered and, although a highly suitable material in most respects, it has not been considered acceptable owing to the known risks of rapid corrosion, under conditions almost peculiar to the naval service. The Ferranti method, in which a thin coating of nickel is drawn over the steel blade, is known to give blades which are in a satisfactory condition in a foreign cruiser after a number of years' use, and a few rows of such blades fitted experimentally in two torpedo-boat destroyers of our service have also proved satisfactory. This system appears, however, only suited to blades of uniform sections, and has not, so far as is known, been applied to the other types.

Our remedy appears, therefore, to lie in a non-ferrous material. Monel metal has many attractions, but we are not aware that the manufacturing and supply difficulties have yet been satisfactorily overcome, although it has been used on a small scale for the blading of turbine auxiliaries.

Dr. Rosenhain has kindly brought to my notice information bearing on his work in connection with processes of blade manufacture, and with the suitability of aluminium bronzes for blading purposes. Sample castings have been made to his suggested compositions and worked up by one of the firms specialising in turbine blade manufacture into what appears to be satisfactory blading; opportunity is awaited to test it under actual running conditions.

As is well known, there are many aspects to consider in connection with the suitability of material for blading work, apart from the matter of strength; but it may be of interest to the Institute to learn that erosion, which appears to have been serious in some shore installations, has not yet troubled us.

With the increasing use of superheat, we shall require the assistance of metallurgists and manufacturers to give us materials capable of withstanding the high stresses, necessary with our limited scantlings, when exposed to high temperatures, and turbine blading will demand a great deal of attention. In addition, it will be necessary to review the work already done in investigating the properties of gun-metal and other alloys when exposed to high stress and high temperatures, and in all probability it will also be necessary to undertake several other new and similar investigations.

I wish next to refer to propeller blade material.

The propellers of our warships for some years have been universally made of manganese bronze, gun-metal propellers still existing in some of the old vessels. The practice of using expensive alloys has been criticised from time to time, but such special alloys are necessary for this purpose, as they possess the several qualities required better than other materials.

To obtain the best efficiency from a propeller of given dimensions, it is necessary that the blades should be thin and their surfaces polished. We should have some difficulty in obtaining thin blades in sound cast steel of the large dimensions required, and a polished surface in either cast or forged steel could not be maintained in sea water. Forged steel blades have been fitted and tried in some of our smaller vessels, but serious practical difficulties attended their use and they were abandoned many years ago.

I now wish to refer to the case of bearing metals.

Very interesting papers were read and discussed at our last meeting at Sheffield on the subject of white metals—interesting because they showed that workers for different purposes were in the same field. To be quite candid, it is probable that the bearing metal problem has lost a great deal of the importance that formerly belonged to it, owing to the fact that the true principles of lubrication so long known but not utilised have now been applied in a manner which can properly be described as revolutionary. It has long been thought that the nature of the bearing metal itself was a minor matter, provided that the oil film between the rubbing surfaces could be maintained; and the problem before engineers for years has been how to maintain that film with the ever-increasing direct bearing pressures and rubbing velocities. Following the mathematical investigation of the problem by Professor Osborn Reynolds some years ago, the practical solution of the problem has been effected by Mr. Michell in no uncertain manner. It has been adopted unreservedly in the Navy for the thrust blocks of all descriptions of engines with complete success. Although some difficulties have presented themselves in the application of the principles to marine journal bearings on account of the need of reversibility, they seem to have been overcome, and a design is in successful operation in two of the turbines of one of our torpedo flotilla leaders, aggregating 40,000 shaft horse-power on two shafts.

Some work of great importance, however, still remains for the metallurgist. We have had, not by any means many, but one or two failures, and the investigations that are in progress may indicate valuable improvements in our workshop methods of dealing with bearing metals. It is further to be borne in mind that, presuming it to be true that the material of the bearing is not of primary importance while the lubricating film is maintained and actual contact of the rubbing metallic surfaces is avoided, immense mischief may be done in a very short time should the lubrication fail, and to provide for such contingencies it is still considered eminently prudent by engineers to provide in bearing materials for such mishaps, and to this extent the problem of the bearing material remains as important as it always has been.

A final example of the use of non-ferrous alloys will be found in the oil engine.

In developing the fast-running heavy oil engines a limitation was set for some time to the piston speed, owing to the high inertia stresses consequent upon the weight of the reciprocating parts. This limitation has been to a considerable extent removed by the adoption of pistons of aluminium alloys, and it is probable that further developments in this direction can be effected when we are more fully aware of the properties of such alloys to withstand the effects of high stress and high temperature, and as they are developed in conjunction with engineering devices to give improved results in the matter of heat flow.

With the view of reducing weight, we are further considering the use of lighter working barrels of the cylinders by the adoption of non-rusting steel, and this appears by experiments made in our laboratory to have been rendered practicable by the use of piston rings made of copper-zinc alloy, shaped in the form of obturator rings.

I have endeavoured by means of a few typical examples to show the manner in which naval machinery has developed, and may be expected to develop, in the future as far as the interest of this Institute is concerned, and the instances I have given show, I think, that all sections can co-operate to considerable all-round advantage.

There has already been a great deal of co-operation, but I have a feeling that it has been to some extent in two pairs. I know that manufacturers have worked with engineers, and very successfully; I know that the metallurgist has worked with the manufacturer, and I believe with equal success. But the metallurgist has not been brought into direct touch with the engineer as much as is desirable, and if contact of this nature can be improved, it will be for the good of engineering science and progress.

I have read and heard a great deal about the advantages that must result from the application of science to industry; it is, of course, true, but a large portion of it has remained for a long time, and still remains, in the abstract and is not really applied. The reason is, I believe, because the user has not been associated as much as he should be in the necessary discussions; after all, it should be realised that the user is the final arbiter.

I have discussed this subject with several men of high standing in their respective spheres, and their views are in agreement with my own as just expressed. On the assumption that they are correct, it has been arranged, with the full concurrence of the professional chemists and metallurgists concerned, that our naval engineer officers now and in future shall receive instruction in metallurgy, not for a moment intended to make them metallurgical experts, but to a sufficient extent to enable them to discuss their experiences and their difficulties on a much more equable basis than has hitherto obtained.

Revision of Charges for London Water.

AT its meeting held on Friday of last week the Metropolitan Water Board had under consideration a Report of its Special Administration Committee concerning the revision of water charges. The Report stated that the Committee was of the unanimous opinion that there must be such a revision of the Board's income as would enable it to meet the expenditure without recourse to a deficiency rate. The expenditure for that purpose must, it was pointed out, include the sinking fund for the redemption of the debt incurred on the acquisition of the water undertakings. The acquisition debt is, it may be explained, to be repaid within a period of eighty years from March 31st, 1923. The Committee also gave it as its opinion that the power to levy a deficiency rate must nevertheless be retained—to be exercised only in cases of emergency—inasmuch as it forms part of the security for the Board's funded debt. In the event of any deficiency, such deficiency, it will be remembered, is chargeable upon the rates leviable by the Common Council of the City of London, the Councils of the Metropolitan Boroughs, and the Councils of the other boroughs and districts entitled to be represented on the Board. The aggregate value rateable of the area administered by these bodies exceeds £57,000,000.

Turning then to the question of how the revenue should be raised without resorting to a precept on the contributory authorities, the Committee commenced with the proposition that public ownership of the waterworks should carry some responsibility to be borne by the public at large, whether water consumers or not. Without going into the various phases of the communal interest in ownership, it may be stated that the question of redeeming the capital debt was, at all events, an owners' charge, and that therefore a public rate should be levied on the ratepayers at large whether consumers of water or not, so as to cover its redemption at least. The capital debt to be so redeemed would include that incurred in acquiring the undertakings and for defraying subsequent capital expenditure. The Committee thought that such a public rate should not exceed 1d. in the £.

It was proposed that the balance of the revenue should be raised from the actual consumers of water. So far as consumers by measure were concerned, the Committee was of opinion that none of them should get water from the Board at less than the cost price. So far as the ordinary domestic consumers were concerned, there should, it was urged, be such an increase of the present domestic rate of 5 per cent. as the circumstances might require. Such an increase would certainly not be unjustifiable, in view of the enhanced cost of production. It was thought that, so far as can be foreseen, the domestic rate actually levied might be 6½ per cent., but the rate would have to be fixed at the beginning of each financial year on carefully prepared estimates submitted to the Board.

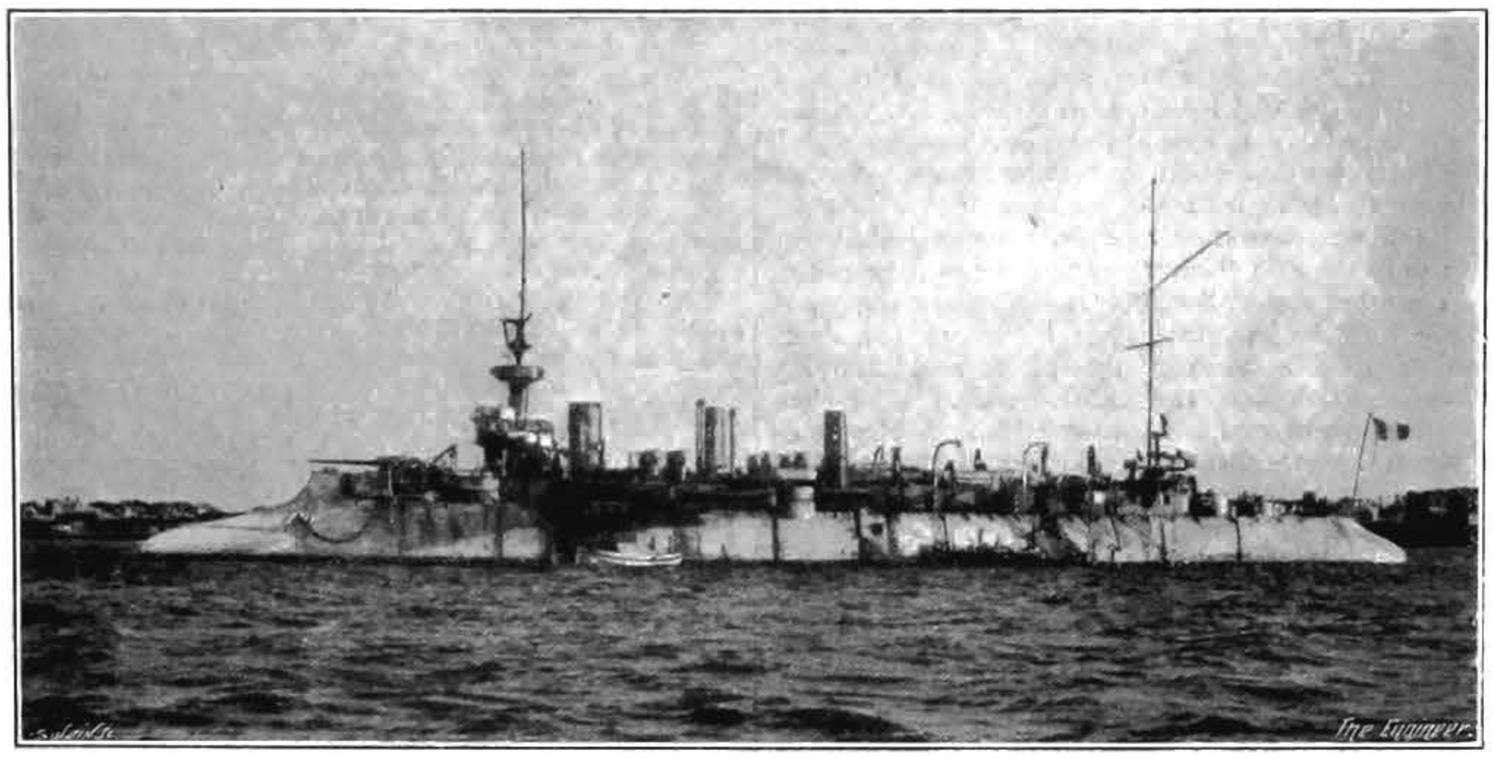
"It is not proposed," continued the Report, "to levy a public rate in the areas which do not at present contribute to the deficiency in the Water Fund. These non-contributory areas comprise rural parishes and urban parishes, some of which are partly supplied by the Board and partly by other water undertakings. In these circumstances technical difficulties might arise in levying a public rate upon the hereditaments comprised in these areas. They nevertheless should bear their quota of the ownership burden, and we propose that this should be accomplished by a provision that the charge for the supply of water in the non-contributory areas should be higher than in the contributory areas. This would be merely applying the precedent of many provincial municipalities owning waterworks who charge an increased rate outside the municipal boundary. We do not lose sight of the circumstance that this method of dealing with the non-contributory areas would in those areas place the ownership burden as well as the consumers' burden on the shoulders of the consumers exclusively. If, however, the consumers in an urban district were unduly burdened with this liability, it would be open to the Water Board or to the Council of that district to make an application to the Ministry of Health under Sec. 26 of the Metropolis Water Act, 1902, with the object of giving the urban district representation on the Board, and thereby making it subject to the public rate instead of to the consumers' special rate."

As regarded charges for bulk supplies, it was shown that in the cases of Croydon, Richmond, and Cheshunt the charges were regulated under statutory provisions, and that the terms could only be revised at the expiration of fixed periods. At the earliest opportunity the Board would naturally take steps to revise the charges for these bulk supplies, as the various prescribed periods arrive. Some other bulk supplies of a minor character were the subject of agreement, and could be dealt with at an earlier date. There were also certain fixed charges, for instance, for garden watering, horses, carriages and automobiles, automatic flushing tanks, small trades and others, which would require revision in the light of the proposed new charges. The latter, however, were matters of detail which did not arise at the present juncture.

COAL ECONOMY.—A proposal for increasing the economy of Lancashire and similar boilers put forward by Mr. W. H. Casmey in a booklet entitled "Coal Economy," published by Charles Griffin, consists in the reduction of the grate area. In support of his theory the author gives particulars of tests on standard Lancashire boilers with grates 6ft. long, and of Yorkshire boilers with much shorter grates, showing that the latter is the more economical type. The grate should be of such a size, he says, that its area is twice the area of the flue at the outlet from the boiler, while the fire should not be less than 10in. thick.

From Cruiser to Merchantman.

IN a recent issue we referred to the conversion of obsolete warships into merchantmen as one of the expedients which have been adopted to relieve the present dearth of tonnage. We mentioned the case of the Dupuy-de-Lôme, an old French armoured cruiser, which has lately been rebuilt as a cargo vessel by that well-known firm of shipbuilders and engineers, Les Chantiers et Ateliers de la Gironde, of Bordeaux. In the interval the directors of the company have been good enough to furnish us with particulars of this interesting piece of work, together with photo-

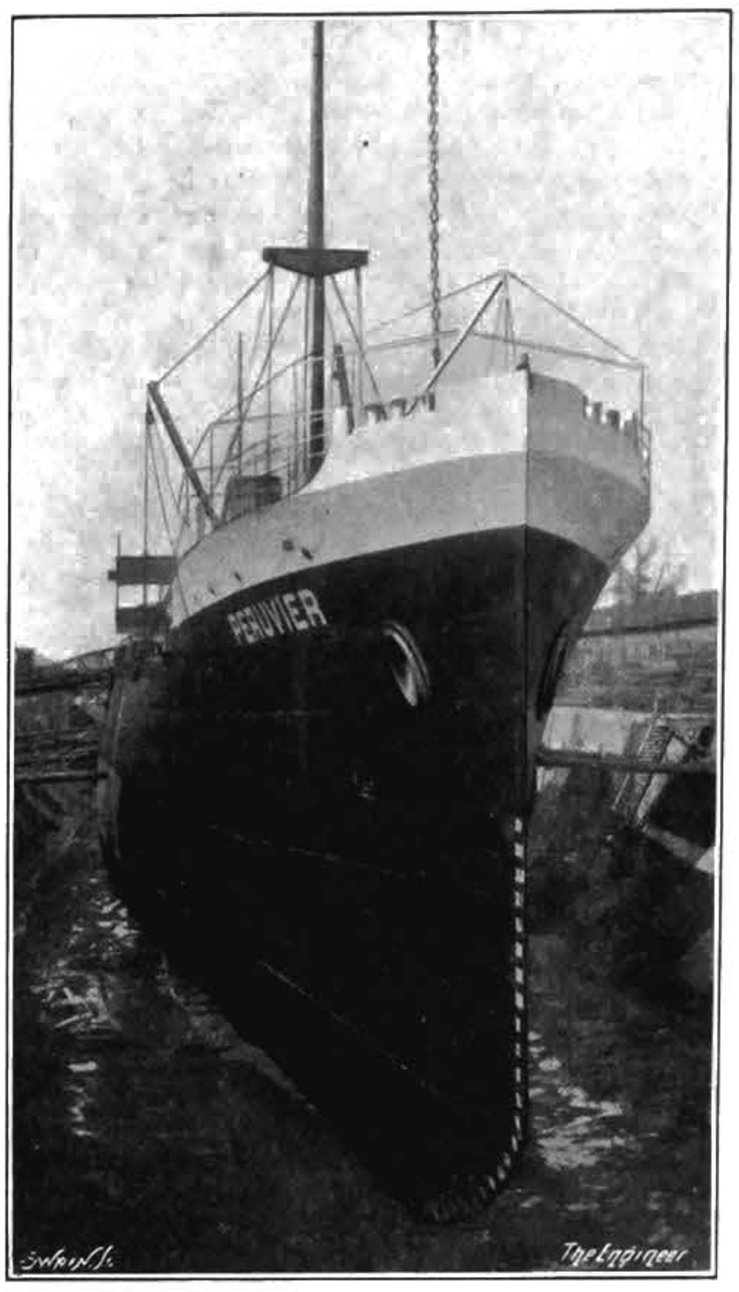


THE OLD FRENCH CRUISER DUPUY-DE-LOME

graphic views depicting the vessel before and after transformation.

The Dupuy-de-Lôme, it may be recalled, was the first of a type of armoured cruisers, the general design of which was widely perpetuated both in France and other countries. Her plans were prepared at the instance of Admiral Aube, who was a great believer in the efficacy of warships that combined high speed, good offensive qualities, and adequate protection with reasonable dimensions and cost, and the Dupuy-de-Lôme was designed in harmony with those principles. She was laid down at Brest in 1886, launched in October, 1890, and completed three years later. Her principal dimensions, &c., were as follows :—Length on water line, 374ft.; beam, 51½ft., draught, 23½ft.; displacement, 6297 tons. Her machinery comprised one vertical triple-expansion engine, driving the centre propeller shaft, and two horizontal compound engines actuating the port and starboard wing shafts respectively. Cylindrical boilers were installed. The machinery was intended to develop 14,000 indicated horse-power for a speed of 20 knots. As protection against shell fire the hull was plated with a broad belt of hardened steel armour, 4in. thick, reaching from several feet below the water line to the level of the upper deck. She was armed with two 7.6in. and six 6.4in. guns, mounted separately in 4in. turrets, and carried four torpedo tubes, mounted above water behind armour. The armour belt was 17½ft. in width and descended to about 4½ft. below the water line. The Dupuy-de-Lôme proved so successful in service that in 1904 she was considered to be worth an extensive refit, including the replacement of her cylindrical boilers by those of the water-tube type. This change enabled her to steam at nearly 22 knots. In 1914 the Peruvian Government offered to purchase the vessel, and negotiations were in train when the war broke out ; but as international law forbids the sale to a neutral country of any warship belonging to a belligerent Power the vessel was laid up in France for the duration of the war. As the Peruvian Government had meanwhile abandoned its intention to purchase the Dupuy-de-Lôme she was placed on the sale list last year and ultimately bought by the Royal Belgian Lloyd, which handed her over to the Chantiers de la Gironde for conversion into a freight steamer, and the work was duly carried out under the supervision of the Bureau Véritas, with which the vessel is to be registered.

The reconstruction took place in the large fitting-out basin of the Bordeaux yard, which is equipped with cranes powerful enough to deal with the heavy weights involved. Two distinct operations were necessary, the ship having first to be dismantled and then rebuilt in her new character. Proceedings began with the removal of the superstructures, only the after deck-house being retained to provide accommodation for a dozen passengers. Most of the bulkheads were taken out, including those which subdivided the machinery space, while the two forward boiler-rooms were dismantled and the fourteen boilers removed. Both the horizontal engines, originally placed before the central vertical engine, were taken out of the ship, and the whole of the armour plating on the sides was removed. When this demolition work was finished the reconstruction was taken in hand. A complete high forecastle was erected above the original ram bow, provision being made for a new capstan and windlass gear. This new forecastle was also utilised to accommodate part of the crew, and incidentally afforded better protection to the ship against sea and weather. The decks were reinforced with new beams and fitted with scuppers in conformity with the regulations of the Bureau Véritas. The bulkheads left in the ship and the hull generally were strengthened by the addition of doubling plates. Four large cargo holds were provided, one in the forepart of the ship in place of the forward gun turrets and magazines ; one in the space formerly occupied by the two forward boiler-rooms ; one in place of the old horizontal engine-room ; and a fourth in place of the after gun turrets and magazines. Each hold was furnished with a large hatch—two in the case of hold No. 2—each fitted with two derricks, save the after hold, which was given but one. This gives a total of nine derricks, six of which are 3-ton and three 5-ton. Above the remaining boiler-room quarters were fitted up for the ship's officers. Two cabins were provided in the forward superstructure and also a wireless telegraphy cabin, with a chart-room and bridge-house above. In the after part of the ship the 'tween deck space was fitted up as quarters for the crew, and the space above the steering gear was converted into a store-room.



BOW OF THE CONVERTED CRUISER

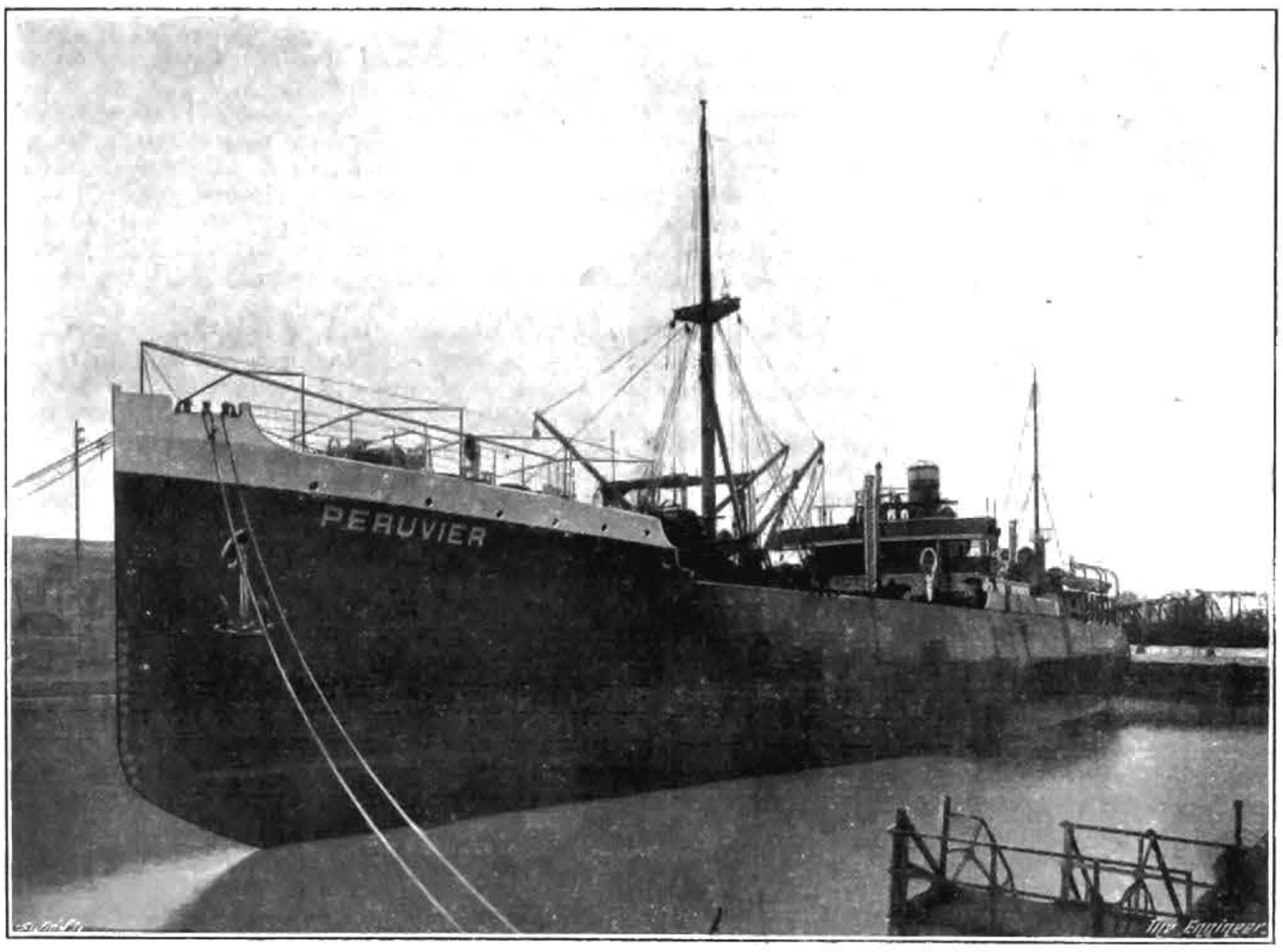
The reconstructed ship, which has been named Peruvier, has the following dimensions, &c.:—

Length	374ft. (114 m.)
Beam	50ft. 9in. (15.5 m.)
Moulded depth	35ft. 9in. (10.9 m.)
Mean draught, light	13ft. 6in. (4.130 m.)
Mean draught, loaded	27ft. 6in. (8.570 m.)
Gross tonnage, approximate	5400 tons (metric)
Displacement, approximate	8240 tons (metric)
Cargo capacity	238,000 cu. ft. (6500 cu. m.)

The machinery comprises one vertical triple-expansion engine and six boilers of the Guyot-du-Temple type, developing a maximum of 1700 to 2000 horse-power and a speed of 10 to 10½ knots.

A comparison of the photographs taken before and after reconstruction shows how completely the appearance of the ship has been changed. Judging from the figures relating to gross tonnage and speed, the operation would appear to have been remarkably successful.

We understand that the Latouche-Tréville and other old cruisers of the French navy are to undergo the same transformation. Germany also is adopting this method of enlarging her depleted tonnage. According to the *Schiffahrt-Zeitung*, two large torpedo-boat destroyers which were lying unfinished at the Danzig State Yard have been purchased with a view to their reconstruction as mercantile ships. It is pointed out that vessels of this description are well adapted for conversion into passenger steamers, as their fine lines render it possible to achieve a good speed with relatively small engine power. The Danzig yard is now rebuilding the protected cruiser Gefion, of 3770 tons, as a motor cargo vessel. In place of her steam machinery she is to be equipped with two Diesel engines, which were originally manufactured for submarines and have a collective horse-power of 1200.



THE DUPUY-DE-LOME AFTER CONVERSION

The Gefion's speed as a merchantman is estimated at 9 knots. It is understood that she will be employed on the Transatlantic route.

Institution of Mechanical Engineers

THE adjourned general meeting of the Institution of Mechanical Engineers was held at Storey's Gate on Friday, March 5th, Captain Riall Sankey, the new president, taking the chair.

There were, of course, no minutes of proceedings to read, and as the new by-laws Nos. 1, 2, and 3 had been passed at the meeting a fortnight before, the President invited Mr. Thompson to explain the reasons for his objections to the amendments to by-laws 10 and 11, which concern the increases to subscriptions and entrance fees. Mr. Thompson read some extracts from past annual reports of the Institution with the object of showing that there had been a steady increase in the balance of receipts over expenditure, amounting on the average to £4386 per annum, and gave the results of some calculations which he had made on the effect of the proposed increases in subscriptions. The increased revenue from members would be, he estimated, £2902 and that from associate members £1778 10s., while the gross increase, including graduates and associates, would be £4782 10s. In view of the fact that the council was trying to balance an advance in expenditure of some £1500, this increase was, he thought, too much to ask from the members. Mr. Thompson then suggested that the subscriptions of existing members should remain as they are and that new members only should pay the advanced fees. No one seconded Mr. Thompson's amendment, and the council's recommendations were passed. Later in the evening, however, Dr. Hele-Shaw and Mr. Robinson both asked Mr. Thompson to let the council have the benefit of the analysis of accounts which he had drawn up.

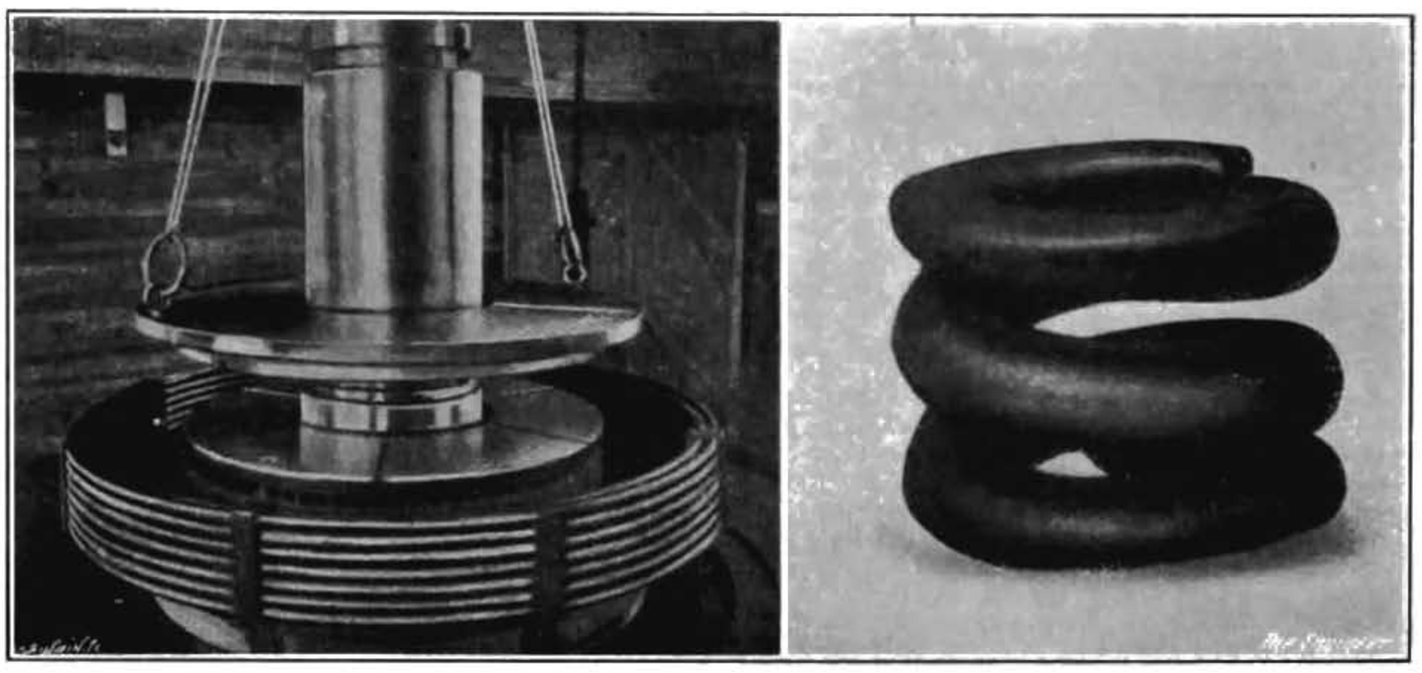
There was only one other of the proposed new by-laws which was not passed by the meeting without comment. It was No. 22, stipulating that the names of new members should be read at the next meeting after election. Mr. Jones asked if he would be in order in speaking on the subject, as he did not wish to put forward an amendment, but wanted the by-law to be entirely omitted? He pointed out that the majority of members were not interested in these lists of names; in fact, on several occasions recently they had expressly asked to have the lists taken as read. The time at meetings, he said, could be better spent than in listening to the repetition of personal names. Dr. Hele-Shaw agreed with Mr. Jones, and after some discussion it was arranged that the council should withdraw the rule.

In connection with the by-laws authorising the organisation of local branches of the Institution, Mr. Longridge told the members how, as long ago as 1913, a meeting was held in Manchester with the object of finding facilities in the provinces for the institution of local branches, but the cost proved to be prohibitive, and it was decided instead to have the papers contributed to the Institution read in the provinces, and correspondents were appointed to arrange such matters. Early in 1914 Sir T. Holland wrote to the *Manchester Guardian* suggesting the organisation of meeting places, furnished with reference libraries, lecture rooms, &c., which would be supported conjointly by several societies. A committee, on which the Institution of Mechanical Engineers was strongly represented, was formed to discuss the matter, but the outbreak of war put an end to the business. The scheme which the council had in mind in framing the new by-law was very much on the lines of Sir T. Holland's proposals.

The President announced the names of the members of the committee formed to consider Mr. Moss' suggestion to permit graduates to join the Institution at the age of sixteen, which included Captain Riall Sankey, Mr. Patchell, Professor Dalby, Mr. Moss, and Mr. Evans. The discussion of Mr. Bergstrom's paper on "The Utilisation of Water Power" was then re-opened, Mr. L. Pendred being the first speaker. He began by querying the suitability of such papers as that before the meeting for presentation to the Institution. There was, he said, little or nothing in the paper that could not be found elsewhere in sources available to the members, and there was next to nothing in it that was suitable for discussion. He suggested that it would be better to bring problems or difficulties forward than to repeat descriptions of well-known plant. That this criticism of papers was seconded by the members was evident from the applause which was heard from various parts of the room. Mr. Pendred then called attention to the fact that there was in the paper no mention of the great work in hydraulic engineering done by France and by Italy, and he showed a slide of a duplex Pelton wheel turbine made by Riva and illustrated in our issue of November 7th last. He then gave a brief history of the Michell and Kingsbury thrust bearings. Michell arrived at his solution of the thrust bearing problem by a study of Osborne Reynolds' thesis of 1886, which followed Beauchamp Towers' research of 1884. Michell's work was done in 1902–3–4 and first published in a German paper, *Z.f ür Math: u. Physik.* in 1905. He took out patents in Great Britain and Australia in January, 1905, but could not meet the expense of foreign patents. Kingsbury's application was filed in the United States on May 20th, 1907, and since two years priority was allowed to American citizens if they could prove that they had been experimenting, Kingsbury secured the American patent. Kingsbury's original design appeared to have been worked out by trial and error, but his later forms followed the correct principles first laid down by Michell.

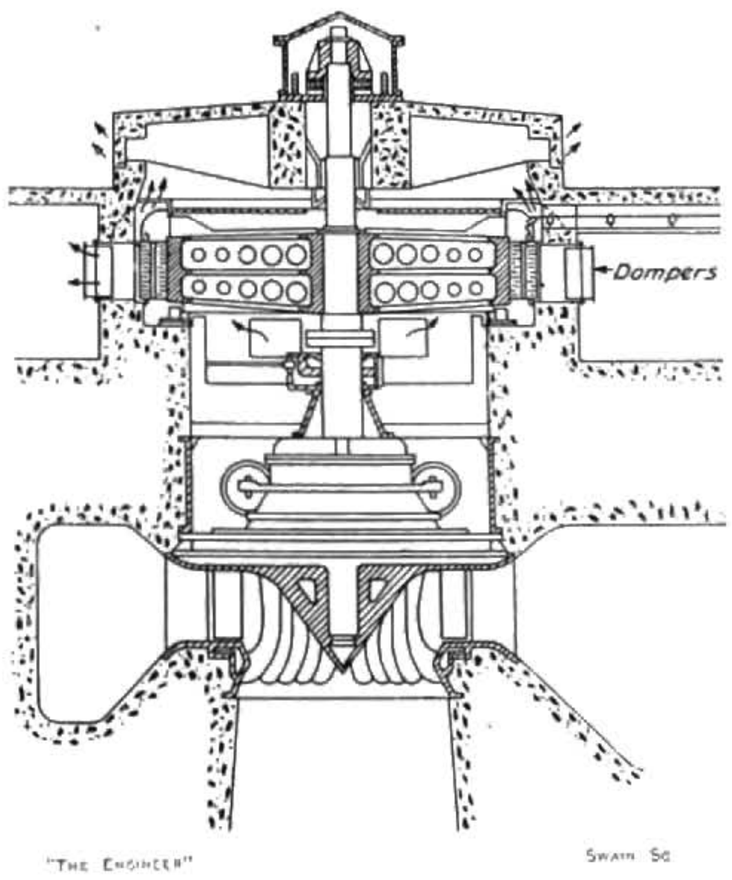
Mr. Anderson complained that the paper was not up to date and included no references to first costs, which were of great importance on account of the variations in the civil engineering work necessary for the development of water power, specially in the case of the utilisation of the tides. Mr. Bergstrom had given considerable credit to American engineers for the development of the high-pressure turbine, but Mr. Anderson thought that the Swiss had done the pioneer work in the development of the Francis turbine for high heads. He also considered that the Kingsbury or Michell bearing was not the most recent form for carrying heavy thrusts, as a new type had been evolved in America in which the load was carried by a spring supported plate and had been installed at the new Cedar Rapids power plant in Canada; while three of the units on the Panama Canal at Gatun had been converted from Kingsbury to spring thrust bearings.

This spring bearing, we may say, was described in a recent issue of the General Electric *Review*, to which house journal we are indebted for the illustrations reproduced herewith. The bearings for Cedar Rapids have to carry a load of 550,000 lb. each when running at slightly more than 55 revolutions per minute, must start from rest as often as necessary and run at 10 revolutions per minute for an hour without injury. The peculiarity of the bearing lies in the comparatively thin spring-supported plate which is employed to carry the thrust. This plate, plainly shown in the engraving, is of steel, with a babbitted rubbing face and is 56in. outside diameter by 28in. inside diameter. It is supported on 368 springs 2in. in diameter by 1½in. high, one of which we illustrate. Across the face of the plate there are several radial slots for lubricating purposes, and one slot is cut right through to prevent the plate warping with changes of temperature. The opposite or moving part of the bearing is a ring of special grade iron with its face ground and highly polished, and it, also, is furnished with oil grooves. The whole bearing is flooded with oil, which circulates under the influence of centrifugal force and is kept cool by means of the coils of water pipe shown in the engraving. Although the babbitted surface of these bearings is put in service just as it comes from the machine shop they are said to give complete satisfaction.



MULTIPLE SPRING THRUST BEARING

Mr. Anderson commented on the fact that Mr. Bergstrom had not mentioned the Seaver system of governing Pelton water wheels, in which guides inside the jet orifice are used to impart a rotary motion to the jet and thus disperse it, on the reduction of load, by centrifugal action. He said that in his opinion the Francis turbine was doomed to extinction as a machine for low falls, and he anticipated the coming of an axial flow turbine for such services. Another development which might take place in the future was the use of reinforced concrete in the construction of electrical generators connected with turbines and the elimination of the power-house building by the production of generators which could safely be exposed to the elements. This idea also was recently put forward by the General Electric *Review* in an article by Mr. C. M. Hackett, in which the author suggests the possibility of employing reinforced concrete for the stator frames and thrust bearing supports of hydro-electric units on the score that savings could thus be effected in the cost of materials and labour, while the difficulty of handling the large individual pieces necessary if these parts were made as metal castings would be eliminated. The line drawing which we reproduce shows a generator designed on these lines.



CONCRETE HOUSING FOR HYDRAULIC TURBO-GENERATOR

Mr. W. H. Patchell prefaced his remarks on the paper by congratulating the President on the happy and informal manner in which the meeting was progressing, and although the meeting was not very well attended it was without doubt one of the most human which the Institution has held for some time past. Mr. Patchell went on to discuss the financial side of water power development as it affects the British Isles, and pointed out that the capital costs in this country work out at something like £87 per kilowatt. As a comparison he mentioned the most recent additions to the Niagara installation, which have an output of 32,500 kilovolt-ampères per unit, cost £30 per kilowatt. This charge was chiefly accounted for by the machines themselves, but also included the deepening of the channel and the construction of three new penstocks and pressure mains. These turbines, Mr. Patchell said, have an efficiency of 83 per cent.

Letters to the Editor.

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

PAYMENT BY RESULTS: THE COLLECTIVE SYSTEM.

SIR,—May I be permitted to reply to the criticism of collective production contained in Mr. J. E. Powell's letter of January 20th, which appeared in a recent issue of your publication, under the title "Payment by Results: The Dangers of Collective Systems"? I would not have troubled you in this matter, but the great national need for increased production is such that I should be wanting in my duty if I did not immediately reply to his attempt, to which my attention has just been called, to undermine a sound economic principle.

Your correspondent admits the urgency for increased production, but claims that the collective system will not appeal to the energetic and able worker with the same force as the individual system does. Herein he is wrong, because the collective system has been in operation for a long enough period to prove conclusively that not only does it appeal to the energetic and able worker, but, by means of its adoption, the less competent worker becomes more competent and the efficiency of the whole of the *personnel* is raised, both collectively and individually.

Mr. Powell speaks of the faulty administration of the individual system and of the tragedy of the relationship between employer and employed under it. He is mistaken when he assumes that the only objection which the worker has to piece rates is that they are likely to be cut. There are many other

objections, probably the greatest being jealousy which they create between the workers themselves. He also grants to advocates of collective systems the recognition of, to quote his own words, "the fundamental fact which must be recognised, if there is any real hope of mutual trust, that promises can be kept only when the foundation on which they are made is economically sound, and the first essential for this is satisfactory organisation that will make efficient production possible."

This concession is immediately followed by an attack on the Priestman system of collective bonus, with a gracious admission that it shows signs "of having had more thought expended upon it than most systems of its kind," but complains that its advocates make no reference to the importance of organisation. To me it appears to be quite unnecessary to advocate the obvious, and that efficient organisation is necessary must be obvious to all engaged in industry, even though there be widely divergent views as to the means best calculated to secure it. We maintain, and we are in a position to prove, that the Priestman system improves organisation almost beyond belief.

In referring to the 10 per cent. increase which was granted by Priestmans, Mr. Powell speaks of it as being "a bribe to buy the goodwill of their employees." This we also admit, but wish to point out that the bribe was necessitated by the deplorable relationship, the outcome of the individual system, existing between employers and employed which Mr. Powell himself describes as "almost tragic." So suspicious were employees concerning any proposal emanating from employers that it was not until the latter produced evidence of their good faith that they would consider the adoption of any untried scheme. The 10 per cent. is no longer a necessary part of a scheme which has proved successful in every way, and it may be ignored so far as the installation of the scheme is concerned because employees do not demand it.

I agree that the increased output obtained may be a reflection on the organisation existing prior to the adoption of the principle, but the fact that payment by results on the collectvei principle increased production, is evidence that bad organisation was corrected in some measure, and that where the management obviously failed, the co-operative effort of the whole of the employees succeeded.

The Priestman system does not lay down, as your correspondent supposes, any hard-and-fast rule that the average for the previous six months shall form the standard for determining increased output. On the contrary, it stipulates that it shall be taken over a period long enough to ensure that the average is fair to both employer and employed.

With reference to Mr. Powell's hypothetical case of three firms, A, B and C, each producing substantially the same machines with equal manufacturing facilities, and in a position to produce 100 per cent. efficiency represented by 100 tons of finished machinery per week, he claims that it is not unreasonable to assume that their actual average output before the introduction of the Priestman system was:—A, 60 tons per week; B, 80 tons per week; and C, 90 tons per week.

Allowing that the ultimate increase obtained amounts to 100 per cent. efficiency for all three firms, and that in each case, of course, the full percentage of any increase in output would be paid on wages, minus war additions, he quotes the following figures:—

	Firm A.	Firm. B.	Firm C.
Present output, tons	60	80	90
Increased, to tons	100	100	100
Percentage increase	66.6	25	11.1
Time wages paid, exclusive of war advance in £	1000	1000	1000
Bonus due in £	660	250	111
Total earnings in £	1660	1250	1111
Wages cost per ton in £	16.6	15.6	12.3

I quote his deductions:—"The relative excellence of the position of firm C will be obvious, while the position of firm A would appear to be amenable to nothing less than adjustment—or, in plain English, cutting the bonus rate—and will thus be seen to be the same as that of a firm using the individual system whose datum line or standard of efficient production has been too low."

Leaving out of consideration for the moment the errors which his figures contain, that the relative excellence of C is obvious cannot be denied, nor can the relative excellence of C before the application of the Priestman system be denied. That is not the question. The principal point of interest is the relative positions of A to B, A to C, and B to C before and after the introduction of co-operative production. A moment's consideration is sufficient to show that A is in a much better position to compete with either B or C after the increased output is secured than he was before, because A's overhead charges, which important figures are not referred to by Mr. Powell, have been spread over a much greater area of production than was formerly the case, so that A has made not only a larger bulk of profit, but he has made a greater percentage of profit per ton because of the reduction of his overhead charge per ton.

The same remark applies in a lesser degree to the relationship of A to B and B to C. A rearrangement of Mr. Powell's figures, plus another column representing overhead charges, will sustain the contention of the betterment of the position of both A and B in their relationship to C.

It should be noted that in those figures appearing under the heading of "Co-operative Production," no allowance has been made for the increase of overhead charges which would take place because of the increased payment made to the management and staff, which must be omitted because of lack of detail as to how these overhead charges are made up:—

Before Co-operative Production.

	Firm A.	Firm B.	Firm C.
Output, tons	60	80	90
Time wages paid, exclusive of war advances, in £	1000	1000	1000
Overhead charges	1000	1000	1000
Cost per ton in £, exclusive of material	33.3	25	22.2

After Co-operative Production.

Output, in tons	100	100	100
Percentage of increase	66.6	25	11.1
Wages paid, less war advances	1600	1250	1111
Overhead charges	1000	1000	1000
Cost per ton in £, exclusive of material	26.6	22.5	21.1

Apart from the improvement in the relative positions of the firms to each other, the relative position of all firms is considerably improved after the adoption of the Priestman system, and two important points stand out clearly. First, that they have secured increased production; secondly, that they have reduced the cost of manufacture by an appreciable amount; and these two facts alone warrant the substitution of the collective system for the individual system.

London, March 8th. ERNEST M. HOWE.

THE "CIVILS" BILL.

SIR,—"An Old Subscriber" gives away the whole case for the above in his attempted support.

Paragraph 3.—Apparently "civil" engineers are not as well educated or as honest in character as other branches of engineering, since they must be controlled and forced to conform to not merely etiquette, but ordinary decent rules of conduct.

Paragraph 4.—A consulting engineer, of course, buys a lot of knowledge he does not himself possess from other engineers. This is very commonly the way in which professional partnerships, permanent or temporary, for the job are formed.

The proposed Act would limit their power in this respect in that they would have to get this knowledge from "registered" men, who, being equal in profession, would demand equality in position—*i.e.*, if wise, they would demand the equality of "joint engineers," or, on the other hand, they could, as now, obtain it from unregistered men, who, having nothing but money results to consider, would, if wise, demand such terms as would leave the engineer with no net receipts from his fees. Not being a pauper, and being an engineer by liking for the work and not from merely the money it might bring me, that is the line I should take myself did I occupy such a degraded position as that in which many men will be placed by this "Bill" if it becomes an Act of Parliament. To put the matter in a nutshell, "An Old Subscriber" in practice proposes that, to a large extent, an engineer should take the fees for work of which he knows nothing, and the man actually doing the work should look on it merely as money grubbing and occupy a degraded position professionally. Is this good for the profession in any branch?

Paragraph 5.—Sir C. Wren was a great architect, and such a man would not be barred out, would he not? Under the proposed Act such a man would certainly be "barred out," for he would have no chance of showing his "greatness" on smaller works.

Paragraph 7.—Apparently all "practising" men are to be registered. But what about all those who are not practising on their own account? Are all those who, past middle age, in the employ, temporary or permanent, of others to be "barred out"? What about those who have supplied consultants and others with special knowledge, and whom present conditions have forced to stand idle for several years? Are they to be degraded permanently—to be barred out?

Paragraph 9.—Of course, a successful engineer must be "educated," so must a wheelwright or any tradesman; but it does not follow that that education must follow stereotyped lines. There is quite enough "grooviness" in engineering as it is, without encouraging further growth of that weed.

And what does "An Old Subscriber" mean by "successful"? Education "on University" lines will not of itself produce monetary success. Quite often quite the reverse.

The fact that a man has contrived to keep his end up as a competent engineer till he is long past middle age should ensure him against such professional degradation as this Bill proposes for many. Further, in general honesty of work and administration our profession in all its branches requires no control, as is shown by results and past experience. If University men are wanted, they can be obtained, but for the greater number of engineers the expensive type of education there obtained is pure waste of time and money. Neither are the latter any worse in "character" than the University men, and in some respects they are better, having had to fight for their place and not been able to buy it easily. Personally I do not much care how it may affect myself. I have often wished I could have brought myself years ago to go into commerce rather than an exacting and badly paid profession.

If refused "registration," I should drop the profession altogether. I am well past middle age, and would refuse to accept any such degraded position as that proposed, and I believe many would follow such a line. The servitude does not carry a high enough price. The scheme, I may add, is silly in its ultimate results, since it would certainly stamp as "competent" men who have no knowledge worth mentioning as "civil" engineers in a narrow sense, and who buy their work in those lines from men who would be excluded.

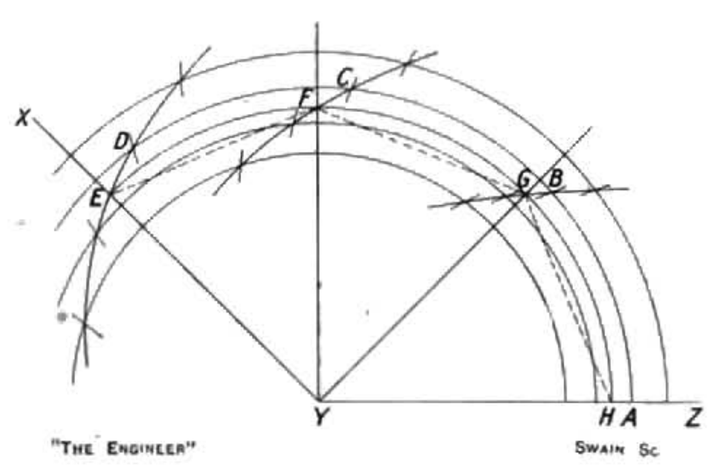
GEO. T. PARDOE.

Angmering, March 6th.

TRISECTION OF AN ANGLE.

SIR,—In view of the interest that this problem has evoked, may I suggest that any angle up to 360 deg. can be readily trisected with the aid of a good French curve.

The accompanying figure shows the construction. A number



of arcs—four or more—are drawn with centre Y and any convenient radii at fairly close intervals. On one of the intermediate arcs A B is marked off with a radius that appears to the eye to place B somewhere in the neighbourhood of the trisection line, B C and C D are marked off with the same radius, and also corresponding points on each of the other arcs. The lines through these corresponding points are drawn with the French curve—the outermost cutting X Y at E. The arc E F G H is drawn with radius Y E. The angle X Y Z is then trisected by the lines Y F and Y G.

With regard to proof, it seems only necessary to point out that, by construction, the curves passing through G, F and E represent in each case the locus of one end of the base of an isosceles triangle having as fixed properties the position of the apex, the locus of the other end of the base and the length of the base. The method should be sufficiently simple and accurate for most practical purposes.

NORMAN C. BRIDGE.

Glasgow, March 8th.

[This process is of practical rather than academic interest. It can only give a mathematically accurate result if the French curves used have certain definite forms. The form of the curve at B is not the same as that of the curve at C, which again is different from that at D—that is to say, three different French curves are required mathematically; we are not justified in using three different portions of one and the same curve.—ED. THE E.]

THE HUMAN STREAM.

SIR,—I fancy that the "Maxwell's Demons" mentioned in your "Random Reflections" this week were not actually molecules of gas, but extraordinarily active creatures invented to show how a gas might be compressed without doing work on it. Maxwell imagined the surface of the vessel containing the gas to be divided into innumerable sections or doors, each one in charge of a "demon." The entire surface will, of course, be subjected to a constant bombardment by the molecules of gas; but if the doors are made small enough there will be times when any one of them will momentarily have no molecule in contact with it. If the demon in charge of that particular door be sufficiently alert, he will be able to push the door inwards without the expenditure of any energy before another molecule strikes it. The combined effect of all the demons will thus be to reduce the size of the vessel, and so compress the gas.

Your entertaining remarks on "The Human Stream," in which you suggest that crowds of people might be made to obey the same laws as fluids, reminds me that the notion has recently been seized upon by *Punch*. The overcrowding in Underground trains was the theme. One picture showed a porter forcing an unusually bulky passenger into the end doorway of a fully loaded carriage. But since, beyond a certain point, humanity is as incompressible as a liquid, this passenger could only enter at the cost of displacing other passengers. In the second picture we see these displaced travellers being extruded from the centre doorway on to the platform.

In the design of modern railway stations some attempt has already been made to limit the pressure set up by crowds. Glasgow Central (Caledonian) Station is built with a circulating area of stepped form—in plan, of course—with the object of breaking up dangerous surges of passengers. The analogy here, I suppose, is with the stepped spillway of a dam, in which the energy of the overflow water from the reservoir is destroyed by the steps instead of being allowed to do damage at the bottom.

H. ADDISON.

Colchester, March 6th.

[We confess we took liberties with Maxwell's "demons.' Is Mr. Addison quite sure that the plan of the Glasgow Central Station was not settled by the conditions rather than with the object of easing the movement of crowds?—ED. THE E.]

"THE SPECIFICATION OF CHEMICAL COMPOSITION."

SIR,—Your leader on the above subject in February 27th issue puts the case in a very able and well-balanced manner. From long observation I am convinced that, whilst an indiscriminate enforcing of chemical specifications often causes unnecessary trouble to the manufacturer, with no corresponding benefit to the user, if they were abandoned altogether there would in some cases unquestionably be too great laxity, and bad material would more frequently escape rejection.

As regards analytically standardised samples, to which you refer as "now becoming increasingly available"—apart from private standards which, however good, have no authoritative value—as the United States Bureau's standards are not freely obtainable here, I know of none so far issued but the "British Chemical Standards" described by you in your issue of November 14th last.

It may interest you to know that these are rapidly becoming international in character, already not only the United States Bureau and other U.S.A. chemists co-operating in their standardisation, but also chemists in Italy and France; and it is hoped this feature will lead to co-ordination of chemists everywhere.

C. H. RIDSDALE.

Middlesbrough, March 5th.

MR. DENDY MARSHALL'S LOCOMOTIVE.

SIR,—I much appreciate Mr. Cecil Poultney's discussion of the proposed engine. His suggestion of instability is, I think, quite unfounded. The four cylinders would absolutely eliminate "noseing." The Philadelphia and Reading engines, as they had coupling-rods, doubtless had side-play to the bogies, and the alternate thrust of the two cylinders would cause tail-wagging, which is resisted where the trailing axle is rigid, and would be prevented in the present case by the fact of the bogie pin being fixed. It is well established that the Bristol and Exeter engines were highly successful.

That the ratio of heating surface to grate area is unconventional I, of course, admit, but I am of opinion that this figure is too high in a large number of cases. I did not make the boiler larger because I did not wish to have the centre of gravity excessively high, nor to obstruct the view from the cab unduly.

Does Mr. Poultney remember the extraordinary performance of a single engine in 1905 on the Great Western Railway, when 90 miles was covered in an hour? The tractive resistance of my engine would be far below that of any ordinary single engine with a fixed wheel base of 8ft. or 9ft. at the rear and a "flopping" bogie in front, and, taking all things into consideration, it should score very heavily in this respect over an engine of the Aspinall type, though, of course, the latter would be infinitely preferable from the point of view of weight-pulling.

C. F. DENDY MARSHALL.

Hove, March 8th.

THE HEAVIER-THAN-AIR FLYING MACHINE.

SIR,—In reply to Mr. Ogilvie's letter on this subject, I regret that I was apparently misled into giving M. Ader credit to which he was not strictly entitled. Owing to absence from home, I am unable to give my authority, but must, of course, accept Mr. Ogilvie's statement, as it is based on an official report, which I do not remember having seen.

With regard to the experiments of the Wright Brothers, however, I do not consider that any correction is called for. Though not carried out on private property, these experiments were private for all practical purposes.

C. F. DENDY MARSHALL.

Hove, March 8th.

Railway Matters.

THE Lancashire and Yorkshire, during last year, carried practically the same tonnage as in 1913, but with a reduction of 1⅛ million train miles.

A COLLISION between two passenger trains occurred on the 24th ultimo on the Aberystwyth and Carmarthen branch of the Great Western Railway.

AS indicative of the increased cost of railway works, it may be observed that the Great Central new fish dock will cost three times the pre-war estimate of £500,000.

THE Great Southern and Western of Ireland has ordered from outside firms six locomotives and 260 wagons. It hopes to build 200 wagons in its own works at Inchicore during the present year.

THE directors of the Caledonian Railway Company have appointed Mr. J. J. Haining, chief assistant in the secretary's office, to be secretary from the 1st instant in place of Mr. Blackburn, who has retired.

THE Underground Railway of London and its allied traffic organisations carried every Saturday in January over 1¼ million passengers, many of whom travelled in connection with football matches.

THE Great Northern Railway Company has placed an order with outside firms for 2300 wagons. When they have been delivered the number of wagons owned by the company will be the same as in 1913, but their carrying capacity will be larger.

THE Railway Advisory Committee of twelve general managers and five representatives of the men had its first meeting on the 25th ultimo. Sir Eric Geddes presided, and it was decided that no statement as to the business done should be published.

AN agreement has been signed between the Minister of Public Works and Mr. S. H. Pearson, representative of the Argentine Transandine Railway, under which the latter is authorised to amalgamate its administration with that of the Chilian Transandine line.

AS compared with the previous year of 1918, the working expenditure of the Great Northern for 1919 increased £1,300,000, or 31 per cent., in wages; £243,000, or 33 per cent., in fuel for locomotives only; and £357,000, or 20 per cent., in the cost of material. The total was £1,900,000, equivalent to an increase of 29 per cent.

A SETTLEMENT has now been arrived at between the committee of general managers, acting on behalf of the Government, and the Railway Clerks' Association as to improved conditions for the clerical staff. A feature about these concessions not generally appreciated is that, as the railway companies pay a proportion of the men's superannuation, the rates of which are regulated by the amount of their salary, these advances will mean greater payments for superannuation.

WE are informed by Mr. A. W. Gattie that on the 15th of this month, at 7.30 p.m., in the Council Chamber, Caxton Hall, Westminster, he will address a public meeting convened for the purpose of discussing the report of the Departmental Committee on the scheme of railway reform generally known as the Gattie system of goods transport. It is Mr. Gattie's intention, and that of other intending speakers at the meeting, to expose "inaccuracies and misstatements" in the report in the plainest possible manner.

SPEAKING at the North Staffordshire Railway annual meeting recently Lord Anslow, the chairman, made an important pronouncement on the subject of compulsory amalgamation of railways. He said that if the North Staffordshire was to be sacrificed in the interests of the nation, it should not be swallowed up in another railway company, which would thus reap where the North Staffordshire had so industriously sown. If any profit was to be made out of the absorption of that railway, let the profit be for the nation and not for the shareholders in some other company.

THE compulsory adoption by the Irish railway companies of the same war bonuses, the same eight hours' day, and the same conditions of employment as in the British railways is causing some concern in Ireland, as some of the lower paid men have received advances of 240 per cent., as against an increase in living of 125 per cent. This has adversely affected both agricultural and commercial concerns, and whilst no one opposes the granting of increased remuneration to meet the higher cost of living, it is felt not to be fair to employers in Ireland to disturb the relative difference which always obtained between the standard of wages paid in the two countries.

THE monthly statement of receipts and expenditure for December, issued by the Ministry of Transport on Tuesday last, show that the receipts were £14,494,282—£500,000, roughly, above the November figures—and the expenditure £18,005,694—nearly £3,000,000 more than in November. For the nine months of the financial year the receipts were £141,219,292 and the expenditure £133,752,153, and the deficit, after paying the guaranteed net receipts, was £31,013,582. By reference to the White Paper, "Railway Working," Cmd. 402, issued in November, we are able to add the first three months of the calendar year and to compare the totals with those of 1913. These show:—Receipts, 1913, £123,406,576; 1919, £180,817,848. Expenditure, 1913, £78,057,044, 1919, £171,469,001.

THE Ministry of Transport has recently issued the report of Major Hall on a minor collision which occurred on the evening of January 1st between Finsbury Park and Holloway, on the Great Northern Railway. It was a case of an empty local train running into a train of empty coaches and was, no doubt, caused by the driver of the former thinking he was on the up slow line, whereas he was on the up goods line. The up slow line signal was "off" for another train and the driver of the local train took it as his. There are four up lines parallel with each other at this point. Major Hall says that the signalling arrangements are of long standing and no evidence was forthcoming to show that drivers were apt to be misled by them In view of these considerations he does not suggest that any immediate alterations should be proposed to the company, but he thinks a detonator placer might be attached to the goods yard home signal.

Notes and Memoranda.

THE accounts of Rotherham Electricity Department for the year ended March 31st show revenue £108,873, gross profit £20,514, and net profit £2514, out of which £912 was paid for a report on electricity supply and other amounts were devoted to provision of new services, leaving £601 to place to renewals fund. Income was equal to 1.06d. per unit sold, as compared with 0.871d. in the previous year; working expenses were 0.859d. (0.651d.), and capital charges 0.176d. (0.158d.). Units sold were 24,623,978.

ACCORDING to Mr. J. B. Marquard, Inspector of Mines in South Africa, during the last fourteen years 360 million tons of rock have been hoisted up the shafts of the Witwatersrand mines. The accidents in the industry for that period amounted to 10,600 persons killed and 22,400 injured. There was, however, great improvement. Whereas in 1911 880 were killed, or 4.10 per thousand, the number last year was 472, or 2.43. Falls of rock were the chief cause of mining accidents, and in 1912 accounted for 27 per cent. of the total deaths.

SIR HAMAR GREENWOOD, speaking recently at the British Industries Fair at the Crystal Palace, referred to the trade tours contemplated in the Empire and in foreign countries. He stated that the Dominion of New Zealand had offered to take complete charge of their touring fair free of all costs. Calcutta had offered the Town Hall at a nominal charge for rent and light, Singapore the same, and the President of Peru had taken upon himself the personal responsibility. The Chilian Government had offered a building and reduced rates on the railways. In Buenos Ayres similar generosity was forthcoming.

IT has recently been calculated by an expert, Professor A. Juselius, that at mean water level the water power available for Finland's industries may amount to 3,000,000 effective horse-power, but it is stated only a fractional part can be put to practical use within the reasonably near future. A large portion of the water power is situated in parts of Northern Finland so remote that for a long time to come it will be impossible to build any industrial establishment there. Furthermore, the available water power is restricted both by the stipulations in the water power laws regarding the protection of the river channels and by agricultural interests. It should also be considered that the water power is not generally produced by high falls, but is gathered from long sloping stretches of the rivers, consequently the hydraulic works are very expensive. Professor Juselius has estimated the water power that within a reasonable future will be available for Finland's industries at 900,000 horse-power effective at the shaft of the turbine.

IN the course of a lecture on "Some Obscure Points in the Theory of the Internal Combustion Engine," given last month at a meeting of the Junior Institution of Engineers, Professor F. W. Burstall said that to sum up the present position as regards the combustion of gases in a metallic envelope, the facts would appear to show that most of the phenomena connected with "after-burning" can be explained when the variation of the specific heat with temperature is taken into consideration, but there still remains doubt as to the correctness of the statement that combustion is complete at the point of maximum temperature. Without any desire to minimise the value of the experimental work which has been done on the internal combustion engine, he feels that nearly the whole of these researches labour under a most serious drawback from the point of view of the student of thermodynamics, namely, the number of variable quantities involved is so great that it becomes almost impossible to deduce any exact laws from a series of experiments.

AS the result of experiments conducted at the Signals Experimental Establishment at Woolwich Common, it has been found to be quite practicable to handle traffic by wireless telegraphy at speeds of 100 words per minute, using the standard Post Office type of Wheatstone transmitter with punched tape for transmission and the standard Wheatstone inker for reception. It is obvious that a message which can be made to operate an inker can also be employed to actuate a printer receiver of the Creed or other well-known type, or to operate a line transmitter, and so translate the wireless message direct on to land lines. The first practical tests of this method were carried out between Woolwich and Bedford in July, 1919, when a speed of 62 words a minute was reached. After other trials, with gradually improved instruments, a prolonged test was made between Woolwich and Weymouth, using quite moderate power. The apparatus was not tried at much over 100 words per minute, but perfect records were obtained at the following speeds:—2017 words in 30 minutes; 901 words in 8 minutes; 379 words in 4 minutes. Judging from the experiments, there would not appear to be very much difficulty from the electrical point of view in attaining very much higher speeds.

A RESEARCH has been instigated by the National Research Council, U.S.A., into the properties of boiler plate at various temperatures up to 900 deg. Fah. A report on the preliminary tests states that the steels tested were ½in. boiler plate of fire-box and marine grades and gave the following results:—In both grades of plates increase in temperature from 70 deg. to 870 deg. Fah. is accompanied by distinct changes in strength and ductility, viz.: (*a*) The tensile strength at first decreases a few thousand pounds per square inch, reaching a minimum at about 200 deg. Fah.; this is followed by an increase up to about 550 deg. Fah., where the tensile strength reaches a maximum about 10 per cent. greater than the normal room temperature value, after which another and final decrease occurs; (*b*) the percentage elongation in 2in. decreases rather slowly up to about 200 deg. Fah., after which it drops more rapidly, until a minimum is reached at about 470 deg. Fah.; this factor then increases throughout the balance of the range under consideration; (*c*) the reduction in area closely follows the inflections registered in the curve for elongation, but has a minimum at slightly higher temperature than the elongation; (*d*) the proportional limit at first increases slightly and shows a maximum in the neighbourhood of 400 deg. Fah. for the fire-box plate and the highest values between 200 deg. and 300 deg. Fah. for the marine plate.

Miscellanea.

THE Government of India has decided on the construction of a permanent aerodrome at Rangoon.

THE provincial mint in Chungking, China, is preparing for the manufacture of steel plates and railway metals.

WORK has been commenced on the construction of an international bridge at Suchiato between Mexico and Guatemala.

IT is proposed to construct a roadway between Canton and Whampoa, China, and to develop Whampoa as a port able to accommodate ocean-going steamers.

A BELGIAN engineer has discovered at Stettin eight large cranes which were removed by the Germans from the port of Antwerp. They will shortly be restored.

CEMENT is at present quoted in Germany as follows:—For Government and military purposes, M. 223 per ton: for N. and S. German industries, M. 230 per ton; and for the Rhine Westphalian provinces, M. 237.75 per ton.

A RECORD is claimed for a flight recently made in Italy, when a speed of 161½ miles per hour was attained by a Fiat A.R.F. biplane with four passengers aboard. The machine is said to be capable of a flight of 2500 miles in nineteen hours and is fitted with a 750 horse-power engine.

THE Sarda-Kicl.ha canal, in India, the construction of which has been sanctioned by the Secretary of State, will cost about 2,00,75,000 rupees and will irrigate an area of over 345,000 acres in the Bareilly district, where it is hoped the sugar cane industry will be developed and improved.

THE iron smelting and steel making industry of the Pretoria district in South Africa is developing to such an extent that the Union Steel Corporation is converting the 10-ton Siemens open-hearth furnace first erected at the works to a capacity of 20 tons. The plant will then have two furnaces of this size.

THE value of the mineral output of the Union of South Africa for last year was £50,841,405, comprising:—Gold, £35,390,609; silver, £203,646; diamonds, £11,237,778; coal, 10,261,859 tons, value £3,430,361; copper, 4905 tons, value £208,902; tin, 1628 tons, value £275,111; other base metals, value £94,998.

ANOTHER large canal scheme has been mooted on the Continent. It concerns the connection of the Rhine, Main, and Danube rivers by means of a canal capable of accommodating vessels of 1200 tons. The canal would follow the Wern Valley, connecting with the Danube at Kelheim, and permit the development of about 100,000 horse-power.

THE French Secretary for Aviation and Transport has appointed a technical and consulting committee for the general improvement and furtherance of aviation in France. The committee will deal with research work, aerodynamics, improvements of all kinds, inventions, aerial navigation, and instruction and examinations in all branches of aviation.

ANALYSIS of the coal which has been got from the outcrops near Tete, on the Zambesi River, of the seams which are to be exploited by the Zambesia Mining Development, Limited, show a calorific value of 12,400 British thermal units and an ash content of 13.2 per cent. Associated with the coal there are seams of torbanite yielding from 60 to 85 gallons of oil per ton.

IN connection with the proposal to establish wireless communication between Burma and England it is noteworthy that the *Pioneer* understands that elaborate research work is being undertaken by a staff of scientists from home in order to find means of overcoming meteorological obstacles which interfere with the proper working of wireless telegraphy in India during certain seasons of the year.

THE development of the Shansi coal mines in Northern China, which is to be undertaken by the Kailan Mining Administration, together with the proposed establishment of iron and steel works, will probably entail the enlargement of the port of Chinwangtao. The improvements would include deepening the harbour, extension of the wharfage, and the installation of loading and unloading machinery.

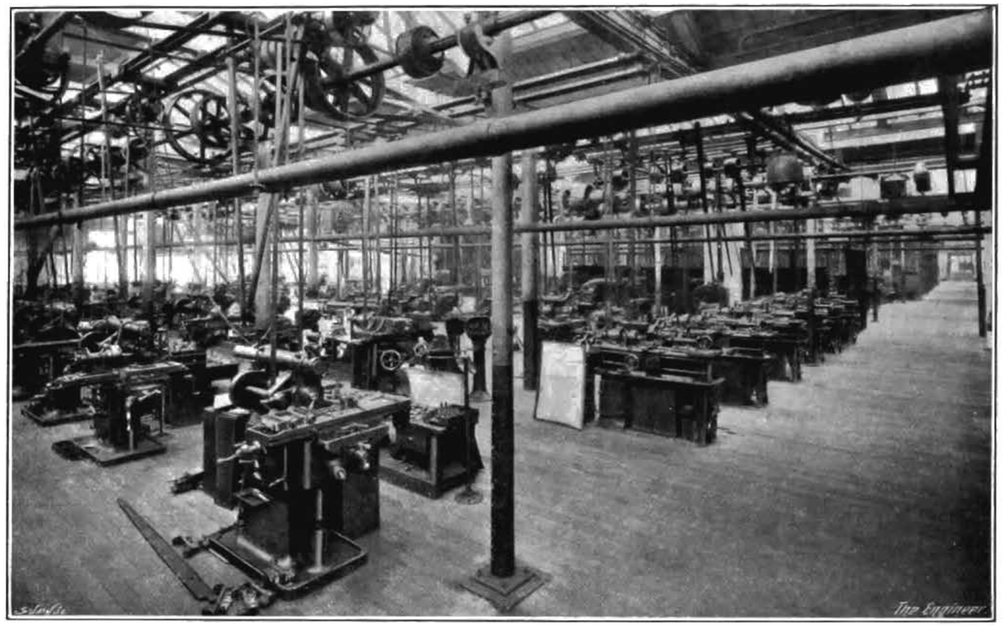
THE Commission appointed by the Swedish Government in 1913 to make an exhaustive investigation as to the most suitable way of exploiting the State ore resources in Norrland recently presented its report on the supply of charcoal in Upper Norrland. This report has been published, together with the report of a similar investigation carried out by the Corporation of Ironmasters in Norrland and Dalecarlia. The Ore Commission has come to the conclusion that there are 18 million cubic metres of charcoal wood in the district of Norrbotten, while the Corporation of Ironmasters considers that there are 15 million cubic metres.

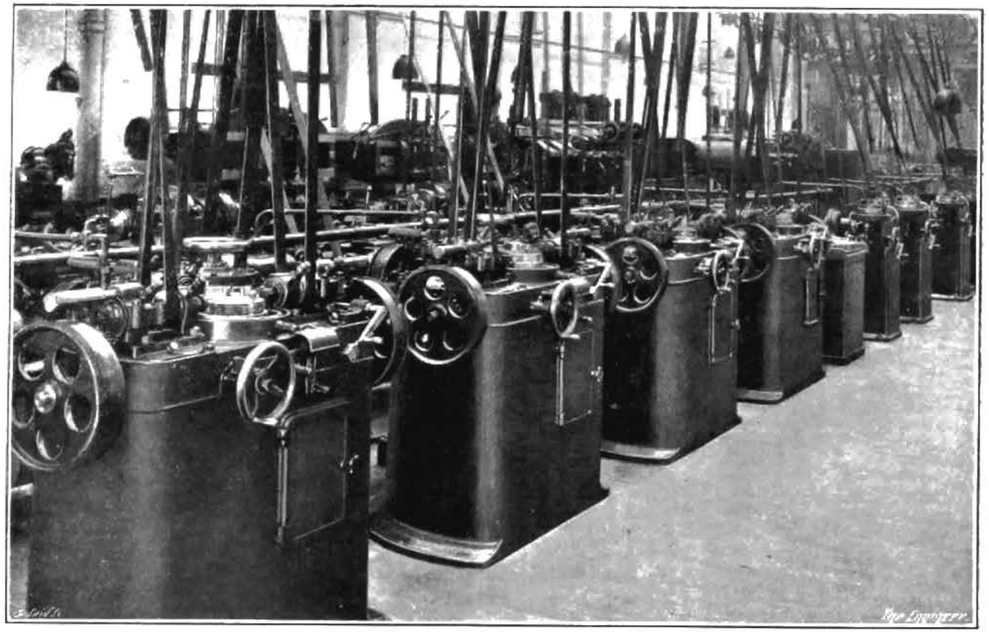
THE United States Navy has recently announced the award of a number of new contracts for electrical machinery to propel the new battle-cruisers and battleships. The battle-cruisers are to have a displacement of about 44,000 tons and a maximum speed of 34 knots The power plant per ship consists of four large steam turbines, each driving a 40,000 kilovolt-ampère three-phase 5000-volt generator at 1835 revolutions per minute. There will be four propeller shafts, on each of which will be mounted two three-phase induction motors of 23,000 horse-power, each having 22 poles and running at 331 revolutions per minute. These motors are designed to operate also with 44 poles giving 6800 horse-power at 170 revolutions per minute, the condition for half speed. The new battleships are larger than the New Mexico, being designed for a displacement of 43,000 tons and require 60,000 horse-power to drive them at their contract speed of 23 knots. The power will be derived from two turbine-driven electric generators rated at 22,000 kilovolt-ampères, two-phase, 5000 volts, 1800 revolutions per minute. There will be one induction motor to each of the four propeller shafts, rated at 15,000 horse-power at 225 revolutions per minute with 16 poles. For fractional speed running the motors will be arranged with 24 poles giving 3600 horse-power at 150 revolutions per minute.

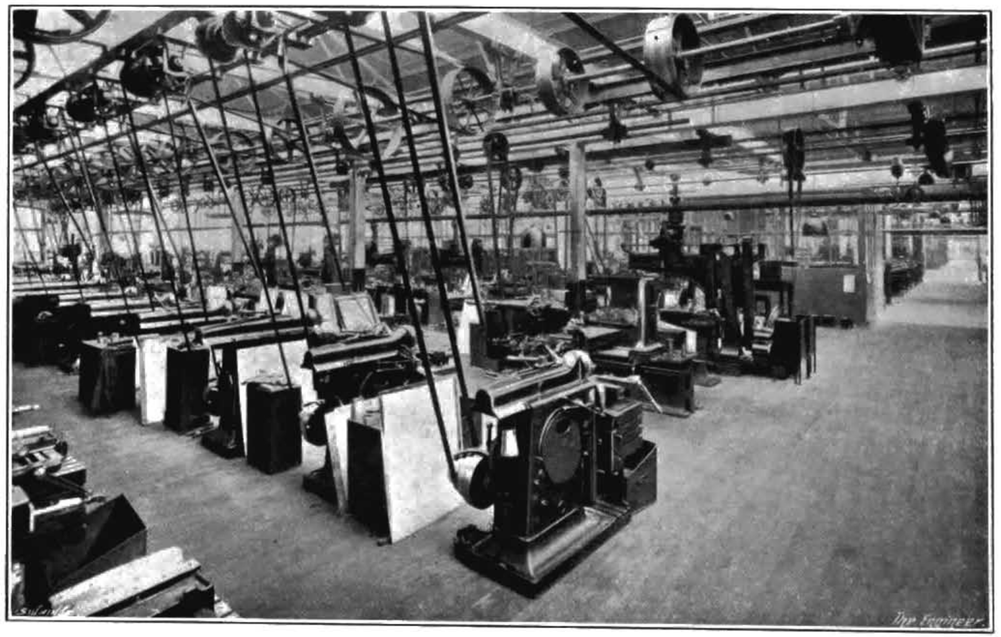
MACHINE SHOP OF SMALL TOOL MANUFACTURING WORKS AT SPARKBROOK

B.S.A. TOOLS, LIMITED, BIRMINGHAM, ENGINEERS

(*For description see page* 266)







CONTENTS.

TO CORRESPONDENTS.

*** *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public and intended for insertion in this column, must in all cases be accompanied by a large envelope, legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

*** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts: we must therefore request correspondents to keep copies.*

THE ENGINEER.

MARCH 12, 1920.

Merchant Shipbuilding in Royal Dockyards.

THE report of the Colwyn Committee is interesting for several reasons, and the recommendations made raise questions which are certain to arouse controversy. It will be recalled that the Committee was appointed to consider how far it might be possible to utilise any facilities which the Admiralty has available in the Royal Dockyards for the construction of merchant ships of any kind. The problem thus outlined is admittedly a difficult one, and if the Committee has elected to take the path of least resistance it is not for want of courage, but probably because no other road would lead to the desired goal. The end aimed at is, of course, the prevention of unemployment in the dockyard towns, a state of things which was certain to be associated with the drastic cut in naval expenditure unless other work could be found. As the report of the Colwyn Committee reminds us—but the fact is quite common knowledge—the dockyard towns depend almost entirely upon the Navy for their existence, as Admiralty policy has in past years tended to discourage any commercial development of the naval ports. Unless, therefore, special steps are taken to provide new employment, a large number of skilled shipyard workers must be stranded. The Government, to do it justice, has never attempted to evade its responsibility to this important body of workers. The only question at issue has been the means by which a period of unemployment might be averted.

One obvious way out of a difficult situation was to undertake the building of merchant ships. A naval dockyard is not ideal for such work, but its equipment and available labour could scarcely be applied to any other purpose than shipbuilding. The Committee was asked, therefore, to investigate offers of private shipbuilders to lease the dockyards or a portion of the yards, or alternatively to consider offers from persons or firms desirous of placing orders for new merchant tonnage with the view to its construction by the State in the Admiralty dockyards. The subsidiary question whether any part of the dock accommodation could be utilised for the accommodation of shipping was also submitted for the consideration of the Committee. For reasons which are clearly stated in the report, the offers of private shipbuilders to lease portions of the dockyards from the Admiralty and undertake the building of merchant ships is not viewed with any favour, and if, as the Committee suggests, such a scheme could not be carried out with any likelihood of commercial success, it is better to make frank recognition of the fact at the outset. It is held that the lay-out and equipment are such that it is not practicable to let a portion of any of the dockyards form a self-contained enterprise. The undertaking would entail, we are told, not only alterations, but additions to the shops and a general increase in power services. At the same time, there will be a disposition to consider that the estimated expenditure for such a purpose at Chatham, which is placed at £130,000, is not a figure which should have prohibited the experiment of leasing part of the dockyard to private interests. The objection raised by the Committee as to the disadvantage of commercial shipbuilding workers and dockyard men being engaged in the same establishment is entitled to more weight, as the disparity in wages and conditions of employment might easily make for discontent. For these and other reasons, the Committee has been induced to favour the policy of building merchant tonnage for shipowners as a State enterprise. It is a policy to which there are the gravest objections. The fact which palliates the recommendation that the Government should compete in the shipbuilding arena with private enterprise is that it is not regarded as a permanent solution, but merely as a means of tiding over a difficult period. An ideal plan of providing employment for the dockyard men would be to transfer those not required for Admiralty work to the commercial shipbuilding areas, but this is, of course, precluded by the housing difficulty, and it is to be feared that by the time houses have been built the boom in shipbuilding will have run its course and it will not then be possible to absorb the dockyard hands into the merchant branch of the industry. If we raise this point here it is because, whatever expedients may be sanctioned to-day, the future employment of the dockyard workers is a problem which must be faced. The policy frequently followed by all political parties of waiting on events will not do in this case, although we have not the least doubt that, having dealt with the immediate question of unemployment in the naval towns, the Government of the day will leave the task of finding a permanent remedy to its successor. In any event it is quite unlikely that merchant shipbuilding in the dockyard can be made a profitable enterprise. There are important differences between warship and merchant ship building, and if the Admiralty adopts the Committee's recommendation to accept work on the basis of price of similar vessels in private yards, it may be assumed that it will build at a loss. The Committee expresses the hope that in the present state of the shipping trade a deficit may be avoided, but on this head doubts will arise, and differences in methods of accountancy between the Admiralty and private shipbuilders may easily prevent just comparison being made. In this connection it should be noted that the Colwyn report, while expressing a belief that the dockyards have an effective system of cost accounting, lays stress on the need of care being taken to secure accurate accounts of building costs. If the Government decides to act on the report, certain changes in organisation at the naval yards and in procedure must be made. One essential is to provide for supervision by men experienced in commercial shipbuilding. It is suggested, too, that the local management in the various yards, with which labour should be associated, should have much freer play than has hitherto been the case in Government establishments. These are radical changes, but they are necessary if even for a brief period the dockyards are to undertake the building of merchant ships. There is one significant paragraph in the report which should not be overlooked. It is that in which the Committee expresses confidence that the men will realise that merchant work is being undertaken primarily with a view to their employment, and for that reason will co-operate to the fullest extent in making the experiment a success. We hope this confidence may be justified. If so, it will supply one of the soundest arguments in favour of a plan which on all grounds, except the difficulty of finding another, would be opposed by the merchant shipbuilding industry.

With the recommendation to utilise a section of Devonport Dockyard as a terminal port for liner traffic there will be general agreement. Plymouth interests have already approached the Admiralty with the object of securing assent to the allocation of the Keyham Extension for the accommodation of merchant shipping, and they have secured a powerful group of advocates in the Colwyn Committee. The present lamentable state of affairs in regard to port congestion warrants the adoption of any measures designed to bring relief, and the utilisation of a part of Devonport for the purpose would achieve a double object. It would reduce the detention of shipping and to some extent at least provide employment at Devonport. Although there are difficulties to be overcome, it is recognised that facilities exist at the dockyard for the efficient and rapid discharging of bulk cargoes, and the Admiralty is asked not only to invite offers from shipowners who require accommodation at Devonport as a terminal port, but, what is perhaps of even more importance, is requested to make every endeavour to meet their requirements. The organisation of the dockyards or some sections of them for merchant shipbuilding may take a little time, but it is believed that the use of Devonport by merchant shipping could be authorised without delay.

London County Council Tramways.

THE financial year of the London County Council's tramways closes at the end of this month, and from figures contained in recent reports of the Highways Committee it is evident that the result of the year's working will be still less happy than those of past years. Even the entire obliteration of both the Renewals and Special Reserve Funds will fail to make ends meet, and the deficit will have to be made good from the rates. What a sad falling off is here disclosed! Where are now the roseate views which the same Committee took of the undertaking as short a time ago as July last? Then, it was confidently

asserted that there would be a total surplus of incomings over outgoings of £962,461, and that after making deductions for debt charges, income tax, and other miscellaneous items of expenditure, there would remain a sum of £221,699 to add to the Renewals Fund, which would thus be raised to £483,082. The cost of the renewals to be paid for during the year was given at £371,480, so that it was estimated that at the end of the present month there would be a balance of £111,602. Let us see what are the actual figures, if so they can be called when the financial year is not yet ended and some of the items must necessarily be estimated. Instead of there being £221,699 to add to the Renewals Fund, there is to be a loss on net revenue account of £90,581. Moreover, the Fund itself, instead of standing at £261,413 on the basis of cost price, is, at present prices, only worth £189,599. The expenditure on renewals is £284,000, which is £87,480 less than the cost estimated at the beginning of the year, so that in all probability something has been "starved" and will cost more to carry out when the work can no longer be delayed. Even with the reduced expenditure, however, the Renewals Fund is entirely wiped out and there remains a deficit of £94,401. Adding this debit to the £90,599 net loss on revenue account, we arrive at a total deficit of £184,982, against which can only be set the Special Reserve Fund, which, at present prices, is worth £48,075. Finally, therefore, there is a net deficit of £136,907, which is chargeable to the rates. Nor is that the whole of the lamentable story. The estimate for next year—and judging by past experience it is to be feared that it will be rather an under than an over-estimate—puts the deficit, unless something be done to ameliorate matters, at £760,000.

The usual explanations of the failure to meet the original estimates are, of course, advanced. First of all, the passenger receipts will be less by some £212,215 than was hoped for, partly because it was not found practicable to bring the increased fares into operation until later than was at first anticipated; partly because of the great growth in working expenses; and partly because of the "heavy competition which has been met with from the motor omnibus undertakings operating along the tramway routes." Much the same sorts of things have been said before, though perhaps they carry rather more weight in the present instance. Still, we cannot help thinking that were the L.C.C. tramways a commercial undertaking one or other of two things would have happened long before this: either the results achieved would have been much nearer the estimates or considerable alterations would have been made in the estimating department. As regards the contention that the receipts were lower than anticipated, it may be pointed out that they average no less than 18.87d. per car mile, whereas in 1913–14 they were only 8.94d. The working expenses in the latter year were, however, only 6.50d. per car mile, whereas in the present financial year they are as much as 16.54d., some 2½d. more than in 1918–19. It is somewhat curious that the difference between the receipts and expenses per car mile in the two years is very nearly the same. In 1913–14 it was 2.44d. and in the present year 2.33d. The percentage of expenses to revenue is, however, on a different footing. In 1913–14 it was 72.7, whereas this year it is 87.65. Costs have certainly gone up in the intervening six years. Salaries and wages charged to working expenses have increased from 4.16d. per car mile to 11.06d.—2.66 times; cost of power, including salaries and wages, from 1.01d. to 2.60d.—2.57 times; and repairs charges, including salaries and wages, 1.41d. to 4.33d.—3.07 times. The ratio of increase in passenger receipts in the meantime is 2.11 times. Two facts stand out from the figures adduced. One is that receipts of 18.87d. per car mile, large as they sound, are not sufficient adequately to operate the L.C.C. tramways as affairs now stand, and the other that the increases in expenses are largely due to increases in wages of employees and to shorter hours. The institution of a forty-eight hour week alone meant a further addition in wages of £360,000—something over 8½ per cent. of the total revenue. As a matter of fact, the wages bill for the next financial year is estimated at no less than £2,942,000, or an increase of 167 per cent., as compared with 1913–14, and that, too, on a less car mileage. On the same car mileage the figures would show an increase of as much as 186 per cent. providing that wages remain at the same level as they are now. The tramways, which, when first mooted, were to be the producers of large surplus revenues, having come on the rates, the Highways Committee has to advise the Council what to do to meet the situation, and it has brought forward several proposals. The first is that fares shall be increased. Now, by statute the charge for the conveyance of passengers must not exceed 1d. per mile. At present passengers are taken an average distance of 1.5 miles for one penny. Until last April, when the change was made, they could travel some 1.8 miles for that sum. The present proposal is that the distance shall be decreased to 1.2 miles. Owing to the necessity of arranging the fare stages as far as possible in conformity with well-recognised traffic points, it was found impracticable to go right down to the limit of one mile for one penny. The proposed change, however, will only bring in an estimated extra amount of £120,000, which is small when compared with the estimated deficit of £760,000, though it is the maximum at present legally obtainable. A saving in the loss at present experienced by carrying workmen at reduced fares is also proposed by so re-arranging the fares that that loss may be diminished from £105,000 a year to £66,000; but even so, the anticipated deficit still remains overwhelmingly large. However, the Finance Committee of the Council opportunely comes forward with a scheme to obtain from H.M. Treasury permission (*a*) to repay outstanding loans on the cumulating annuity system—3½ per cent. table—instead of on the instalment system as at present, and (*b*) to charge to capital account for a period of twelve years half the cost of renewals of tramway track, repayment to be made within a period of twelve years. We do not propose at the present moment to discuss the propriety of these proposals, nor their chance of obtaining the sanction of the Treasury, but confine ourselves to saying that even with the decrease in immediate expenditure which they would involve and the increase in revenue obtainable from the higher fares, there will still be a deficit on next year's working which is estimated to be but little short of £300,000. In these circumstances—and freely admitting that the Finance Committee's proposals would, in effect, merely involve a postponement of charges against revenue, which, with added interest charges, would have to be met at a later period and would, even if adopted, be far from establishing equilibrium between revenue and expenditure at the present time—it is hardly to be wondered at that the Highways Committee should have sought frantically for some measure which would, to use its own words, "*maintain* (the italics are ours) the undertaking in a sound financial position." In our opinion it never has been in such a position, so how it can be maintained in it is hard to see. But that apart, the expedient at length hit upon and now put forward, is somewhat drastic and has already received a considerable amount of opposition. It is that application should be made to the Ministry of Transport for sanction to increase the statutory maximum charges up to a limit of 50 per cent. or by such less amount as is sufficient, so far as can be estimated, to enable the undertaking to be carried on without loss. It is pointed out that such a course has already been taken by several provincial tramways undertakings, and that an increase of 50 per cent. in railway charges was made some time ago. It may here be stated that, after an all night's sitting on Tuesday last, the Council, while consenting to the proposed increase of fares, decided to postpone for the time being the question of increasing the limit of charges beyond that at present legally in force.

Such, then, is the parlous state in which the great London County Council tramways now find themselves. Whichever way one looks at it the unfortunate ratepayers of the County of London will have to face additional expenditure, whether in the form of rates or increased fares, or of both. The system has suffered since the very beginning by reason of the enormous first cost of the lines, which for a large portion of their length are on the conduit system. We have always been of opinion that there was no necessity to use that system over the major part of the network. Then, too, it has suffered by bad management and by the fact—which we have frequently pointed out and which is now amply proved—that a sufficient sum was not put by each year for renewals. It was some years before any such provision was made at all, and when it was instituted the amount decided on was but two-thirds of a penny per car mile, in spite of the fact that in expert opinion it was not enough. Furthermore, we distinctly think that in the past fares on the whole have been too low. Passengers naturally resent increase in charges to which they have become accustomed, whereas if higher rates had been charged in the first instance they would have been paid without question. The present position will not tend to make the ratepayers regard with favour the Council's proposals to lay down further tramways at a total cost of some £8,000,000, especially as even such a body as the London County Council can no longer borrow money at, say, 2¾ per cent.

Random Reflections.

[THIRD SERIES.]

Pepper's Ghost.

We observed an interesting phenomenon in a District Railway carriage a few days ago. The carriage was fitted with ventilating windows hinged at the bottom, and some of them were open. Suddenly one closed itself with a sharp snap, remained shut for a few seconds, and then fell open again. The cause of this uncanny action was the passing of another train, and recalled to mind the famous collision of the Olympic and the Hawke and the hot discussion about the theory of that accident. In this case there could be no doubt about the suction, for it was just as the trains cleared each other that the window fell open again. The little event set us thinking, as we have often thought, that all around us all day long natural phenomena are occurring which we have not the eyes to see. Does it never strike you, "gentle reader," as a remarkable thing that no one invented Pepper's Ghost before Pepper did? Goodness knows how many years windows had been in use before the Polytechnic was built, and what an incalculable number of people must have seen ghostly reflections in such windows and yet not one of them had won immortality by applying the observation to the mystification of mankind! Personally, we never see Pepper's Ghost in a half-open casement window—a "magic casement" indeed—without taunting ourselves with lack of perspicacity. If so obvious a thing could lie hid for a few hundred years, is it not probable that there are scores and scores of others waiting for their Peppers? Taught as we all are taught—and as there is no other way we must not grumble about it—by laboratory and lecture-room experiments, we are rather prone to grow up thinking of phenomena as exceptional occurrences only to be effected by elaborate apparatus manipulated by skilful hands. We fall into the mistake of looking at things the wrong way round. We exalt the experiment and forget that it is a miniature presentment of events that are occurring around us all day and all night long on the grand scale. We snatch a little bit of electricity from the inexhaustible supply of the universe and play, to loud applause, our little tricks with it, and all the time our eyes are blind to the fact that we ourselves are living constantly in the midst of, are possibly acting a part in, similar experiments which are the everyday occupation of Dame Nature. It is the geniuses of the world, the seers, who lay hands upon the common observation and turn it to useful purposes whilst we others stand by wondering why we had missed something that all the time was under our very noses.

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A Palpable Hit.

AGE has not robbed Mr. Frederic Harrison's thought of its energy nor his pen of its incisiveness. For real trenchant truths for labour we must go far to beat the "appeal"—save the mark!—which, through the medium of the Liberal Anti-Nationalisation Committee, he has addressed to British trades unionists. Nationalisation! His blows resound upon the ribs of that hollow god. The miners, he exclaims with scathing sarcasm, "go rather slack, naturally, for mineowners; but how furiously they would work for the 'Nation'! Why, swagger like this can hardly take in the smallest pit boy." On the subject of the Sankey Report, he tells the unions that they are "being bamboozled by a juggling use of names and phrases. If you want bureaucracy, say so. If you want mines for the miners, speak out. That is plain Bolshevism." But it is when Mr. Harrison comes to direct action that his straight left—or would it be more correct in this connection to say his "hook to the jaw" is used with most "deadly effect." "When we come to what is called 'Direct Action,' that is terrorism—to pass from rotten economics to a dastardly crime—you who are about one-tenth of the nation in voting power want to put more money in your pockets, and think an Act of Parliament of your own making will do it for you. So, if twenty millions of free electors do not accept your Bill, you intend to strangle mines, rails, docks, so that infants may die, business may be suspended, wages stopped all round—and general 'hell given them.' Given to whom? Why, to yourselves and your own kin!" "You know very well," he continues, "—or rather your leaders know, but they hide the truth—that you are now living on doles—*i.e.*, on charity. Your labour does not produce the value of what you receive in payment. Most of your living is paid for by others. . . . You are being maintained by a gigantic system of outdoor labour relief! And yet you want to plunge into a huge eight thousand million deal—the cost of compensation to capitalists—and throw trade into a gambling chaos." It is good now and again to give blunt facts in a blunt way; to quit arguing philosophically, to "drop the items and give the tot," to fire off conclusions and omit the stages of reasoning by which they have been reached. Fabians, high-brows and intellectuals may deplore the unseemly directness of Mr. Harrison, they may deprecate the violence of his methods, and remind him that whatever may be

permitted to other ladies, the prejudices of Mrs. Grundy must be observed where Truth is concerned and her appearance in her conventional attire cannot be tolerated. But other people who do not care to smother common sense in a "smoke of words" will rejoice that someone has been found to tell labour the truth in the fewest possible syllables, and to express the general sentiment with an energy and directness that few others can and none dare command.

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Institutions and their Councils.

No one who has given any thought to the elections of Members of Council of our engineering institutions can feel satisfied that they are conducted in the best possible way. In the hands of the Councils rests the welfare of the institutions, and it is they who are responsible for such progress as the institutions may make, or for such weakness as they may display. Unless, then, members are content to regard the work of these learned societies as complete when they have conferred upon those who are duly elected and pay their annual tolls the right to put certain symbols after their names, the importance of having the right men on the Councils is manifest. Yet what do we find? This, that only from ten to fifteen per cent. of the members return their ballot papers, and that the remainder exhibit no interest whatever in the result. This carelessness about a matter of such great importance is deplorable, and on several occasions we have urged that steps should be taken both to awaken members to their responsibilities and to place the elections on a better footing. Much of the indifference is, we are convinced, the result of ignorance. Members do not know why they should elect certain men in preference to others, and hence either vote for none or, worse still, strike out those names nearest the end of an alphabetical list! We have urged that steps should be taken to inform the electors of certain facts. In the first place, where members of Councils offer themselves for re-election some indication of the zealousness with which they have performed their duties during the preceding year should be given, and in the second, where new members are nominated, a brief outline of their qualifications should be presented. We do not think this is all that can be done to give life to the elections, but it is the first and most important step. For its recent election the Institution of Automobile Engineers acted on our suggestion, and, we are glad to know that the result is excellent. The ballot papers contained a brief outline of the qualifications of all candidates for the Council and a record of attendances—in percentages—at Council and Committee meetings. The electors were therefore given some facts on which to base their choice. As a result the number of ballot papers returned rose to nearly 40 per cent. of those sent out, and when we contrast the names of re-elected members with their records of attendance it is clear that this factor has been given the weight it deserves. Three candidates who never appeared at Council or Committee meetings were rejected, and in the two cases where men with poor records for attendances were nevertheless returned we have only to glance at their qualifications to find the reason. We congratulate the Institution very heartily on this issue. It is particularly gratifying to us, because it verifies our anticipation and it fortifies us in our resolution to continue to press for a reform which is so obviously beneficial.

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Ex-Service Men and the Unions.

It cannot be said that the resistance which many trades unions are making to the training of ex-Service men is either incomprehensible or illogical, but it is, nevertheless, very deplorable and very injurious. The unions can never get out of their heads that there is only a certain amount of work to be done in the world, and that if they permit the number of skilled men to increase beyond a certain rate unemployment will follow. It is on this hypothesis that the number of apprentices is settled, and it is, in part at least, responsible for "ca-canny" and for short hours. We must not forget that instability of employment is the nightmare of the artisan. He lives in almost constant dread of trade depression, and each union endeavours to ward off from itself its effects by adjusting the numbers engaged in the trade at the lowest possible figure. Condemnation of the unions must be tempered by our appreciation of this point of view. The action of each union is, of course, selfish—but that is a common failing from which there is no escape. "Taken i' the lump, human nature is nought but selfishness." If all trades, as at present, refuse to allow their ranks to be recruited by ex-Service men, then unemployment for those men must follow, and though each union may be able to congratulate itself that the men do not belong to it and do not fall as a charge upon its out-of-work benefits, the result in the long run is the same. It may be said that the unions could avoid the financial stress to which we have alluded by refusing to accept ex-Service men as members, but they are not likely to see the matter in that light, for the plain reason that at some time or other ex-Service men may get jobs which would have fallen to unionists. . . . We have put the case for the unions because it is only fair that their attitude should be understood, but at the same time we must deprecate their action, both as inhuman and as uneconomical. It is inhuman because it makes men who served their country suffer a double sacrifice, and it is uneconomical because many trades could now, and will in all probability for some years to come be able to, support many more men than are now engaged in them. Finally, it, in a measure, smacks of just that kind of "tyranny" which labour protests so loudly against. Labour insists that there should be equal opportunity for all, and yet refuses, in a case where one would have thought there are most reasons for concession, to concede to its fellow-workmen the very right which it demands for itself

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One Man One Job.

We trust there are many works managers who agree with us that the doctrine of the concentration of labour on a single operation is bad in essence and is not likely to prove for long effective. This inhuman doctrine was put forward in its bitterest form during the war by Mr. Cecil Walton. He went so far as to advocate that boys and girls should be taught a single trifling operation and that until they had grown grey in the service they should do nothing else. The only defence he could offer for this demoralising method—apart from its economic efficiency—was that such proficiency would be attained that hours of labour could be greatly reduced and that the longer periods of relaxation would make up for the daily hours of monotonous mechanical toil. Economic efficiency, let us say once more, even though it could be attained by such means—which we ask leave to doubt—would be bought at far too high a price. It is a treasure not worth having unless it is accompanied by contentment, and we find it impossible to conceive that any bodies of men or women could remain consistently happy, consistently healthy, consistently active-minded, were they compelled even for no more than three or four hours a day, but day after day, year in and year out, to perform an operation which, while it might call for some alertness of the senses, would make no call on the intellect. We say again, as we have before said, that if the principles of rapid production require the repetition of simple operations, then, since it is in the power of invention to effect those operations by mechanical means, to employ human labour on them is a disgrace to our humanity. We know, alas! that many and many of the products which our "civilisation" demands are made under these horrible conditions, but we hope in time to see them fall into disuse, and until that better age comes we urge employers as far as possible to give variety to their workpeople; to change them from one job to another; to relieve somehow the bitter monotony of a great deal, a great deal too much, of factory life. "I have seen girls in the first six days of their training," said Mr Harry Tipper, in a paper reprinted in the January issue of the *Journal* of the Engineers' Club of Philadelphia, "become hysterical and have to be taken out, who absolutely became sick, due to the very high tension of that constant necessity for repetition at a single given second, and you know how they must relax in order to get away from it when they get out. The intensity of their emotional relaxation on the outside is the reflex—the necessity or protection of nature to get away from that intensity of concentration in their work. I do not believe that is good production. I am sure it is not good human production, and I do not believe it is making a race of men who are more capable politically for self-discipline, for self-government, and for real sound judgment."

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Workshop Education.

In more than one works during the war production was increased by the simple expedient of calling the workpeople together now and then and giving them a little lecture on the jobs on which they were engaged. In big factories, particularly those in which there is a great quantity of repetition work, only a small proportion of the workpeople have any notion of the final use to which the parts they produce are put. They know the parts by name, but they have no living interest in them because they are ignorant of their uses. Now there is no reason at all, but the indifference of employers, why all the workpeople in a factory, down to the humblest rivet boy, should not know something about the machines they are helping to produce, and there are not wanting reasons to believe that given that knowledge they would work better, more intelligently, and certainly more contentedly. Even a child will rebel at being ordered to do something of which it does not understand the object; how much more, then, must it be irksome to adult intelligences, and by how much must the absence of such knowledge tend to dwarf and stunt the growth of a lively intellect? A fair number of engineering works, we are glad to know, have schools through which trade lads must pass, and there is thus being bred up a race of mechanics who understand the object of the work on which they are engaged; but it is not always possible to arrange classes of the kind, and even where they exist there are always a great many of the workpeople who for one cause or another are ignorant of the finished product to which they contribute their quota. Would it not, we ask, be easy in nearly all works to arrange lectures illustrated by the lantern or cinema, or demonstrated by models or actual machines in which the duties of every part would be explained and some outlines given of the general principles involved in the design? An hour taken but once a month—twelve hours a year—from working time would be sufficient, and we are confident would well repay the cost. Who can say how far the restlessness of labour is due to the uninteresting nature of its work—work which could in many cases be made interesting by the simple expedient of explaining its object? We have to face the fact that labour is not what it was of yore. Education has stimulated the intellect, and if that intellect is not turned into useful and safe channels it is prone to seek an outlet in dangerous and unprofitable fields.

Obituary.

JAMES PROCTER.

We regret to have to record the death of Mr. James Procter, which took place suddenly at Halesowen, Worcestershire, on Saturday, March 6th. Mr. Procter was born at Wigan in Lancashire in the year 1841. After a general education he was apprenticed under premium indentures at the Haigh Foundry Company, at Wigan, and after serving the usual apprenticeship he remained for a number of years in the service of the company, during which time he designed and made various blowing machines for blast-furnace work, winding engines, rolling mill engines for iron and steel works, pumping engines, &c. Amongst the undertakings in which he was interested was the installation of the first rail mill engines for the London and North-Western Railway at Crewe.

Mr. Procter, who left the Haigh Foundry Company to take up an appointment with Stevensons, Limited, of Preston, which was at the time engaged in making blast-furnace and steelwork plant, gas producers, &c., was, after some nine years at Preston, appointed to the position of chief mechanical engineer to the Lilleshall Company, of Shropshire, the well-known old-established concern which is making cold-blast pig iron to this day.

Mr. Procter was thereafter responsible for modernising, re-equipping and rebuilding the large engine shops of the company, and for the designing and building of high-powered pumping machinery, colliery and mining plant, as well as blowing engines, rolling mill engines, heavy iron and steel plant, gas producers, Siemens furnaces, ladle carriages, &c. He was generally reputed to have been concerned in the design and construction of more blast-furnace blowing engines than any other living Englishman, and in various districts of Great Britain and on the Continent may be seen successful and economically working blowing engines constructed by the Lilleshall Company. He also remodelled various iron and steel plants at existing works as far as he could persuade proprietors to go. He was, it is said, the first engineer in England to pay America the compliment of constructing blowing engines with mechanically controlled valves. A very fine pair of the Reynolds Kennedy Corliss vertical blowing engines, which he designed, can be seen at the Lilleshall Company's Priors Lee Blast-furnaces, in Shropshire.

Nine years ago Mr. Procter went to Halesowen and took up a position with Walter Somers, Limited, as engineer with charge of the drawing-office, a position which he held right up to the time of his death. He was for many years a member of the Institution of Mechanical Engineers, was a member of the Iron and Steel Institute, and a member of the Council of the Staffordshire Iron and Steel Institute.

TRIALS OF PALM OIL AND HEAVY PETROLEUM TRACTORS.

The Belgian Colonial Office has decided, at the request of several firms, to delay till next July the trials of colonial tractors, burning palm oil or heavy petroleum, that were previously fixed for the middle of April. Applications to enter for these trials can therefore be made to the Ministère des Colonies (8E Direction-Agriculture), 7, Rue Thérésienne, Brussels, up till June 15th. Attention is attracted to the fact that the premiums to the two best tractors of each category are subordinate to the condition that the tractors be really practical machines, giving every satisfaction to the jury. Two premiums of 15,000f. and 10,000f. respectively will be awarded to the two best tractors using vegetable oils; two premiums of 5000f. and 3000f. respectively will be awarded to the two best tractors burning fuel oil or some similar grade of heavy petroleum residues.

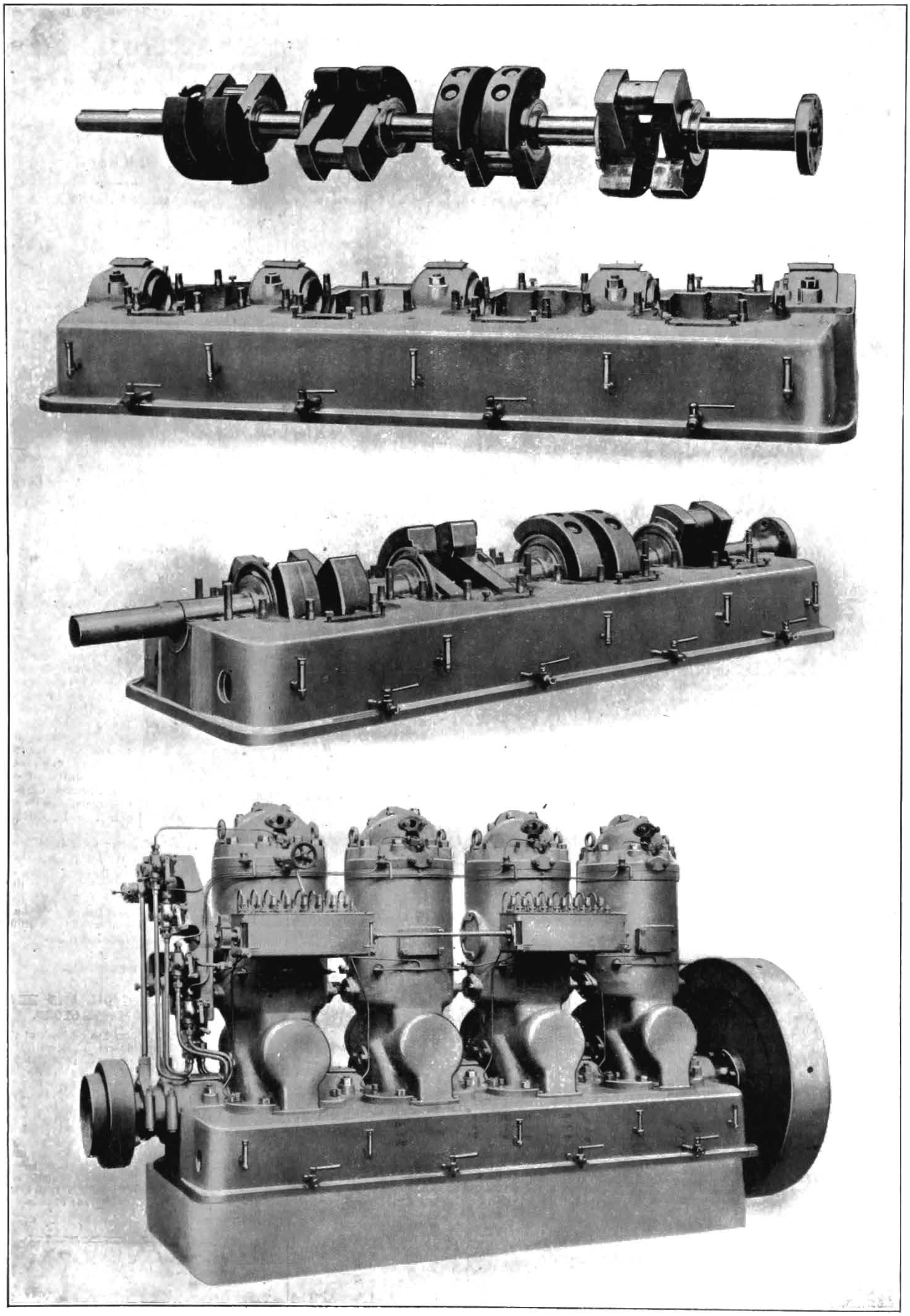
ERRATUM.

Tairoa.—In the notice of the launch of the Tairoa given in our issue of March 5th, we stated in error that the quadruple-expansion engines of the vessel were constructed by the shipbuilders. We should have said that they were constructed by the North-Eastern Marine Engineering Company, Limited.

FOUR-CYLINDER HOT-BULB HEAVY OIL ENGINE

W. H. ALLEN, SON AND CO., LIMITED, BEDFORD, ENGINEERS

(For description see opposite page)



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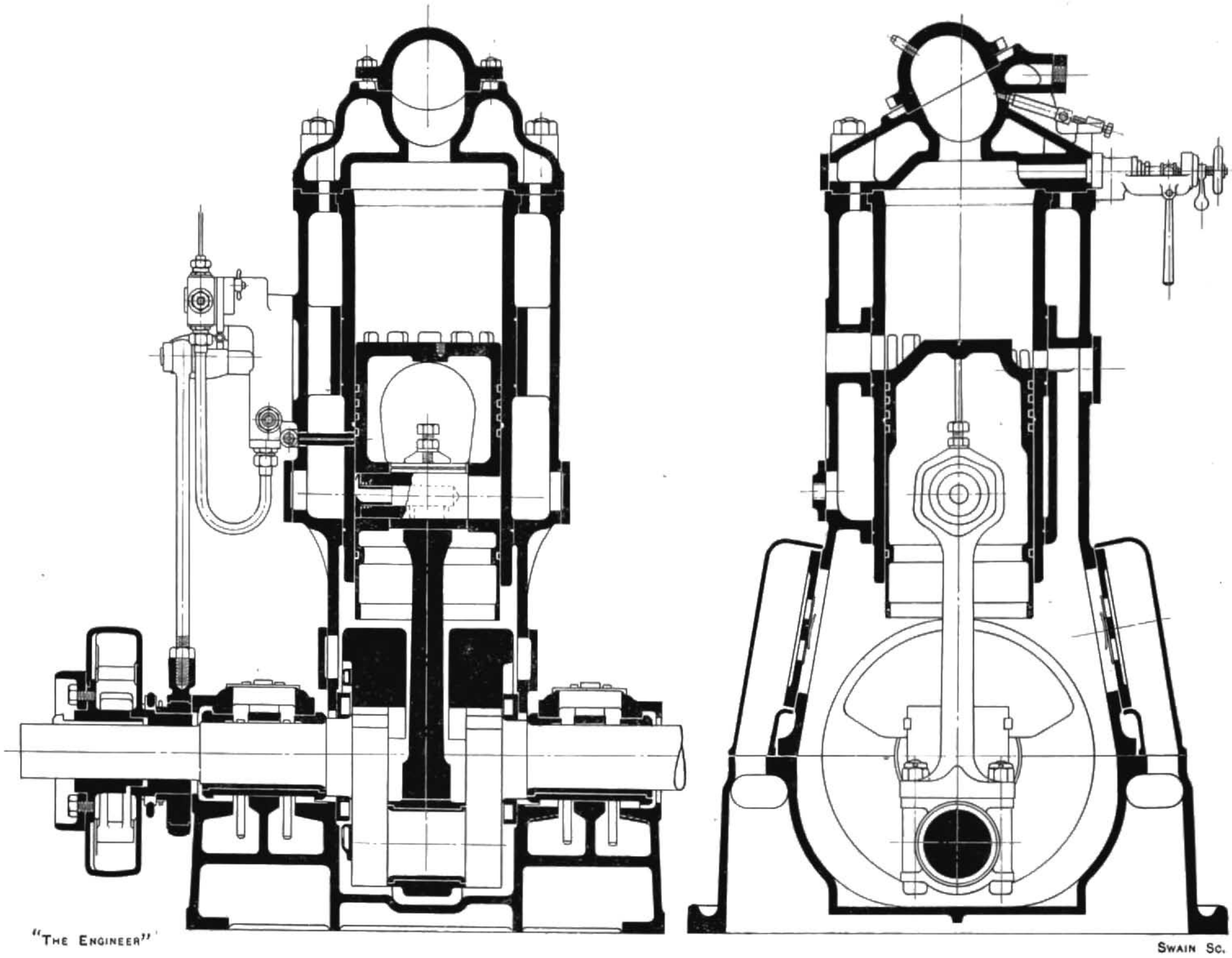


"THE ENGINEER" SWAIN SC.

A New Crude Oil Engine.

WITH the object of utilising some of the new plant which was installed at the Queen's Engineering Works, Bedford, for the purpose of coping with Government orders during the war, W. H. Allen, Son and Co. have recently undertaken the manufacture of a heavy oil engine of the hot-bulb type, designed by Messrs. S. Z. Hall and A. V. Clarke, of Westminster, which, though it does not differ radically from other successful designs, possesses several valuable features.

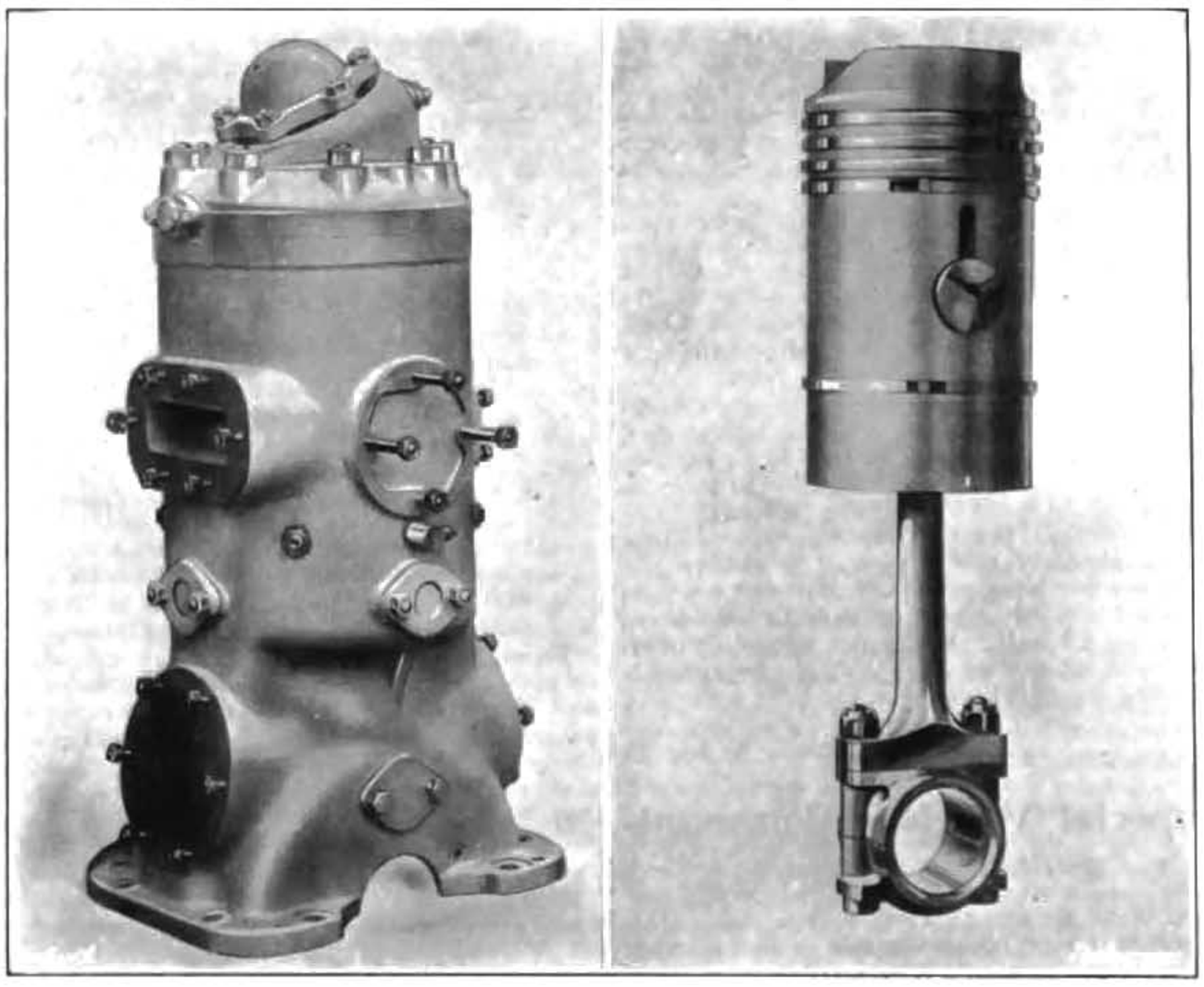
We recently had an opportunity of inspecting several of these engines at work, and were struck at the outset by the satisfactory manner in which they would continue to run at no load even when operating on heavy residual oil. The reason for this satisfactory performance at light loads is ascribed largely to the form of the combustion chamber, which, as will be seen from the line drawing, is of a more or less spherical shape, combined with the system of injecting the fuel oil. In regulating the injection to suit the load, the governor not only varies the quantity, but also the time of injection, so that at light load injection may take place as much as 30 deg. before the dead centre, with the result that there is ample time for the fuel to be vaporised before explosion takes place. As the load on the engine increases, the injection begins later in the compression stroke until at full load it occurs between 30 deg. advance and the dead centre. Another feature which influences the ability of the engine to run at light loads is the complete manner in which the charge is compressed into the combustion chamber at the top of the stroke by the reduction of the cylinder clearance to a minimum. The experience of some six months has shown that single and double-cylinder engines of this type will run for any length of time at no load, while the four-cylinder pattern will keep going for at least half an hour. The reason for the four-cylinder engine not comparing so favourably in this respect with the two-cylinder is, of course, found in its relatively higher mechanical efficiency and correspondingly smaller amount of fuel used at no load.

The fuel is injected into the cylinders by means of separate pumps, operated in the case of the one and two-cylinder engines by means of a single excentric. Where there are four cylinders, however, two excentrics are employed to operate the four separate plungers. Governing is effected by varying the throw of the excentrics. At the same time, their angular position with regard to the crank shaft is varied to produce the advance in the time of injection already mentioned.

An interesting point in connection with the fuel injection system is the remarkably high pressures necessary in the oil pipes. At the time of injection the pressure in the cylinder is only some 160 lb. per square inch, and yet a pressure of approximately 1000 lb. per square inch is necessary to spray the oil into the cylinder. Of course, the duration of this pressure is very short, but it nevertheless necessitates all the parts in connection with the fuel pumps being of very substantial design. There is a considerable amount of lost motion between the driving tappets and the plungers of the fuel pumps, so that the pump acts very much as if it were struck with a hammer and very effectively sprays the fuel. This arrangement possesses the advantage of permitting the suction valves, which are in pairs in tandem, to sett down on their seats before being subjected to the full pressure.

In general design the engine does not differ radically from other two-stroke cycle engines burning heavy oil. It is, as will be gathered from the engravings, of substantial proportions, but the metal has been so disposed that the weight is, if anything, slightly less than that of some other makes. Thus, the four-cylinder engine—which we illustrate—develops 100 brake horse-power, with cylinders 9½in. by 11in., and weighs 122 cwt. An engine with a single-cylinder of the same size gives 25 brake horse-power for a weight of 48 cwt.

In common with all the engines built at the Queen's Engineering Works, these oil engines have been provided with a very thorough system of lubrication. The main bearings have a pair of oil rings each and a sight feed lubricator, which has been specially designed for the purpose, is used to supply oil to the pistons, &c. This lubricator—plainly shown in the engraving—is operated from the pump gear by a ratchet mechanism, and works at a quite reasonable speed. A characteristic feature is the

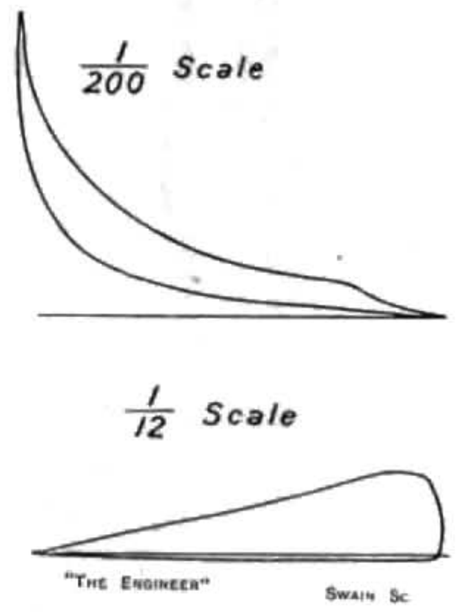


CYLINDER AND PISTON

use of two plungers to each feed. One of the plungers draws the oil from a reservoir and delivers it to a sight feed, from which the oil flows to the other plunger and is then forced to the part needing lubrication.

The gudgeon pin secures its lubrication by scraping oil off the cylinder wall. It will be noticed in the line drawing of the single-cylinder engine that the pin is shown hollow, and is fitted with a bush at one end. This bush has an upwardly turned lip which fits against the cylinder wall and scrapes off enough oil to lubricate the pin. This drawing also shows the ample proportions of the main bearings. The bearing on the tail end of the crank shaft is of the same dimensions as that on the fly-wheel side, in order to reduce the number of spare parts necessary.

The air for scavenging the cylinders is, as usual with this class of engine, provided by the compressive action of the under side of the pistons in the crank case. It flows through the bed-plate on its way to the crank case, and thus produces a quite appreciable cooling effect on the main bearings. Tne air is carried upward from the base by an external trunk and enters the crank case through steel plate valves. The indicator diagrams which we repro-



CYLINDER AND CRANK CASE CARDS

duce show the high volumetric efficiency of the pumping action, which, of course, is largely accounted for by the effective exhaust and consequent rapid reduction in the pressure in the cylinder at the end of the working stroke to that of the atmosphere. There is a floating ring on the crank shaft which makes an air-tight joint with the casing regardless of the alignment of the shaft.

On the occasion of our visit to the makers' works, two of the engines were coupled direct to dynamos, and their output was dissipated in water rheostats. It was thus a simple matter to vary the load on the engines, and we studied their behaviour as regards speed and surety of firing over a wide range of load. The variation in speed, both momentary and persistent, when full load was thrown on or off was within the usual limits specified for lighting sets, and the engines would easily carry 20 per cent. of overload without slowing up. At this load, however, the smoky nature of the exhaust showed that the limit had practically been reached when all the fuel possible was being burnt by the air available in the cylinder. Variations in the load between the values usually experienced in actual working conditions had no appreciable effect on the speed of the engine.

Starting is effected by compressed air, or exhaust gases, drawn from a receiver, the starting valve being fitted to but one cylinder in multiple cylinder designs. The dome of the combustion chamber is, as usual, heated by a blow lamp before starting.

A noteworthy feature about the engine is the rapid way in which it has been evolved. The first drawing was made on May 19th of last year, and by September 29th a single-cylinder set of 25 horse-power was running at full load. After this engine had been running for eight weeks, it was dismantled and submitted to the inspection department of the works. The examiners reported that every part was still exact to gauge and in a condition equal to new parts.

It is proposed to construct these engines with cylinders of four different dimensions, and group the cylinders together to form units of the required power. Thus, one size is 9½in. bore by 11in. stroke, and running at 375 revolutions per minute, each cylinder gives 50 horse-power. The next size is 11¼in. by 13in., and the output 35 horse-power at 325 revolutions per minute. Each cylinder, 13¾in. by 15in., gives 50 horse-power when working at 275 revolutions per minute, and the largest size, 80 horse-power, has a cylinder 16¾in. by 17½in., running at 250 revolutions per minute, so that units as large as 320 horse-power can be made with four cylinders.

The makers say that the fuel consumption of these engines is approximately half a pint of petroleum per brake horse-power per hour, and that they will work on almost any good quality crude or residual petroleum, or shale oil having a specific gravity not exceeding 0.95, which is free from acidity and impurities. Provision is made for warming the heavier oils.

Inter-Imperial Wireless Communication.

A COMPREHENSIVE scheme of wireless communications, capable of serving the needs of the whole British Empire, has been prepared by Marconi's Wireless Telegraph Company, Limited, and submitted for consideration to the Government Sub-committee dealing with this subject. The principles which it is suggested should govern the drawing up of an Empire-wide scheme of wireless communications include the following:—(1) That such trunk routes and branch routes be provided as will enable England to obtain wireless communication with any part of the Empire. (2) That any part of the Empire be capable of communicating with any ship suitably equipped with modern wireless receivers, in whatever sea she be; roughly speaking, between latitude 60 N. and 50 S. (3) That no submarine cable be relied upon to form part of this network of communications. (4) That the use of land telegraph lines be, as far as possible, avoided; and that these lines be restricted to the passage of messages between the public and the nearest wireless station. (5) That, where alternative routes are available, such as between England and South Africa, *viâ* the east coast or west coast, both routes be provided. (6) That, on the trunk routes, automatic transmission and reception at a speed of not less than one hundred words per minute be provided, and that separate transmitting and receiving stations be erected, in order that the service may be duplexed, *i.e.*, available for simultaneous transmission and reception. In order to construct the wireless network in accordance with these principles, the company proposes that no main trunk station be required to communicate with more than one corresponding station, and that in consequence each country be provided with a separate trunk station for each route to which it forms a terminal. Again, in a country which forms the terminal of more than one route, the various trunk transmitting stations would be erected as close together as avoidance of mutual induction will allow, and that consequently there would be only one trunk transmitting area in any country. In conjunction with this area, smaller transmitting stations would be erected, to serve as main feeder transmitting stations, and that they would be situated within one main feeder transmitting area.

As regards control, the main trunk transmitting area, the main feeder transmitting area, and the main receiving area would be operated by means of underground cables from a central control office situated in a convenient telegraph centre of the country—*e.g.*, London, in the case of England. Both the trunk and feeder stations would employ continuous, or "undamped," waves for the transmission of signals. It has been mentioned that each trunk station and main feeder station should communicate with only one corresponding station. Such communication would have to be conducted on a fixed wave length, and the whole question of allotment of wave lengths, with a view to enabling the requisite number of stations to work without mutual interference, would necessitate the most careful consideration. This matter is clearly an international one, as the ranges of stations are now so great. The company considers that it is of the greatest importance that a claim should be made at the earliest possible moment to the various waves required to carry out this service.

Returning to the system of transmission to be employed, it is remarked that the extensive employment of continuous waves has, until recently, been restricted, owing to lack of suitable methods of generating them. We have been limited to the timed spark and the arc. Neither of these systems is very efficient, and each has its own disadvantages. Although, therefore, both systems, in the absence of any other, have proved of inestimable value in the development of continuous wave telegraphy, they can no longer be recommended, in view of the rival claims of the high-frequency alternator and of the valve. Such rapid strides have been made in the development of valves, and in their application to high power working, that apparatus is already being assembled capable of dealing efficiently with an output of 100 kilowatts. The corresponding aerial power is confidently expected to be 75 kilowatts, and the design of the set is such that it can readily be adapted to three or four times this power. The figures given are only limited to the value quoted by the capabilities of the power plant to be used for this trial. Recent research with a view to the reduction of the total effective aerial resistance, without loss of radiation, leads to the expectation of an aerial current of upwards of 300 ampères.

Separate aerial systems are essential for the several receiving stations on one site. The newest methods of reception invented is the Franklin aerial, which is a development of the now well-known Marconi-Bellini-Tosi direction finder. Owing to the ability of the Franklin receiving system to reject signals arriving from practically any direction other than that from which it is desired to receive, any number of receiving stations may be located on one site.

The routes and branches proposed by the company are as follows:—(1) England to India, and thence to Singapore, Australia and New Zealand, with a branch from Singapore to Hong-Kong. (2) England to Egypt, and thence to East Africa and South Africa. (2A) England to Egypt, and thence to India, Singapore, &c. (3) England to West Africa, and thence to South Africa, with a branch from West Africa to South America. (4) England to West Indies. (5) England to Montreal, and thence to Vancouver. (6) Australia to Vancouver. The above routes would necessitate five main trunk stations in England; three similar stations in Egypt and India; two stations in East Africa, Montreal, Vancouver, South Africa, West Africa, Singapore, and Australia; and one station in the West Indies. In addition, West Africa and Singapore would each be provided with one auxiliary trunk station to connect West Africa to South America and Singapore with Hong-Kong. Australia would be linked with New Zealand by one of the main feeder stations.

Numerous feeder stations are also required, and in order to give a rough idea of the magnitude of the scheme, and also to establish a basis for the calculation of *personnel* to be provided for, the following figures are tentatively submitted:—30 main trunk stations, 50 main feeder stations, 100 local feeder stations, and 200 small local stations. On this basis the company includes in the proposals an estimate of the complete *personnel* required to operate the network.

The company includes with these proposals its offer to construct, maintain and operate the system entirely at its own cost, and to pay yearly into the Treasury of each Government, in whose territory one or more stations may be situated, a sum equal to 25 per cent. of the net profits earned by the said station or stations. On the expiration of a period of thirty years, dating from the inauguration of any wireless service comprised in the network, the stations conducting such service would become, if so desired, the property of the Government concerned, free of any payment. It is noted that the company guarantees to complete the trunk stations within a period of three years from the date on which permission to commence work is given. The Governments concerned will also have the right to take over the stations at any time under certain terms of payment. The offer is made subject to certain conditions, including the right of the company to extend the system to foreign countries to any extent and on any terms that may be commercially advantageous, provided that Imperial traffic shall invariably have preference over foreign traffic. The Government would have the right to take over the control of the stations during any period of war or national emergency.

INSTITUTION OF NAVAL ARCHITECTS.

ANNUAL MEETINGS PROGRAMME.

Wednesday, March 24th.—Morning meeting at 11 a.m. (1) Annual report of council; (2) election of officers and council; (3) election of new members, associate members, associates, and students; (4) appointment of scrutineers for the next annual meeting; (5) presentation of the Institution Gold Medal and Premium; (6) address by the president, the Right Hon. the Earl of Durham. Papers: (1) "H.M.S. Hood," by Sir Eustace d'Eyncourt; (2) "German Submarines," by Mr. A. W. Johns; (3) "Model Experiments in connection with Submarine Warfare," by Mr. G. S. Baker.

Thursday, March 25th.—Morning meeting at 11 a.m. Papers: (4) "Notes on our Economic Position as a Shipbuilding Country," by Sir Alfred Yarrow, Bart.; (5) "Further Notes on the Dimensions of Cargo Steamers," by Mr. J. Anderson; (6) "Freeboard and Strength of Ships," by Dr. J. Bruhn. Afternoon meeting at 3 p.m. Papers: (7) "The Stabilisation of Ships by means of Gyroscopes," by Mr. P. R. Jackson; (8) "Yawing of Ships Caused by Oscillation amongst Waves," by Professor K. Suyehiro. Evening meeting at 7.30 p.m. Papers: (9) "The Effect of Size upon Performance of Rigid Airships," by Mr. C. I. R. Campbell and Mr. C. H. May; (10) "The Effects of Holes, Cracks, and other Discontinuities in Ships' Plating," by Professor E. G. Coker and Mr. A. L. Kemball.

Friday, March 26th.—Morning meeting at 11 a.m. Election of new members, associate members, asscciates, and students. Papers: (11) "Experience and Practice in Mechanical Reduction Gears in Warships," by Engineer-Commander H. B. Tostevin, R.N.; (12) "The Balancing of Rotors and Determining the Position and Amount of the Balancing Weights," by Mr. J. J. King-Salter; (13) "Turbulent Fluid Motion and Skin Friction," by Professor T. H. Havelock, F.R.S.

INCOME TAX AND SCIENCE.—A joint committee of the British Association of Chemists, the Institute of Chemistry, and the National Union of Scientific Workers is putting forward the claim that the following expenses should be treated as a charge against income in arriving at the assessment of those who earn their livings either by purely scientific pursuits or by the application of science to industry:—(1) Subscriptions to scientific and technical societies, libraries and periodicals; (2) purchase and renewal of scientific and technical books, instruments, apparatus, chemicals, and other materials; (3) rent and expenses of laboratory or study; (4) travelling and other expenses incurred in attending scientific meetings or congresses; (5) provision of special clothing and renewal of clothes damaged in the course of employment; (6) other expenses incurred in the course of research. Enquiries should be addressed to Bedford House, York-place, London, W.

ELECTRICAL TRADES UNION, LONDON.—Agreement has now been arrived at as between the London members of the National Federated Electrical Association and the London District Committee of the Electrical Trades Union as to rates and working conditions. The agreement, which was signed by both parties on Friday, the 27th ult., makes the rate now payable to a fully qualified electrician 2s. 3d. per hour, and assistants over 21 1s. 9d. per hour, the men to get from home to job and from job to their homes in their own time if the job is within the agreed-upon area, namely, 12 miles from Charing Cross and within 12 miles of the employer's office. A joint committee has been set up to adjudicate on any disputes that might arise as between the parties, also as to the interpretation of the rules, and to consider, for submission to the parties, any further rules which might be suggested. The signing of this agreement will, it is hoped, do away with the friction that has existed for many years between the members of the E.T.U. and their employers.

THE INDUSTRIAL LEAGUE AND COUNCIL.—The Industrial League and Council, in order to cope with the tremendous increase in the work it is called upon to do, has had to remove into more commodious premises. The Executive Committee of the League has been fortunate indeed in being able to acquire a fine suite of rooms at 82, Victoria-street, S.W. 1, and on March 3rd the leaders and pioneers of the movement assembled to officiate at the opening of the new premises. The Right Hon. G. H. Roberts and the Right Hon. J. H. Whitley, the joint Presidents of the League, in conjunction with the Bishop of Birmingham, who is President of the Birmingham Branch, received the guests as they arrived and conducted them over the offices, and the Right Hon. G. H. Roberts afterwards presided over the gathering which took place in the board room. The company afterwards lunched together, and, replying to the toast of "The Industrial League and Council," Mr. Robert Young said the influence of the organisation was growing steadily among both the workmen and the employers.

DEPARTMENT OF OVERSEAS TRADE, VISITS TO INDUSTRIAL CENTRES.—Arrangements have now been completed for the periodical dispatch of officers of the Department of Overseas Trade, having specialised knowledge of particular trades, to the more important industrial centres throughout the country for the purpose of bringing the Department more directly into touch with provincial firms than has been possible hitherto. With the co-operation of the Association of British Chambers of Commerce the necessary facilities will be provided by the local Chambers of Commerce to enable the representatives of firms desiring to export British goods to interview the officers of the Department in their own locality. This arrangement, it is hoped, will obviate the inconvenience of travelling to London for the purpose of consulting the Department on matters connected with overseas trade. It is intended that the visits of officers shall be monthly and will extend in each case over a period of about five days. Birmingham has been visited during the present week, and the following programme has been arranged for the next two months:—Manchester Chamber of Commerce, March 15th to 19th; Glasgow Chamber of Commerce, March 22nd to 26th; Sheffield Chamber of Commerce, March 29th to April 1st; Bradford Chamber of Commerce, April 12th to 16th; North Staffordshire Chamber of Commerce, Tunstall, April 26th to 30th. The officers visiting the centres named will deal with inquiries connected with overseas trade possibilities and conditions, and as far as may be possible will discuss such matters as the following:—(1) Contracts open to tender; (2) overseas demand for particular goods; (3) importers of various goods in overseas markets; (4) agencies for British manufacturers; (5) general conditions obtaining in overseas markets including best method of marketing and distribution, credit conditions, terms of payment, nature of competition and best methods of meeting same, &c.; and (6) shipping and transport. It is further hoped that these visits may be the means of enabling the Department to keep abreast of local industrial developments in their bearing on overseas trade.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Iron Follows Coke Up.

LAST week's advance of 5s. a ton in the price of coke, notified by South Yorkshire and Derbyshire producers, to which I directed attention in your "Latest News" column, has thrown iron and steel prices once more into the melting pot. The advance in coke involves a big addition to selling prices of iron and steel, increasing with each stage of manufacture. It is almost impossible to say what the ultimate price to be paid for any class of material will be with one or two exceptions. But consumers are content to leave the matter in suspense if they can only secure deliveries. Remarkable premiums are rumoured to have been paid to secure the acceptance of orders. These amount in some cases to £3 and £4 on bars and gas strip. Many ironmasters are declining to quote, in view of the large arrears they already have on their order books. Additions of from 25s. to 30s. in bars and some other descriptions of manufactured iron and in finished steel are being discussed and are expected to be declared before this week is out, but at the time of writing the exact extent of the advances is not known. Even this week's advances will not mark the limits if the smelters further raise their demands as they threaten to. Already Northamptonshire smelters have announced an advance of 5s. per ton, and give notice of their intention again to advance prices by 7s. at the beginning of April. One reason assigned for progressing by two stages is that there is a number of coke contracts running till the end of the current month that will be exempt from the increase. Another is that the furnace owners have to protect themselves against advancing costs in details unconnected with coke. Staffordshire pig iron has been advanced 7s. 6d., making part-mine £10 12s. 6d. and foundry iron £11. Probably the April rise will be a further 5s. In the finished iron branches only small orders are being placed, but that is because of the limited resources of producers, and not on account of the reluctance of consumers. Buyers are ready to pay as much as £27 for "Crown" bars and for iron strip £27 10s. Puddled iron—bars and billets—at £19 10s. to £20 have been regarded as unremunerative, and makers have been confining their limited output to distribution among old customers. Present price contingencies are this week unsettling prices throughout a vast range of business, gravely handicapping manufacturers in quoting for orders both at home and abroad. Prices of galvanised sheets are still soaring. It is reported in Birmingham this week that at Glasgow galvanised sheets have been sold as high as £60 per ton. In this district, although business is not now accepted, recent sales have been as high as £53 and £55. For the most part millowners are restricting themselves to home orders. Enormous tonnages of business offered from India, South America, and continental neutrals are being turned down. Foreign buyers are greatly increasing the weight of their inquiries. In some circles it is even boasted that the tonnages on offer are from eight to ten times those which Birmingham exporters have been accustomed to handle.

Welsh Steel Strike and Steel Market.

The better news this week regarding the Welsh steel strike is earnestly welcomed. It is abundantly realised here that if there was no chance of a settlement the tin-plate trade and sheet trade would be brought very nearly to a standstill. Fortunately for this district, although about ten Welsh steel works were originally involved, the Ebbw Vale Company, which resumed operations after a six months' strike at the beginning of the year, has been able to keep at work. Probably the largest contribution of billets to this district comes from that company. The whole strike has been the more regrettable since the men's demand was not actuated by any increased cost of living, but simply by the chance occurrence of a trade boom, which may be of short duration, in one particular trade in the overseas business. Industry needs all the help it can get from the foreign markets to right the present adverse trade balance. But, if these sudden activities in individual branches are to be made the excuse by labour of enormously increasing costs of production in other industries, they are likely to be a very doubtful gain. An advance of 40 per cent. had been given to the operatives in the tin plate industry because of the very high prices in the markets abroad and the steel workers demanded to be placed upon an equal footing. It is this week almost impossible to place orders for billets, while no assurance can be got with regard to delivery. All offers to purchase have still to be submitted to the steel works, merchants being unable to accept business on their own account. New price changes are announced in finished steel. The official minimum for angles has been raised to £21 10s. Black steel bars for export have been advanced £1 10s., making them £30; bright steel bars have been similarly advanced, being now £36. So upset is the steel market at date that prices generally are a matter of bargaining. An advance of £3 in bedstead angles has been notified, making the price £25 delivered in the district. A small consignment of American wire rods has recently come to hand, though they are not of the sizes mostly used in this district. They are, however, suitable for a few firms. Ferro-manganese has been put up from £30 to £32 10s.

Coke Advance and Pig Iron Position.

Ever since the Coal Controller intervened to stop the huge diversion abroad of the indispensable raw material of hard coke the pig iron makers had been warned that they might expect to pay a higher price. Last week's advance of 5s. per ton therefore came as no sort of a surprise. Pig iron makers are now called upon to pay about double the amount for their supplies that they were paying a year ago. In addition to the increased demands of the ovens they have to meet the higher railway rates plus additional wagon hire. The latter charge is now based on mileage. Instead of paying a flat rate of 7d. or 8d. a ton per journey the hirer has to pay 1s. to 1s. 6d. up to 50 miles and for journeys between 50 and 100 miles 2s. The ovens have been headed off from a very profitable export trade by the Coal Controller, acting in the interests of the iron and steel trades, and they are recouping themselves in some measure by putting up the price to the home consumer. At the beginning of the year they advanced the price 3s. 6d., making it 53s. 6d., as against the 40s. which was put on the article when the trade settled down to the new post-war position on the removal of the control at the beginning of last May. The new advanced figure, as I stated in last week's "Latest News" column, is 58s. 6d. at South Yorkshire ovens.

More Pig Iron News.

In addition to the advances in pig iron noted at the opening of this letter, sellers of pig iron reserve the right to make further advances in respect of any increases in wages or raw materials, and a special clause has now been introduced to secure proportionate increases for any shortening of hours which may take place. Pig iron production has for a long time been restricted because of insufficient supplies, and numbers of furnaces in Derbyshire, Northamptonshire, South Staffordshire, and East Worcestershire are idle in consequence. The market could absorb probably a third more than is now coming to hand, and prompt steps will be taken to re-start furnaces as soon as supplies of coke are assured. Two entirely new furnaces are being built by the Willingsworth Iron Company and one by Messrs. Bradley and Foster at Darlaston, South Staffordshire. In North Staffordshire there are eleven furnaces in blast out of twenty-three and seven are being refitted or rebuilt. The Shelton Iron, Steel, and Coal Company is building a new furnace. Of the active furnaces in both districts fourteen are making forge and foundry iron and ten are on basic iron.

Staffordshire's Water-logged Mines.

The inquiry by the Coal Controller into the possibility of saving the waterlogged mines in South Staffordshire has been postponed. Sir Richard Redmayne, formerly the Chief Mines Inspector of the kingdom, who is to preside, is, however, it is understood, busy with the preliminary work, and it is hoped this problem may be decided with as little delay as possible. The present position is peculiarly unsatisfactory from every point of view. The fate of being drowned out, which has overtaken the Tipton area, may be the portion of the Stourbridge district and the Kingswinford district unless comprehensive measures are taken to fight the floods. Following an inquiry held last Easter the Tipton area was condemned by the Mines Drainage Commissioners and other interested parties as not being worth the cost which would be involved in unwatering the pits. But that there are valuable mineral deposits in the area which modern engineering could make available for the community is undoubted. A score or so of small owners who sunk a little capital during the war on the faith of pumping operations being maintained by the Commissioners for a further ten years or so feel themselves aggrieved by the doom pronounced upon their property, and they hope for a reversal of the verdict by the coal control inquiry now to be held. Meanwhile they are lodging claims for compensation for the withdrawal of the pumping, which, they say, was promised by the Commissioners, who are a body appointed by Act of Parliament.

Overseas Trade and Government Help.

Birmingham manufacturers have this week been offered some help by the Board of Trade in the conduct of export business. They have received a four days' visit from one of the representatives of the Department of Overseas Trade to afford them information—if they care to ask the Department—upon details with which they are not conversant. The Chamber of Commerce has been the venue of the interviews and the matters discussed have included such subjects as contracts open to tender, overseas demand for particular goods, the importers of different goods in the export markets, agencies for British manufacturers. The ever-increasing competition of other countries has rendered imperative a scientific study of the requirements of the world's markets. This bringing the Department into personal touch with those for whose benefit it exists has the advantage that every aspect of a question can be examined. It was fitting that the visit should follow immediately upon the conclusion of the British Industries Fair—Birmingham Section. Addressing the Chamber of Commerce upon the benefits of the Fair since it closed, Sir Hamar Greenwood, head of the Overseas Trade Department, said, referring to the immediate future, that he believed we had passed through the worst of our industrial troubles. We were justified in now looking forward to a period of expansion in trade such as the country had never before seen, subject to the qualification that strikes in vital industries did not wreck commerce.

LANCASHIRE.

(From our own Correspondent.)

MANCHESTER, Thursday.

Iron, Steel, and Metals.

So far as the iron and steel markets are concerned, there is still an enormous demand and a pressure upon all producers which continues to force prices up whether they will or whether they strive to keep them down. It is obvious that the main causes of the scarcity are the collapse of German steel production and the failure of America to fill in the gap; but there are some subsidiary causes, and one of them is the inadequacy of the world's fuel production. An attempt has been made to mitigate this by the greater use of liquid fuel for manufacturing purposes, and such a course was practicable when mineral fuel oils were cheap and when creosote could be obtained at 3d. to 4d. per gallon. The price of creosote to-day is 11d. to 1s. per gallon, and liquid fuel for manufacturing purposes is becoming a very costly matter. The scarcity of fuel is putting a stop to any attempts to increase the output of British pig iron, and it is pitiable to see so many blast-furnaces compulsorily idle while the need for more pig iron is so urgent.

Metals.

The collapse in the metal market last Friday came as a rather unpleasant surprise to many of those engaged in the Manchester trade. It was difficult to find anyone who could give any sensible reason for the fall in prices, although the general opinion seemed to be that the movement was temporary, and that the shaking-out of weak speculators would be a good thing in the end. A curious feature was that the fall in copper coincided with much more favourable reports as to the position of the metal in America, which might, one would think, have stimulated speculators to buy standard in much larger quantities. It may be, of course, that the set-back in copper prices was engineered with a view of producing a favourable situation for the beginning of a bull movement, and the general position of copper in relation to almost all the other metals makes this conjecture the more probable. The belief that the mineral resources of Mexico are now about to be developed with energy on account of the political settlement of that long-distracted country may have had some effect, but this would apply to lead more forcibly than to copper. The rise in the American exchange will also have had an influence on copper prices. From the lowest point touched this now amounts to 35 cents on the pound sterling, or equal to a saving of about 10 per cent. on the cost of imported American copper. The official prices for sheet copper and for copper and brass tubes were not altered at the time of the fall in standard and refined sorts, but they may be affected if the market does not recover during the present week to any considerable extent. Tin followed copper at the end of last week, but one cannot see that there is any material difference in the position, and although astute operators have opportunities of making money, it is really too soon to look for any serious cheapening of the metal. Germany is now becoming a more effective buyer for her own tin-plate manufacturing trade, and this will help to draw away any surplus metal from our market. There has been no serious downward movement in silver, and cheap silver is what is required to enable the East to produce cheap tin. There is talk of a bull movement in tin to start from about £400 per ton, and although, according to ingrained ideas as to values, this seems a dangerous basis upon which to found a big speculation, yet it is possible that success may be met with. Lead is now in a very uncertain position, and those optimists who maintained that the price must go to £60 are rather disappointed with the actual state of affairs. A point which has been commented upon by the *Metal Bulletin* is that inquiries are being made with a view to buying up Broken Hill shares, suggesting that the strike is near settlement. This and the development of Mexico might make a good deal of difference in our supplies of lead, and consumers must keep very wary just now. For one thing, copper is only about 33 per cent. above a normal pre-war price, while lead is some 400 per cent. in advance of its value in the old days. Spelter has been rather a weak market here for some time, but in America the metal remains exceedingly strong, and even with the help of a better exchange it is not possible to arrange for fresh importations of American spelter to show a profit on our prices.

Pig Iron.

The market for foundry iron in Manchester is now very meagrely supplied with material, and it is difficult to say what may happen to the prices. Scotch iron was advanced 5s. at the end of last week, and if a merchant is asked to supply it here free of carriage, he cannot ask less than £13 5s., and then the margin is not very much upon material which stands so high. A profit of 1s. 6d. to 2s. was ample when the iron was sold at 70s. to 75s. per ton, but a profit of 4s. will scarcely pay at present prices. Ordinary No. 3 foundry iron is scarce here, and the only iron offered early this week at a fixed price was some Derbyshire No. 3 at £11 per ton delivered, but this was for delivery up to the end of April only. For any further deliveries it is impossible to get a fixed price for Derbyshire or any other iron, and the buyer—if he will buy—must be content to agree to pay whatever advance may be made before the date of delivery. One does not know that he would be credited with any fall, but there is not much probability of that, at any rate until after May and June.

Finished Material.

The demand for all kinds of finished iron and steel is as insistent as it ever was, and prices are probably as variable. Ship plates vary from £23 10s. to £26 10s., and angles from £21 to £26 (!). Round bar steel now goes up as high as £27 10s., but in some cases considerably less than this is taken.

Scrap.

There is again a firmer feeling in the scrap market, and dealers are expecting to be able soon to raise their prices considerably, but up to the present there has not been any very serious business. With common pig iron at £11 and Scotch at £13 5s., £10 10s. to £11 10s. would be a fair price for cast scrap, but at present dealers do not hope to get the price up much above £9, and would probably be satisfied with that figure for a time. Heavy steel scrap is a little more saleable, and £9 per ton is expected for it. The demand for heavy wrought scrap is strong enough, and consumers are anxious to take all they can get, but the highest price offered is still only £9 5s. delivered, and many holders and collectors are of opinion that by keeing out of the market they will get much more.

Richard Trevithick.

A valuable contribution to the history of mechanical engineering was recently made by Mr. J. H. Trevithick by an address which he gave to the members of the Engineers' Club on his great-grandfather, Richard Trevithick. Although in Smiles' "Lives of the

Engineers " mention is made of Trevithick's steam carriage and tram engine, full justice has not been done to the Cornishman's great inventive talents. Although Murdock anticipated Trevithick with a small working model of a steam-propelled carriage, there is little doubt that the latter was really the first to build such a vehicle to carry passengers. Trevithick's machine embraced one of the first high-pressure engines in which the principle of moving a piston by the elasticity of steam against the pressure only of the atmosphere was employed. What is more, the engine was double-acting. His tram engine had a wrought iron boiler, with the furnace and flue and working cylinder inside, the motion of the piston being transmitted to the driving wheels by means of spur gearing. But Smiles makes no mention of many other of Trevithick's inventions, such, for instance, as his pumping engines, thrashing engine and steam-propelled plough, constructed somewhat on the lines of a modern potato digger. Mr. J. H. Trevithick has collated a considerable amount of information on the numerous inventions of his great-grandfather, together with drawings and photographs, all of which would provide material enough for a book comparable in thickness to Smiles' famous volumes. It is to be hoped that some day he will see fit to publish these in book form for the benefit of all who are interested in the historical side of engineering science.

The Engineers' Club.

Although from a business point of view the Manchester Engineers' Club had not quite such a successful year in 1919 as in 1918, in view of the abnormal conditions, the Committee is to be congratulated on the satisfactory annual report which it has just issued. The report states that one of the chief difficulties which the Committee had to contend with was the greatly increased cost of maintenance, owing to the abnormally high price of food, drink, and, in fact, everything which is necessary in an establishment of this description. During the war there was a natural tendency on the part of the management to lighten the burden of expenditure in the hope that when hostilities ceased there would be some relaxation in the prices of commodities, which, however, has not come about. The Committee therefore has had to meet a considerable extra amount of expense in renewals and replacements. The Committee also decided to make material increases in the wages and salaries of the staff. Owing to the increased cost of working, together with the necessity for further and better accommodation for the members, the Committee decided to obtain the members' consent to an increase in the annual subscription from three to six guineas. This matter was brought before the members at a largely attended special general meeting, held on November 18th, 1919, when the necessary sanction to the increase was given almost unanimously. As a result of the increased subscription, there were seventy-one resignations, chiefly of members who resided at a distance. During the year the Club premises have been increasingly utilised for meetings of different engineering societies, including the Institutions of Mechanical and Electrical Engineers, and the Club debates have been well attended. The number of members is now 840. The President is Mr. Daniel Adamson; the Chairman of Committee, Mr. W. E. Gower; the Hon. Treasurer, Mr. J. Owden O'Brien; and the Hon. Secretary, Mr. H. Richardson.

Chester's Industrial Development.

The possibilities in connection with the industrial development of Chester were emphasised at a recent conference of local authorities for the purpose of considering an electrical scheme for a large area of which Chester would be the centre. The Mayor has now invited Mr. Britton, the city electrical engineer, to formulate for the consideration of the Development Committee, a scheme, the object of which is to provide information for those looking for industrial sites, especially as regards railways, waterways, drainage, supply of water, gas and electricity, labour, housing, localities and areas of sites and buildings, in a form that will be appreciated, not only by them, but also by those who have suitable property for disposal. Mr. Britton has taken the matter in hand, and he hopes to deal with it in a way that will inspire confidence and be of mutual advantage to all parties concerned.

BARROW-IN-FURNESS, Thursday.

Hematites.

Makers of hematite pig iron in North Lancashire and Cumberland are very busily employed. They hold sufficient orders to occupy their attention for the present and for a while to come. They are faced with a very big demand for iron on local as well as general home account, but are still not in a position to enter into huge contracts, for their output is limited. Raw materials are coming to hand in heavier tonnages, but much bigger deliveries are required before any considerable expansion can be looked for. In all, there are twenty-one furnaces in blast, and there is prospect of another furnace going into operation in Cumberland. Of iron for export there is no chance for some time to come. Prices are steady, with parcels of mixed numbers of Bessemer iron at £12 5s. per ton net f.o.t., and special brands are up to £13 5s. per ton net. Further increases will be brought about next month.

Iron Ore.

In the hematite iron ore trade there is plenty of life. The demand is very heavy, and the output is practically all used up in the immediate district. Average qualities of native ore are at 52s. 6d. per ton net at mines, and Spanish or North African ores are at 62s. 6d. per ton delivered.

Steel.

There are no new features to record in the steel trade. At Barrow and at Workington most of the plant is busily employed, and rails continue to be the chief output, although smaller sections are receiving attention and castings are being turned out. The demand for steel generally is good. Prices are higher for rails, with heavy sections at £21 5s. to £22 5s. per ton. and light rails are up to £22 10s. to £24 5s. per ton. Billets are a steady business at £22 10s. per ton. There is nothing being done in ship or boiler plates. The quotations remain at £21 for ship and £26 10s. per ton for boiler plates.

Shipbuilding and Engineering.

There is a pretty busy state of things in these trades. The work done is wholly on merchant tonnage, hulls and engines, with particular attention to the construction of oil-driven engines.

Fuel.

The demand for steam coal is brisk, and the quotation remains at 36s. per ton delivered. House coal is in full demand and short supply at from 38s. 6d. to 42s. 6d. per ton delivered. The demand for coke is heavy, with East Coast qualities at 60s. per ton delivered to West Coast furnaces.

SHEFFIELD.

(From our own Correspondent.)

Transporting a Furnace.

SINCE writing my previous letter a rather interesting feat has been accomplished here. About two years ago Samuel Osborn and Co., Limited, had three solid fuel heat treatment furnaces put down, two at the firm's Clyde steei works, the Wicker, and one at that portion of the company's Rutland Bridge property operating under the style of Bury and Co., its former owners. Recently it was decided to remove the one at Rutland Bridge to the Clyde works, and the actual transportation took place last week. The three furnaces had been erected by August's Muffle Furnaces, Limited, of Halifax, which had claimed that they could be removed bodily at any time without disturbing the lining or any other part of the furnace, though so far as appears to be known, the risk of transporting a solid fuel furnace of approximately 30 tons weight, 18ft. over all, 6ft. high, and 5ft. wide, had never before been accepted by any user. The operation, however, was successfully completed by Osborn's, and the furnace is now installed in the Wicker in proximity to the two others. I learn that about half a dozen of this type of furnace are being put down in the Sheffield district at the present time, all the same size as the one described, and known as " standard 15-footers." The special claim for them is certainty in heat treatment, a regular temperature, it is said, being secured as easily at 350 deg. C. for non-ferrous metals as at 1050 deg. C., or at any given degree within those extremes.

Railway Charges.

The manufacturers and traders of Sheffield and Rotherham are very indignant. Soon after the imposition of the increased railway traffic charges they discovered that the manner in which the increases were being applied by the railway companies was not in accordance with the published notice of the Ministry of Transport, and that the readjustment of cartage and siding rebates in respect of the increased rates was not being properly made. Meetings of the firms concerned were held under the auspices of the Sheffield and Rotherham Chambers of Commerce, and as a result of resolutions passed the case was laid before the Minister of Transport with a request that Sir Eric Geddes would issue such instructions to the railway companies as would ensure their obligations being properly carried out. Instead, however, of receiving the sympathetic reply confidently anticipated, the Ministry's response was a reminder that the Ministry had issued directions to the railway companies as to the charges they were to make in accordance with the advice of the Rates Advisory Committee and an expression of view that it was for the railway companies to decide how best to carry into effect the new obligations. The suggestion of the Ministry, therefore, was that the Chambers concerned should take up with the railways direct any question in which they considered the companies were not carrying out the directions of the Minister of Transport. Now, at fighting railway companies manufacturers are particularly adept. They simply have to be. They all have their railway rates departments, many of them managed by ex-railwaymen, who are generally very successful, on the principle—or policy—of setting a thief to catch a thief; but why they should be expected to " fight it out " with railway companies upon points made involved and difficult, or easy for railways to get round, as the case may be, by the ambiguity of official phraseology, they very reasonably fail to see. They consider the reply of the Ministry absurdly weak, and I shall be surprised if the matter is allowed to drop. Railway companies, badgered by the men on one hand and the Government on the other, are not in any fit mental condition calmly to reconsider a matter which might easily involve the passing of a judgment opposed to their own special interests. In other words, if the Ministry cannot take up the complaint of the manufacturers and examine it the railway companies never will. Indeed, why should the Ministry expect them to do so? Are they not the defendants in the action? How can they be the judges also?

Carbon Percentage in File Steels.

The right percentage of carbon in file steels made upon scientific lines has been one of the most discussed questions among the group of Sheffield men who may be described as file-making reformers and who have been chiefly responsible for the existence and vitality of the File Trades' Technical Society. Some of the papers read before that body since its formation a year or so ago have been worthy of being raised to the status of text-books, and it would be a thousand pities if the Applied Science Department of the University, which has taken such a leading part in the promotion of these technical societies, failed to find some means of preserving the papers for reference by those concerned. They are not all of that character, however, for a recent one, I believe, advocated a continuance of the old file-making methods in preference to proceeding along new scientific lines. It is quite conceivable that much of the craftmanship and wonderful intuition of the old-time file-making practice the trade can ill afford to lose, and, if possible, a place should be found for it where it would supplement the certainty of results associated with modern practice. But if it cannot usefully supplement scientific methods there surely can be no good ground for its retention. One of the progressives, Dr. F. C. Thompson, lecturer in metallurgy at the Sheffield University, provided an interesting evening at a meeting of the society a few days ago. Taking as his subject " File Steels and their Treatment," Dr. Thompson gave an account of the composition of file steels, explaining that the percentage of carbon for small files should be 1.4, for medium 1.1, and for large files .9. Chromium from about ½ to 2 per cent. or over was added and at times tungsten. The addition of chromium raised the carbon change point and therefore necessitated higher temperatures for quenching and annealing. The effect of quenching in the case of chrome steels was somewhat more profound than in the case of steels from which this element was absent.

The Old Way and the New.

Reverting to the question of old unscientific methods of manufacture—not of files only—the same subject was touched upon by Dr. F. Rogers in a paper read before the Sheffield branch of the Institution of British Foundrymen, on the same night as that chosen by Dr. Thompson. Dealing with " Factors Lending Soundness to Castings," Dr. Rogers traced the evolution of the " born " practical foundry expert, endeavouring to give true value to his innate physical sensitiveness and to show that he was really working by measurement when such means were available, even in the old days when he was not credited with having done so. The modern product of technical training, added Dr. Rogers, had his faculties trained primarily, and the measurement and recording of all possible factors in his work and the happy combination of the two types had led to real progress. So it must be in all departments of iron and steel production.

High Speed Steel and the U.S.A.

In a recent letter I referred to the movement in the United States in the direction of making the importation of British high-speed steels an unprofitable proposition. The matter affects Sheffield, of course, almost wholly, and in its monthly journal the Chamber of Commerce refers to the question at some length, pointing out that the proposal of the American House of Representatives is to add a special duty of 1 dol. per pound on tungsten content in steel goods. That would bring up the full tariff on 18 per cent. tungsten steel to about 1s. 3d. per pound and about 11d. per pound on 4 per cent. tungsten steel. Our inability to spare high-speed steel for America during the war led that country to find means of supplying itself, just in the same way as we had to discover how to supply ourselves with tungsten powder for high-speed steel making—that form of alloy having, of course, formerly come from Germany—and now, not unnaturally the Americans wish to retain the industry, though very many users over there quite evidently prefer the Sheffield make. The proposed new tariff is designed to keep the trade at home by making the importation of British high-speed steel practically prohibitive. In spite of all that, however, the exports from Sheffield to the States are just now showing a very decided improvement, and a manufacturer recently home from an American tour assures me that in point of quality the high-speed steel produced on the other side of the Atlantic is streets behind the British make.

General Conditions.

So far as it is possible to judge by official figures, there are now about 4400 unemployed persons in the Sheffield district, which, compared with quite recent figures, marks a very appreciable reduction. All but about 1000 are men and, unfortunately, 2000 of the total are ex-Service men. However, every effort is being made to get them settled in permanent work, and the progress toward that desirable end is encouraging. Sheffield is, of course, a very strong centre for metallurgical chemistry, and whilst I do not know that the market for steel works chemists is particularly overdone, I was interested to note the other day that students have been advised to take into their serious consideration the subject of hydro-carbons and their derivatives, on the ground that with the opening up of oil wells in Derbyshire and the discovery of oil shale, it would be well if a body of chemists was ready and trained for developing what promised to be a new industry in the district. I notice that the directors of Brown Bayley's Steel Works, Limited, have acquired a controlling interest in the Farnley Iron Company, Limited, near Leeds, the figure being £143,780. It is in that district that a new file factory was recently commenced by a company financed, I believe, by Sheffield interests. Brown Bayleys, too, have just purchased at Handsworth, a suburb of Sheffield, about 45 acres of land which it is proposed to develop as a recreation ground for the firm's employees. A few weeks ago I mentioned that the Yorkshire Engine Company, Limited, whose works are here, has in hand the construction of one of the largest types of passenger locomotives, in which some new features will be introduced. The directors now report that the past year has been a good one, the works having been very fully employed, largely upon repairs of main line locomotives, and that at the present time there is a considerable amount of work on hand. The company has done sufficiently well to be able to pay off five years' arrears of preference dividend and to hold out a hope of clearing off during the current year some at least of the remaining four years' arrears. The United Strip and Bar Mills, Limited—a subsidiary of the United Steel Companies, Limited—which was registered only a short time ago, is now definitely in the market with an offer of a million and a-half cumulative preference shares of £1 each and carrying an 8 per cent. dividend guaranteed by the United Steel Companies, Limited. The estimated output of the new company's strip mill, I see, is from 3000 to 7000 tons a month, and that of the bar mill about 12,000 tons of merchant bars a month. Another development is the decision of Ambrose Shardlow and Co., Limited, a well-known Sheffield engineering concern, to raise the capital of the company from £200,000 to £500,000. This half-a-century-old firm has undergone a good deal of

quiet expansion in the past, but there is evidently still more to come, and the directors say that their order books contain sufficient business to keep the works going fully for some years. That seems no uncommon experience here. For example, I am told that John Brown's have enough orders for railway and tramway tires, axles, springs, and kindred material to keep those particular departments going for five years, and the other large firms say much the same thing. I cannot vouch for it, but I hear that gun tubes made in excess of the war's requirements are being utilised for tire making. The silver trade is still heading for a big general strike, though I believe the Lord Mayor may be asked to use his good offices to avert it; but the cutlery industry continues driving busy, and I learn that the Durham Duplex razor people of New York have recently acquired a considerable interest in the Sheffield cutlery firm of W. and S. Butcher, Limited, a business which is more than two centuries old. As to trade as a whole, there is little change in conditions compared with a week ago, except the increasing scarcity of iron and steel.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Prices Advanced.

THE rise in Cleveland pig iron prices, which had been long anticipated, constitutes the outstanding feature in iron trade circles this week. In every other producing area prices had already moved up, but the Cleveland makers have displayed the utmost reluctance to take part in the further inflation of values, well knowing that in its ultimate effects any further advance would be injurious to the trade as a whole. But the force of circumstances has been too much for them. Costs of production have been steadily mounting, and, having stayed their hands to the last possible moment, the Cleveland makers by agreement have advanced the price of Cleveland iron by 25s. per ton and of East Coast hematite by 40s. per ton. It is a big jump—bigger perhaps than some traders anticipated—but if the trade can now be assured of stable prices for a period, it will tend to restore a little more freedom to the market. It is not to be expected that much iron will be released for sale, for the output has been passing almost straight from the pig beds into consumption: but it may now be possible to make contracts for forward delivery, and in this way an improvement may be effected. Buyers are very eager to contract for supplies, and no difficulty is anticipated in realising the higher prices in the home market, and possibly also to France, Belgium, and Italy, where the premium is only 5s. per ton over the home figures. But it is feared that if another 25s. per ton is added to the general export trade of Cleveland foundry iron, it will kill or at least cripple our trade with Scandinavia and other European countries, which, with the depreciated state of the German exchange, are beginning to buy German iron. It is, however, still early to say what the export figure will be. All that can be said at the moment is that for home consumption No. 1 is now 207s. 6d. per ton. No. 3 Cleveland G.M.B. and all the lower qualities 200s., whilst in both cases 5s. per ton is added if the iron is for export to France, Belgium, and Italy. Even at these figures it is almost impossible to get prompt iron. Scottish consumers are now so badly off for supplies that a deputation came to the district this week to investigate the position, and the prospects of obtaining better supplies from Cleveland. It is to be feared that they would get little comfort. There is, unfortunately, small prospect of an increased output. Many furnaces are ready for relighting, but the chronic shortage of fuel and raw materials makes any expansion of the production impracticable. It is to be hoped that the position will become easier as the year goes on, but there are certainly no present indications in this direction.

Hematite Pig Iron.

The differentiation in the advance as between Cleveland and hematite iron is not surprising having regard to the phenomenal price of foreign ore, and consumers recognise that under the circumstances 260s. for mixed numbers and 262s. 6d. for No. 1 is not an exorbitant figure. The premium for export to France, Italy, and Belgium is still at 10s. per ton. There is no iron available for other destinations, and quotations are purely nominal.

Iron-making Materials.

A little more business is reported in the foreign ore trade due to an easier situation in regard to freights. Last week as much as 39s. 6d. was paid, but now the freight is down to 38s., which brings the c.i.f. price of best Rubio down to 71s. per ton. Transport is not plentiful, but still the position is a little easier, and it is hoped that, as in the case of pig iron prices so in regard to ore freights, high-water mark has been reached. The coke makers generally have not yet advanced the price of blast-furnace coke, although in one or two instances as contracts have expired coke makers have refused to renew except upon a week-to-week basis of 2s. 6d. per ton advance. Now, however, that the price of pig iron has gone up, coke will almost certainly follow suit, and an early announcement is expected. Meanwhile, except from Durham and Northumberland, the export of coke has been stopped, and even from these counties little indeed is being shipped. These measures have not yet led to any perceptible improvement in the supplies to the furnaces, but better things are looked for. Ordinary qualities of blast-furnace coke are still nominally 50s. 6d. per ton at the ovens.

Manufactured Iron and Steel.

In the manufactured iron and steel trade the great problem of the moment is to get delivery. Manufacturers have orders in hand that will keep the works busy for some considerable time ahead, and there is any amount of new business on offer. The wagon position, unfortunately, shows practically no improvement, with the result that the works, owing to the enormous congestion, find themselves increasingly unable to deal with the pressure of demand, and much business has to be turned down. Steel billets are in strong request, and shipbuilders are pressing for more plates. Famine conditions prevail in regard to galvanised corrugated sheets, and it is reported that for some gauges up to £60 has been paid. This week there has been a further revision of the entire range of steel prices. All angles, joists, and ship plates and sectional material have been advanced a further 20s. per ton, rails 25s. per ton, billets 30s. per ton, and boiler plates 40s. per ton. This is the third advance which has been notified in a period of less than two months, and, as indicating the extent of the advance, it may be mentioned that last October steel billets, now £21 to £22 per ton, were selling at £15 5s. The new quotations are as follows:—Rounds and squares, 3in. to 5½in., £22 2s. 6d.; 3in. down to ⅝in., £24; flats, 5in. to 8in., £22 5s.; over 8in., £22 15s.; 1½in. to 5in., £24; angles, 4-ton lots minimum, £21 10s.; tees, £22 10s.; joists, 4-ton lots minimum, £21 10s.; heavy steel rails, £21; fish-plates and sleepers, £26; ship, bridge, and tank plates, £22; boiler plates, £28 10s.; packing steel, parallels, £18 5s.; tapered, £22 10s.; convex bars, £23 2s. 6d.; common iron bars, £24; steel strip and hoops, £27 10s.; soft steel billets, £21; hard billets, £22. Export prices are not fixed, but are usually higher than the home trade quotations.

The Scrap Iron and Steel Trade.

Business continues to rule on fairly active lines in the scrap iron and steel trades, there being a consistent demand for all descriptions. Prices show a marked upward tendency. The demand for steel scrap is not quite so heavy as it has been, but the price has advanced to £8 5s. to £8 10s. per ton delivered, and a further increase is inevitable. Heavy wrought iron is finding its level, and the price is now in the region of £9 per ton f.o.r. For special forge material up to £10 5s. has been paid. The great bulk of the demand for cast iron scrap is for the Scottish trade, and the price is fully £8 12s. 6d. on rail. There is not a great local demand, most of the foundries being well stocked. The supply of turnings is quite inadequate to meet the strong demand. As much as £7 15s. is being paid for supplies delivered. There is a heavy inquiry for borings at about £7 10s. per ton delivered.

The Coal Trade.

The Northern coal trade situation displays no new or important features. All the old and vexatious restrictions of the embargo and requisitioning continue unrelieved, and the position generally remains one of extreme awkwardness and anxiety for everyone in any way connected with the shipment of either coal or coke. The openings for profitable trading with buyers in almost every European country were never more numerous or important than they are at the present time, while it is doubtful if the turnover for exports was ever so small as now, which anomaly is entirely and absolutely occasioned by the exercise of the coal control and the consequent necessity of turning down most, if not all, foreign inquiries, however desirable they might otherwise be. The output at the various collieries in both counties is very satisfactory, and gives little ground for serious complaint, while the supply of wagons and locomotives is also on fairly ample lines, but the trouble from the exporters' point of view is that much of the supply in hand is either requisitioned direct for official and Admiralty requirements or is diverted inland or coastwise for the purposes of the home trade, leaving next to nothing for exporters to handle. The volume and extent of the home market, and especially the inland manufacturing trade, is remarkably extensive, and quite overshadows and dwarfs any previous estimates or experiences, while, so far as can be seen at present, there is no sign of the demand easing off. There is in a general way a strong undertone in the forward market, and, despite the state of the famine—so far as supplies for shipment are concerned—foreign buyers are active and constant in their efforts to induce collieries to place their orders on their books, however far ahead the prospective deliveries may be placed. It must be said, however, that their results are not encouraging, as it is impossible to arrange business for forward delivery at even approximate dates, in view of the uncertainty respecting the requirements of the home market and the Coal Controller. The coke market is very strong, but in turn is suffering from an acute shortage of supplies which prevents prospective buyers from booking their orders for more than a decent proportion of their clients' requirements, while it is understood that the position is also aggravated by wholesale requisitioning of coke. A further rise has taken place in the price of gas coke, which has been repeatedly sold at as high as 125s. The principal other market quotations are as follows:—Northumberlands: Best Blyth steams, 120s.; second Blyth steams, 110s.; unscreened, 100s. to 110s.; best steam smalls, 95s. to 100s.; second smalls, 90s. to 95s.; best screened households, 120s. Durhams: Best gas, 110s. to 120s.; second gas, 100s. to 110s.; special Wear gas, 110s. to 120s.; coking, 100s. to 110s.; bunkers for British boats, 105s. to 110s.; for neutral steamers, 115s. to 120s.; best beehive foundry, patent oven, and gas coke, each 125s.

SCOTLAND

(From our own Correspondent.)

Tin in Scotland.

IT is reported that Lord Leverhulme has under consideration a report prepared for him on the discovery of deposits of surface tin and traces of other metals in the Hebrides. The tin is said to be found on part of Lord Leverhulme's estate and on other islands, as well as on parts of the Argyllshire and Ross-shire mainlands. There are also traces of lead and copper. Iron is said to be found on other islands besides Raasay, where it has been worked by a Glasgow firm for some time. It remains to be seen if the deposits have a commercial value. The discovery of tin on one of the islands is said to have been made by two scientists while on a yachting holiday. Calling at an island for ballast, they discovered tin stone traceable on the beach and on the face of a cliff. It is also said that the discoveries of Hebridean tin have aroused considerable interest in archæological circles, the theory having previously obtained that the tin used in the manufacture of Scottish bronze in prehistoric times had been imported from Cornwall. In this connection, it is noted that Scottish bronze contains a larger proportion of lead than the English bronze. Hebridean tin is said to have more than the usual proportion of lead.

Rise in Steel.

Scotch steel prices have been advanced 40s. per ton, and are now quoted as follow:—Boiler plates, £28 10s.; ship plates, ⅜in. and up, £24; ditto, under ¼in. to 3/16in., £29 10s.; ditto, under 3/16in. to ⅛in., £31; angles, £23 10s.; joists, no rebate, £23 10s.; forging blooms and slabs, £25 15s.; small flats and rounds, £26—all net delivered customer's siding or nearest railway station.

Clyde Shipping.

Many are viewing with regret and not a little concern the continued reduction in the number of Clyde-owned boats, and the ultimate effect on Glasgow as a shipping centre. A number of the better-known Glasgow coast and channel line firms have already sold out, and it is understood that negotiations are in progress for the acquisition of the remaining interests. The large ocean-going concerns are not affected so far, but the great reduction in individual ownership on the Clyde is much deplored. Many Clyde fleets have passed into the hands of large combines whose future intentions are still wrapped in obscurity.

Pig Iron.

Supplies of Scotch pig iron are becoming more stringent than ever, and makers have to discriminate between orders. No. 1 foundry is particularly scarce, and though practically nothing is being done for export, prices continue to advance and are now on the level of £14 for No. 1 and £13 15s. for No. 3 foundry per ton, f.o.b. Glasgow.

Finished Iron and Steel.

There is no change in the Scotch steel and iron trades. The demand is as keen as ever, despite ever-increasing values, and makers are overwhelmed with orders. Little impression is being made on arrears of deliveries, and consequently many works are not accepting any fresh business, deliveries being impossible under three or six months. Those works depending on imports of semi-finished material are feeling the strain most acutely, and even those which manufacture their own are finding difficulty in arranging for sufficient raw material to meet requirements. As already mentioned, steel prices have advanced 40s. per ton, while black steel sheets are £3 10s. dearer. The galvanised article has reached a very great height, as much as £60 per ton having been paid recently. Bar iron is affected by the general rise. Business is still confined to home requirements, little or nothing being done in the export line. Engineering firms are very busy, and shipyards also are working as fully as supplies of material will allow.

Coal.

The scarcity of Scotch fuel is still very acute. Some little improvement in household deliveries is reported, but there is still a long way to go before a normal supply is possible. Industrial sorts are obtained with fair regularity, but shipments of these to Irish ports have been interfered with owing to the trouble with the Belfast dockers, the men at the Ayrshire ports refusing to handle consignments so long as there is trouble at the first-named port. Fifeshire collieries are doing a fair business with Holland, but clearances generally are coastwise, with a moderate allied turnover. Shipments for the week amounted to 120,512 tons, against 130,686 tons in the preceding week, and 115,272 tons in the same week last year. Export prices are practically unchanged, as follows:—F.o.b. Glasgow: Ell coal, allied 68s. 6d. to 70s., neutral 85s. to 87s. 6d.; splint coal, 70s. to 72s. and 85s. to 90s.; steam coal, 68s. 6d. and 83s. F.o.b. Methil or Burntisland: Screened navigation, allied 68s. to 70s., neutral 100s. to 105s.; unscreened navigation, 65s. to 66s. and 92s. 6d. to 95s.; first-class steams, 70s. and 105s.; third-class steams, 66s. and 85s. F.o.b. Leith: Best steams, allied 68s. 6d., neutral 100s.; secondary steams, 67s. 6d. and 95s.; screened bunker, 67s. and 101s. 6d.; unscreened bunker, 66s. and 99s.

WALES AND ADJOINING COUNTIES

(From our own Correspondent.)

The Coal Trade.

ALL engaged in the coal trade, but more especially on its commercial side, have sufficient to occupy their minds at the present time. The export trade is virtually in a state of suspense, colliery companies and exporters are getting more and more behind in their contracts owing to home demands, there are rumours of a return to limited coal prices and freight rates for France and Italy, and we now have the miners entering on the final phase of their activities to compel the Government to nationalise the coal mines. Such a combination of adverse conditions and their influence can scarcely be imagined by those who are not actually in the business. It is true that difficult times have before prevailed, and that fact helps members of the trade to regard the present situation philosophically; but for all that it is doubtful whether the conditions were ever more deadening in their effect upon business than they are at the present time. The attitude and decision of the South Wales miners in voting in favour of direct action naturally means that the authorities will be more determined than ever in seeing to it that domestic and industrial needs at home are fully met; but quite apart from that, the question which was on every exporter's tongue, viz., how long is coal for export to be held up, was met by the

District Coal and Coke Supplies Committee for South Wales towards the end of last week, when that body communicated with the various colliery undertakings, informing them that for the ensuing four to six weeks large quantities of coal would be required per week for inland consumption, both coastwise and by rail; that allocations had already been made as far as railway coal was concerned; and that allocations were being made for house coal. The Committee pointed out that the whole of these allocations must take preference over exports, and any failure by a colliery company to comply immediately with such allocations would necessitate the suspension of its shipments. The fact that the authorities require heavy quantities of coal for home use during the next month or more means that there can be no improvement of any account in export business until well after Easter, by which time many things may have happened in the labour world.

Miners and Nationalisation.

The adjourned delegate conference of the South Wales Miners' Federation took place on Monday, when, as expected, the decision favoured direct action on the question of nationalisation. The card vote showed a majority of 2877 out of a total vote of 3487 for a general strike, there being 610 for political action. This voting expressed in membership of the Federation means a total of 174,350 for a strike and 30,500 for political action. How far this voting really represents the coalfield of South Wales it is difficult to say, but it may be added that the delegates, while authorised by the various lodges as to how they were to vote, do not always fully interpret the opinions of the members, and in this case it should be made clear that there has been no ballot of the miners on the question of direct action. The conference also discussed a report from the Executive Committee regarding the negotiations with the Government respecting a reduction in the price of industrial coal, or in the alternative an increase in wages. The conference resolved that at the Miners' Federation of Great Britain conference local delegates should press for an application for an immediate all-round increase of £2 per week. The voting was 2139 in favour of the demand and 2064 against, so that the majority was only 75. The argument of many of the delegates was that if the price of domestic coal could be reduced so also could the price of industrial coal, but as long as the latter ruled high so the cost of all commodities must keep high. While, however, the delegates are out for more money and more control of the industry, they were not in favour of increasing contributions to their own organisation. The Miners' Federa- of Great Britain conference in January recommended that members' contributions to Federation funds should be increased to 1s. per week or 4s. per month, but the South Wales conference declined to adopt this recommendation.

Steel Trade Idleness.

The outlook has improved a little since last week in respect of the strike in the steel trade, but the men are not yet back at work, and altogether it is computed that about 65,000 men are idle. The men in the first place ignored the advice of their leaders that they should tender twenty-eight days' notice. They preferred to "down tools" at once, although the men's executive sent a telegram to the Employers' Association stating that "instructions have been given to our members to tender twenty-eight days' notice." Last Friday the men agreed to resume work conditional upon the employers regarding the notices as operating from the time that the executive sent their telegram, which amounted practically to a week out of the twenty-eight days having expired. The employers, however, refused to recognise the telegram as a good notice, as none of the members of the Association had received notices from their employees. On Monday the workmen persisted in the attitude they had taken up and decided to wait by deputation on the various employers. Some of these deputations waited on individual employers on Tuesday, but so far employers decline to act separately and will only act together as an Association.

Dock Strike Ended.

The strike last week of the coal trimmers at Port Talbot, as the result of which coal loading operations were held up, did not last very long. The men came out on Thursday, but decided to resume on the Friday night. Short-lived as it was, a very important principle was involved. Some months ago the employers made application for an increase in the number of trimmers on the register so that the work could be coped with, but the trimmers were opposed to this course until just recently, when they suggested that an additional ten men shoud be registered, bringing the number to 120. The Port Talbot Trimming Board agreement expressly states that the Board has the right to engage, control, and discharge trimmers, but in the case in dispute the trimmers stipulated that their own working committee should nominate and engage trimmers. The employers' representatives on the Board objected, the result being that the trimmers went out on strike, but the trouble came to an end on the Friday, the name of the proposed new trimmer being submitted to the Board and approved in the proper way.

Current Business.

The conditions now prevailing on the coal market are practically unchanged as compared with what they were a week ago, although the longer they prevail the more pronounced becomes the effect and the more difficult will it be to straighten out matters and return to a normal state. Home supplies are heavy both by rail inland and by steamship coastwise, after which bunkering coals are in great demand, and British coaling depôts receive consideration; but foreign exports come last, the result being that next to nothing is being exported. Here and there inferior smalls and throughs are released and occasionally a little dry large, but the quantities are negligible. Nominally prices are unchanged from 110s. to 120s. for large, 100s. to 105s. for through, and 85s. to 95s. for smalls, but business is almost at a standstill. The authorities will not release any bituminous or semi-bituminous coals, and consequently exporters have to look on and chartered tonnage has to wait until such time as owners can cancel charters. It is frequent for vessels to wait a fortnight or more for supplies, and in spite of the large number of steamers which have been "directed" by the Ministry of Shipping and have left in ballast, the supplies of tonnage at South Wales ports are unusually heavy. The congestion is very acute, and the general feeling prevailing is that the conditions will not improve until shipowners, coalowners, and others in the business are permitted to manage their own affairs. Patent fuel is a firm market, the demand for this commodity being great, as there is no difficulty in getting it released for export; but makers are full up with orders for the next two months or more, the nominal price being 115s. to 120s. Coke is scarce and rules about 155s. to 160s., while pitwood is rather on the easy side at about 85s.

Newport.

The market is firm, but business for export is very quiet, as Monmouthshire coals are very largely allocated for home consumption.

Swansea.

The tone of the anthracite market is unchanged and is firm. Colliery salesmen are very fully sold for some weeks, the result being that business is on a very limited scale.

Latest News from the Provinces.

THE MIDLANDS AND STAFFORDSHIRE.

Advanced Iron Prices.

THE Derbyshire pig iron makers have this week decided upon a definite advance in forge and foundry iron of 5s. per ton as from March 1st, sales made in the meantime having been subject to price adjustment as decided by the associated makers. The Staffordshire manufacturers of iron tube strip announce an advance of £2 per ton, bringing quotations up to £27 10s. Bars and other descriptions of manufactured iron are definitely expected to be advanced before the end of the week.

Ironfounders' Wages.

Staffordshire and Midland master ironfounders received with undisguised opposition the report this week that the Scottish ironmoulders have lodged a demand for wages throughout the country to be brought up to the same level as those in Glasgow.

SHEFFIELD.

Iron, Steel, and Coal.

Quotations of iron and steel have risen here again all round this week. Derbyshire iron prices have been withdrawn, and new figures are about to come into operation. At the moment of writing they are not officially fixed, but it is understood the advance will be from 12s. 6d. to 15s. per ton. Hematite irons have risen by 40s., making the delivered prices £12 8s. 6d. for East Coast and £13 10s. for West Coast. All locally made steel billets are 30s. up, Bessemer acid being now £24 5s. and Siemens £24 15s. per ton delivered. Wire rods and most finished steel have been advanced by 30s. Regarding fuel, in spite of the suspension of exports and the fact that production is being kept at a fairly good level, no very great impression seems to have been made upon the volume of supplies to inland works, and little has been possible in the building up of reserves. Railways are receiving more, but the quantity stacked on the ground is not what it should be. Slacks are in particularly short supply. There is no material change in the position of house coal supplies. Best South Yorkshire steam hards are quoted at 29s. to 29s. 6d.; best Derbyshire, 28s. 6d. to 29s.; seconds, 27s. 6d. to 28s.; cobbles and nuts, ditto; washed smalls, 24s. 6d. to 26s.; best hard slacks, 24s. 3d. to 24s. 9d.; seconds, 23s. 9d. to 24s. 3d.; soft nutty, 23s. 6d. to 24s.; peas, 22s. to 22s. 6d.; and small slacks, 19s. to 20s. Blast-furnace coke is at 58s. 6d. per ton on rail at ovens, but no export business appears to be passing. For house sorts branch is still quoted at 33s. to 33s. 6d. and best Silkstone at 29s. 6d. to 30s. 6d. per ton at pits.

WALES AND ADJOINING COUNTIES.

Coal Production.

Mr. J. W. Beynon has been elected Chairman of the Monmouthshire and South Wales Coalowners' Association for the ensuing year. Details of the output of the members' collieries for the year ending December 31st last and the quantity assured during the ensuing year are as follow:—Cardiff: Output, 27,567,633 tons; assurance, 30,563,148 tons. Newport: Output, 9,395,389 tons; assurance, 9,641,607 tons. Swansea: Output, 4,413,317 tons; assurance, 4,698,585 tons. Total output, 41,376,339 tons; total assurance, 44,903,340 tons. The total increase in output is 246,888 tons, or .6 per cent., and the decrease in the assured quantity 258,724 tons, or .57 per cent.

Tin-plates, &c.

The tin-plate trade is badly disorganised as the result of the continued strike of the steel workers. The reduction in production and the keen demand for supplies are responsible for enhanced prices of tin-plates, which on the basis of 20 × 14 × 112 sheets are quoted about 77s. to 80s. Other quotations are: Block tin, £372 cash, £376 5s. three months; copper, £105 15s. cash, £109 three months; Spanish lead, £50 5s. cash, £53 three months; spelter, £54 cash and £57 10s. three months.

THE INSTITUTION OF CIVIL ENGINEERS.

OCTOBER EXAMINATIONS, 1919, PASS LIST.

PRELIMINARY (45).

W. F. Alderton, N. P. Angus, J. G. Barrett, J. H. Barton, H. S. Boyes, S. A. Bradfield, H. Burleigh, A. Carstairs, A. F. C. Churchyard, H. F. Cornick, M.C., J. H. C. Crawford, F. M. Daniel, A. W. Eeclestone, J. L. Edwards, C. W. Foxley, E. D. Grubb, E. P. Hall, P. Hamilton, G. Harley, B. F. J. Johnson, A. E. Kidner, W. A. Laing, R. M. Lawrence, D. C. Luck, W. J. McLean, J. E. W. Monkhouse, J. T. Morris, A. Nicol, G. Neilson, G. H. Parkinson, V. H. B. Peart, E. A. Phillipson, J. H. M. Richards, S. J. Ricketts, S. Rouse, F. G. Rule, J. I. A. Scribante, D. Seed, W. G. Sides, T. H. Stanton, S. Sweeney, T. H. Tandy, T. Watson, M.C., T. H. Webster, P. J. Wells.

ASSOCIATE MEMBERSHIP (53).

Whole Examination (Sections A, B, and C) (8).—J. Anderson, G. H. Bradshaw, W. F. de Penning, B. Hodgkinson, W. H. C. Howe, R. J. Mitchell, C. H. Old, G. A. V. Russell.

Sections A and B only (14).—A. G. Chatterji, L. E. Edwards, E. C. Fowle, D. M. Gibson, E. Harwood, H. L. Milner, C. F. MacGuire, L. V. Pereira, R. E. Ponsonby, B. V. N. Rao, E. T. Roch, R. Shaw, W. F. Slater, G. Stanley.

Sections B and C only (1) (*Section A passed previously*).—W. J. H. Rennie.

Section A only (21).—W. Aiston, T. H. Bryce, J. P. Candy, M. L. Cobb, H. Eccles, W. C. Evans, F. Ewbank, J. D. Farmer, P. A. Foy, J. B. Glass, G. B. Hardy, L. C. Hose, F. L. James, N. W. King, M.C., E. C. Lightbody, J. V. Lord, G. S. Paterson, N. E. L. Pearse, S. B. Reid, F. W. E. Vanstone, T. H. Watson.

Section B only (8) (*Section A passed previously*).—S. M. A. Bilgrami, G. P. Bridges, W. G. R. Crow, C. E. Fox, E. Gibson, H. W. Hanauer, J. Marshall, W. L. Morrison.

Section C only (1).—H. H. Burness, B.Sc. (St. Andrews).

The foregoing list includes the results of examinations held in India and the Colonies.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

HENRY BERRY AND CO., Limited, of Croydon Works, Leeds, have opened a London office at No. 38, Victoria-street, Westminster, S.W. 1, under the management of Messrs. W. A. Walber and Co.

THE GENERAL ELECTRIC COMPANY, Limited, has undertaken the sole agency in this country for the "H. and H." Hart rotary snap switches and other specialities produced by the Hart and Hegeman Manufacturing Company, of Hartford, Conn., U.S.A.

MR. A. P. TROTTER, of Messrs. Handcock, Dykes and Trotter, is retiring from the firm as from March 25th, but will continue to give attention to his special subjects in engineering and science from his new address, Greystones, Teffont, Salisbury, Wilts.

THE LONDON WARMING AND VENTILATING COMPANY, Limited, of 20, Newman-street, London, W., which equipped both of the late Captain Scott's expeditions with its heating and cooking apparatus, has received instructions to equip the forthcoming British Antarctic expedition with its "Kooksjoie" anthracite ranges adapted to oil fuel, on the new principle of the "Welcome" oil heater.

A NEW company having the style and title of Sir J. F. Payne Gallwey, Brown and Co., Limited, has acquired the interests of Payne Gallwey, Brown and Co., formerly trading at 49, Queen Victoria-street, E.C. 4. The offices of the new company are at 58, Victoria-street, S.W. 1, and the joint managing directors Sir J. F. Payne Gallwey and C. L. Brown, A.M.I.E.E. (Telephone Victoria 6560).

WE have been asked to announce that the London office of Armstrongs and Main, Limited, general and constructional engineers—an allied company of Sir W. G. Armstrong, Whitworth and Co., Limited—has been removed from 3, Blenheim-street, New Bond-street, W. 1, to Australia House, Strand, W.C. 2, to which address, on and after the 22nd instant, all communications should be addressed.

THE STANTON IRONWORKS COMPANY, Limited, near Nottingham, which is the proprietor of the Holwell Iron Company, Limited, and of James Oakes and Co., has decided to take up the manufacture of ferro-concrete pipes and is proceeding to put down large works adjoining its ironworks at Stanton for the manufacture of pipes under the Hume patents, in sizes ranging from 4in. in diameter up to 60in. diameter.

WE are requested to state that the Monmouth Shipbuilding Company, Limited, has acquired the interest of the Ministry of Shipping in the National Shipyards at Chepstow and Edward Finch and Co. (1916), Limited, as from March 3rd, and that all correspondence should therefore be addressed in future to the Monmouth Shipbuilding Company, Limited, Chepstow, Mon., and not to the National Shipyards and Edward Finch and Co. (1916), Limited, as heretofore.

CONTRACTS.—The Royal National Lifeboat Institution has placed an order with J. Samuel White and Co., Limited, East Cowes, Isle of Wight, for twelve new motor lifeboats, which have been allocated as follows:—Norfolk and Suffolk type, 46½ft. by 12ft. 9in., to Cromer; Watson type, 45ft. by 12ft. 6in., to Penlee, The Mumbles, Dunmore East, and Youghal; Watson type, 40ft. by 11ft., to Barry Dock and Tenby; self-righting type, 40ft. by 10ft. 6in., to Brixham, Selsey, and Bembridge; and self-righting type, 38ft. by 9ft. 9in., to Sennen Cove and Appledore.

CATALOGUES FOR MESOPOTAMIAN RAILWAYS.—The Comptroller-General of the Department of Overseas Trade of the Foreign Office and Board of Trade announces that information has been received in the Department to the effect that the Superintendent of Stores, Mesopotamian Railways, in order to facilitate the preparation of demands and also for his general guidance, is desirous of obtaining copies of British manufacturers' catalogues dealing with the following materials:—(*a*) Locomotives and rolling stock, standard, metre gauge, and narrow gauge; (*b*) pumps, steam and oil, all descriptions; (*c*) cars, motor rail; (*d*) permanent way material—rails, fastenings, &c.; (*e*) tanks, sectional, wrought iron, cast iron, and staging, &c., for; (*f*) machinery—workshop, repair and manufactory; (*g*) tools, heavy and light, as used on railways; (*h*) instruments, surveying, mathematical and precision; (*i*) lights, flare, high-power and ordinary; (*j*) piping, wrought iron and fittings; (*k*) hardware, general; (*l*) cranes, hand and power, stationary and travelling, all purposes; (*m*) electrical plant and accessories, general; (*n*) engines, stationary and portable, steam and oil; and (*o*) ropeways, conveyors, elevators, &c. (labour-saving devices generally). An advice to the Department of any action taken with regard to this matter would also be appreciated.

French Engineering Notes.

(From our Correspondent in Paris.)

The Railwaymen's Strike.

AFTER lasting barely four days, the railwaymen's strike collapsed in a manner that emphasised again the difficulty of even the most powerful labour organisation succeeding in a struggle which suspends the vital forces of the nation. The strike was in no way premeditated, and was not officially authorised by the men's federation. It was started by the secretary of a local branch of the union over a question of discipline, and it spread with remarkable rapidity, thereby showing that there is a good deal of discipline amongst the men themselves, although they object to it when imposed by the companies. Nevertheless, the discipline was far from being general, since very few men went out on the Northern Railway, the services of which were practically normal throughout the strike. On the other hand, the number of men returning to work showed that the strike was not popular, for the reason that the cloven hoof of politics was too plainly discernible, and the energetic action of the Government made it clear that no interference with those who desired to work would be tolerated. After the first two days a certain number of trains were running with the aid of the companies' engineers and of students from the engineering schools and others, while thousands of men of all categories volunteered to give their services if necessary. The railwaymen were made to feel the hostility of the public by the refusal of tradespeople in several towns to serve the strikers until they returned to work. This boycotting of the railwaymen was as effective as anything else in breaking the strike, and when the Government mobilised the railwaymen the Federation promptly accepted to submit the matter in dispute to arbitration after the men had resumed their duties. Of the long list of claims made out by the union as an afterthought to justify the strike, not one of any importance was conceded. Nevertheless, it must be admitted that the strike has left an aftermath of agitation which has extended to other industries.

Advancing Prices.

The recent railway trouble has given another impetus to the upward movement in prices for all kinds of material. It occurred at a moment when producers were already suffering from a severe shortage of fuel, and the strike offered a pretext for further putting up prices, which are now reaching a level that makes the situation extremely precarious for consumers. Cokes have advanced from 160f. to 220f. a ton, and the Longwy pig iron producers are credited with the intention of raising the price of crude iron from 450f. to 525f. a ton. The outlook is so precarious that blast-furnace proprietors will not quote for future deliveries. For the same reason, sheets are expected to advance a further 150f. a ton. Of this material there is a great shortage, and the scarcity of sheets and plates is seriously interfering with urgent work in the locomotive shops and shipbuilding yards.

Industrial Difficulties.

There are so many factors operating against an industrial recovery that the future is fraught with some danger unless something is done speedily to bring about an adjustment of the various conflicting elements. The fall in the exchange rate has been accentuated to such an extent the last few days that there appears little hope of anything being done to prevent a collapse except by some international agreement. It was expected that the deliberations of the London Conference would have resulted in something tangible, whereby France would have been assured of credits, and until a satisfactory working arrangement is come to between the different countries it is feared that the depreciated exchange will impose increasing burdens and render it more and more difficult to secure industrial stability. Nevertheless, there is still hope of the London Conference arriving at a solution which is necessary for the prosperity of all the countries concerned. Meanwhile, there is plenty of work if only the conditions were favourable to its being executed under satisfactory conditions. The work of reconstruction in the devastated regions is proceeding very slowly, since the financial situation precludes the giving out of extensive contracts, and the great majority of the huge public undertakings which ought by now to have been put in hand are held in abeyance. Any immediate recovery can now only depend upon the success of the national loan. If the public respond readily to the appeal, the Government will be in a position to carry out much of the work that it is obliged for the moment to withhold, and it is presumed that the improvement in the country's financial situation, following upon the public contribution to the Treasury, will result in a rise in the exchange rate, which will inspire confidence in a commercial and industrial recovery.

Export Problems.

The advance of 115 per cent. in the railway charges for goods has necessarily helped to increase productive costs, and it has also had the effect of placing another obstacle in the way of developing an export trade which the Government is anxious to encourage, with a view of improving the situation abroad. The new rates are so obviously detrimental to firms which do a foreign business that a reduction of 10 per cent. is now accorded on the railway charges for the transport of goods for export, but the concession is quite insufficient to counterbalance the other drawbacks that stand in the way of an active export trade, of which the railway deficiencies are the most serious. The Chamber of Commerce at Lille has replied to the appeal of the Minister of Commerce for a more energetic development of export business, by pointing out that nothing can be done until the railway services are reorganised. It states that while there are considerable delays in consigning goods, it is still more difficult for manufacturers to get deliveries of material and machinery, and cited an instanceof a firm having vainly endeavoured for months past to get delivery of machinery which is lying at one of the ports.

British Patent Specifications.

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

When an abridgement 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 6d. each.

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

INTERNAL COMBUSTION ENGINES.

138,277. August 21st, 1919.—REVERSING VALVE GEAR, The North British Diesel Engine Works, Limited, South-street, Whiteinch, Glasgow, and J. C. MacCall Maclagan, 14, Park-corner, Westland-drive, Glasgow.

IN order to facilitate the longitudinal movement of a cam shaft, so as to bring either the ahead or astern cams under the valve rockers, the shaft is sometimes first moved away from the

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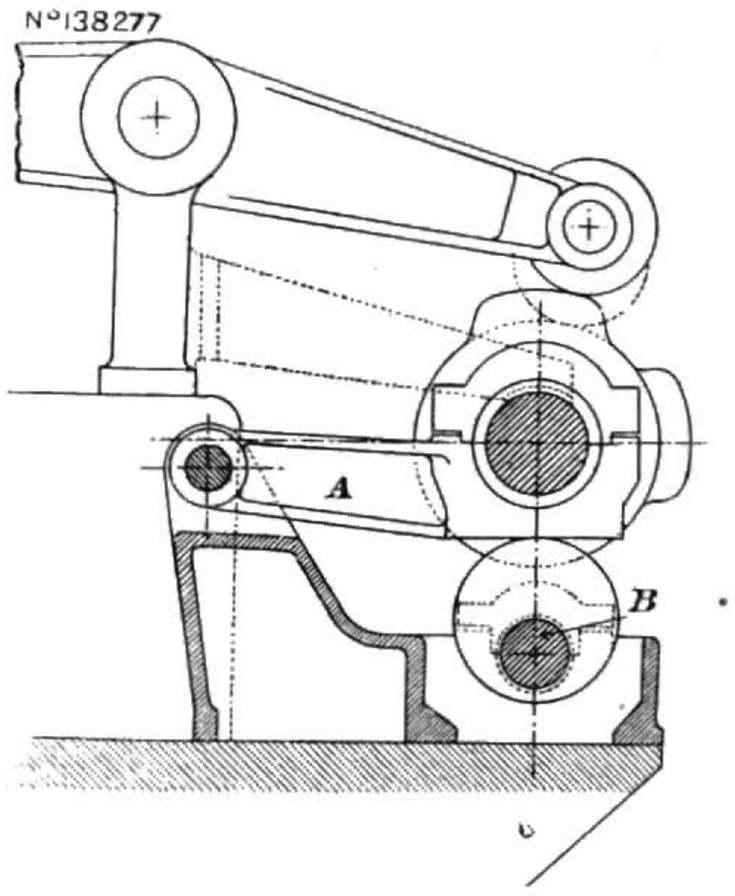

rockers. This invention has for its object a simple means of effecting this movement. The cam shaft bearings are mounted on rocking arms A, and an excentric B is used to advance or withdraw the cam shaft.—*February 5th*, 1920.

DYNAMOS AND MOTORS.

138,227. April 11th, 1919.—BRUSH-HOLDERS FOR USE WITH DYNAMO ELECTRIC MACHINES, The Electric Construction Company, Limited, Dashwood House, No. 9, New Broad-street, London, and of Bushbury Engineering Works, Wolverhampton, Stafford, and P. J. Stirrup, "Langdale," Church-lane, Oxley, Wolverhampton.

The design of brush-holder described in this specification is arranged with a ball A mounted within a recess B formed in the carrier C. This recess is exposed to the surface of the slide D, and has opposite thereto a slanting face E, as shown. The ball A is constantly pressed in a direction away from the commutator bars by a coil spring F. The ball A wedges itself between the slanting face E and the face of the slide D, both

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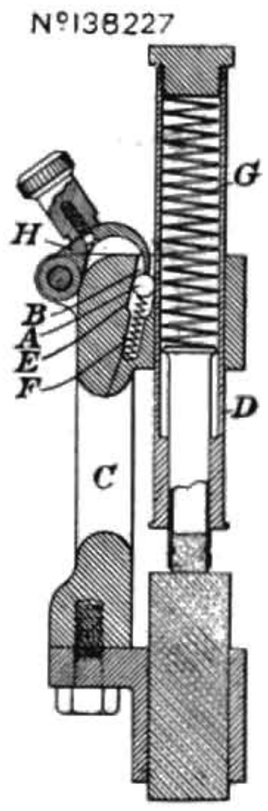

because the ball is pressed by the spring and because the slide is pressed in an outward direction through the action of the coil spring G. A pivoted claw H is provided with a suitable handle, and so positioned that when the handle is pressed the claw presses in the ball A and frees the slide D, which will then be pressed out by the action of its spring. This movement may be steadied by hand, and the slide D adjusted outwards to any desired position. The slide D can be adjusted inwards without operating the handle, because any inward movement of the slide D tends to disengage the ball.—*February 5th*, 1920.

SWITCHGEAR.

138,204. March 15th, 1919.—CONTROLLERS FOR USE WITH ELECTRIC MOTORS, R. Amberton, the Electrical Apparatus Company, Limited, of Vauxhall Works, South Lambeth-road, London.

It is the object of the present invention to provide a form of controller wherein the contact member is moved forward against the action of a spring, while a no-voltage release operates normally to hold a pawl in action to prevent return of the switch by the spring until the switch is positively moved back or until a no-voltage or overload condition occurs. The illustrations show a shunt and series regulator provided with a no-volt release device, according to this invention. Around the spindle of the switch arm A is disposed a spring drum B formed with ratchet teeth C at its edges. D is the no-volt release, provided with an armature, which is held up, drawing up in turn a lever E pivoted on the base. This lever carries a spring-pressed pawl G, which in the position shown engages with the ratchet teeth C of the spring drum B. The pawl G has a tail piece F, which limits its turning movement, and when the no-volt release

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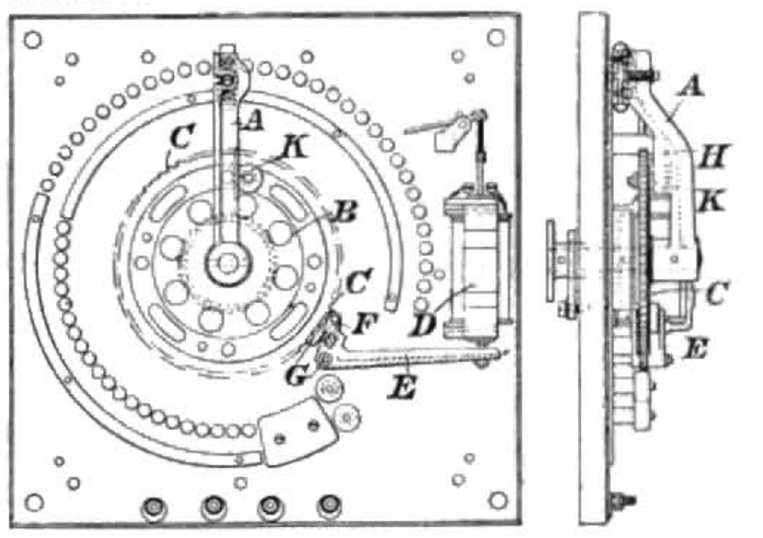

operates, allowing the lever E to fall, the pawl G is disengaged from the ratchet teeth C. The switch arm has a downward projecting lug H, which is adapted to strike against a roller K on the drum. As the arm is moved in a clockwise direction it must carry round the drum with it, winding up the usual spring in the drum. The arm can be moved backwards from any position, leaving the spring drum where it was, but in whatever position the arm may be left, when the no-volt release operates, the spring drum will fly backwards, and the roller K, striking against the lug H on the arm, turns it back to the starting position, where it is stopped by the usual stops. An arrangement is also described in the specification which secures that the sliding brush will always lie correctly in position on each stud.—*February 5th*, 1920.

138,246. May 17th, 1919.—ELECTRICAL SWITCHES, A. P. Lundberg, G. C. Lundberg, P. A. Lundberg, and G. Pegg, all of Pioneer Electrical Works, 477 to 489, Liverpool-road, Holloway, Middlesex.

The switch actuating device described in this specification actuates a tumbler switch to and from its "on" or "off" position by the rectilineal movement of an operating member, the first pull on which effects the first movement and the next pull produces the second movement. The pin A lies at one end of the slot B and engages, say, the depression C; when a pull is exerted on the slide bar D the pull is transmitted through the

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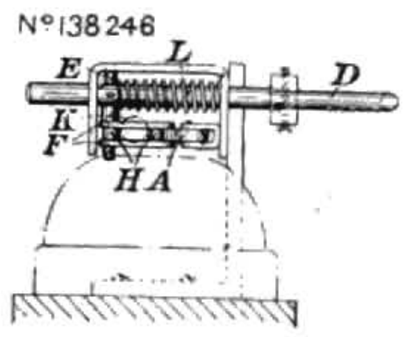

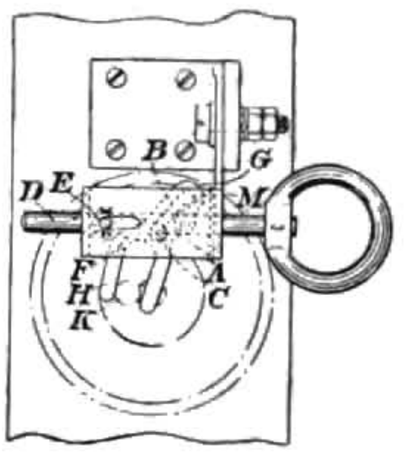

pin E to the links F, which press through the pin A on the member G. This member is caused to turn on its pin and actuate, through the forked or Y-shaped extension H, the actuating lever K. When the pull on the slide bar D is relieved, the spring L returns this bar to its normal position, and the return movement causes the pin E to travel along the slot B and to enter the depression M. The parts are then in position to actuate the switch when a pull is again exerted on the slide bar. —*February 5th*, 1920.

MINES AND METALS.

138,304. November 20th, 1919.—ROCK DRILLS, G. H. T. Rayner, Grange Farm House, Carter Knowle-road, Abbeydale, and P. Rayner, 38, Chantrey-road, Woodseats, Sheffield.

The peculiarity in this rock drill lies in the provision of unusually ample exhaust ports. Air is admitted at the inlet G

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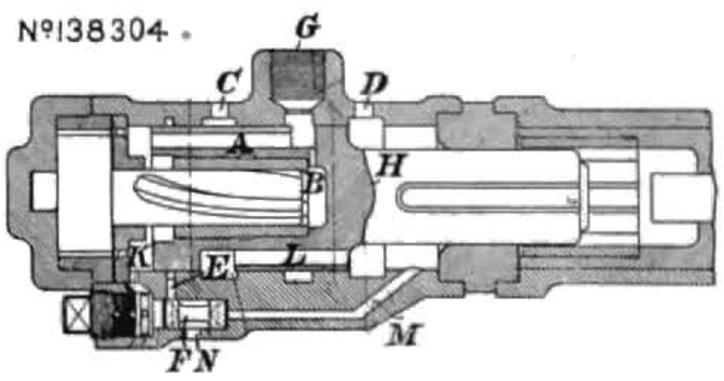

and passes to the passages A, and so to the rear end face of the piston H, thereby forcing it to the right. At the same time air passes by ports B to the hollow interior of the piston H and assists in propelling it. The incoming air also enters the passage

K and the chamber containing the valve F, which is thereupon thrown to the right. When the piston H is in the position shown it will be seen that the front of the piston is open to exhaust through the passages L, port C, and also through the port D. As the piston moves to the right the passage A is shut off from the inlet G, and the front of the piston is shut off from the exhaust port D. Simultaneously the passages L are shut off from the annular exhaust groove C. As the piston proceeds the forward ends of the passages A are put into communication with the exhaust port D through its annular groove. Shortly afterwards the rear ends of these passages A and the rear of the piston H are in communication with the exhaust port C through the uncovering of the annular groove. The further progress of the piston causes the mouths of passages L to coincide with air inlet groove, thereby admitting air to the front of the piston, which, besides pressing on the face of the piston, also enters the passage M and throws the valve F to the left, thereby placing the annular recess around the valve simultaneously in communication with the auxiliary exhaust passage E and the auxiliary exhaust port N. From the foregoing it will be understood that the rear of the piston H is open to exhaust by three routes D, C, and N. As the back stroke proceeds the exhaust port C is first closed, then the port D, but the auxiliary exhaust port N continues open until air is again admitted to the rear of the piston, when the valve F is thrown to the right. In this way an adequate exhaust is provided, so that no premature cushioning of air occurs on the back stroke, and consequently a full length forward stroke is obtained.—*February 5th*, 1920.

TRANSMISSION OF POWER.

138,257. June 11th, 1919.—ELECTRIC INSULATORS, H. Lutz, Turin-via Arsenale 17, Italy.

The present invention relates to an electric insulator comprising two metal cup-shape conducting members arranged in reversible positions with a gap between their mouth edges, and separated from one another by an interposed insulating piece. The insulator consists of a spindle A, with threaded ends and of insulating material, which may be surrounded by a tube B of porcelain or other insulating material, and two caps C C of cylindrical or other form, which may be of metal or other strong substance. The caps have parts that are screw-threaded and attached in reverse positions on the ends of the insulating spindle in such a way that one cap enters within the other. The space between the tube B, when used, and the spindle A

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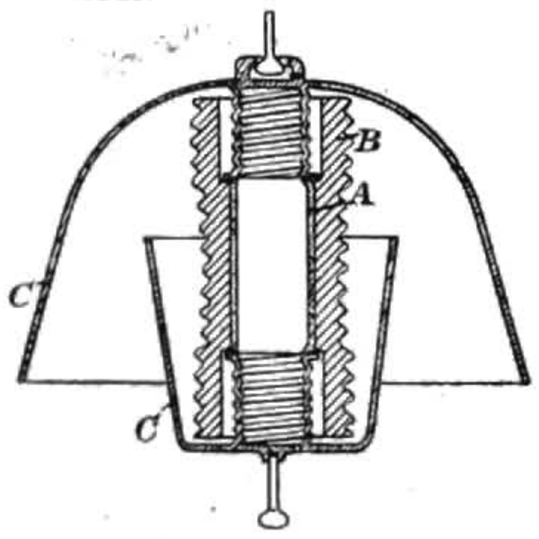

is hermetically closed by means of packing between the tube and the screw-threaded portions of spindle A. For very high tension this space may be filled with insulating substances to prevent arcing between the two caps along the spindle and across the space. The purport of the tube B is to increase the distance between the screw-threaded parts of the two caps along the external surface of the insulating tube. For cases of low tension the tube B may be omitted. The caps C protect the insulating parts against rain, injury by stones, and sudden discharges which occur at excessive tension between the caps. The caps also tend to diminish the so-called silent discharges, which in time injure the surfaces of the insulators, since the greatest electrostatic effect is between the two caps. Other arrangements of the insulator are described in the specification.—*February 5th*, 1920.

MACHINE TOOLS AND SHOP APPLIANCES.

138,252. May 28th, 1919.—STUDS OR SPIGOTS FOR CHANGE WHEELS OF LATHES, G. L. Norman, Basinghurst, Nightingale-road, Guildford, and A. Drummond, Ryde's Hill, near Guildford.

This invention relates to the studs or spigots employed in lathes for the purpose of mounting the change-speed gear wheels, and has for its chief object to provide a simple and easily applied

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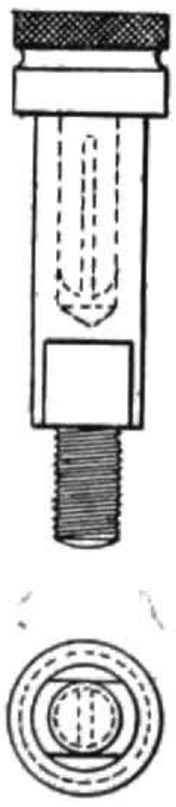

device to take the place of the usual nut secured on the end of the spigot to retain the wheel. The spigot is formed with a longitudinal hole extending for a substantial distance from its end and a split pin with a head is pushed into the hole and held therein by the spreading force of the split portion, which is arranged to spring out slightly. It is found that the pressure exerted by the split pin against the wall of the hole is sufficient to hold the pin in place against such side pressures as are likely to occur.—*February 5th*, 1920.

MEASURING AND TESTING INSTRUMENTS.

138,240. May 10th, 1919.—MICROMETERS, R. O. C. Hurst, 233, Bellingham-road, Catford, London, S.E. 6.

For the purpose of compensating the wear of the measuring screw in micrometers the female thread is cut in a tapered split bush, and arrangements made for screwing the bush into a tapered hole. In order to provide a zero adjustment for use

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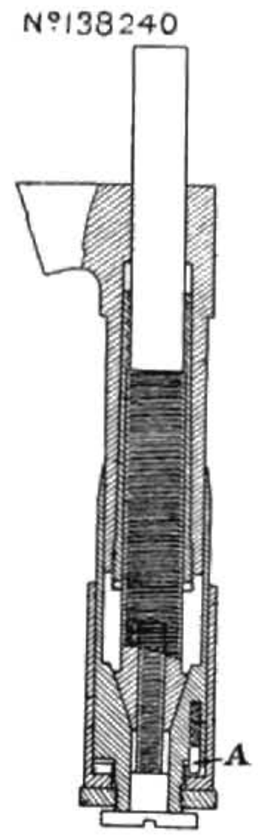

after compensating wear of the screw, the graduated thimble is attached to the stem of the measuring screw by means of a tapered joint, as shown. The thimble is made in two parts, and the usual ratchet stop A introduced between the two parts.—*February 5th*, 1920.

MISCELLANEOUS.

138,292. September 26th, 1919.—DRAINING AIR PIPES, J. E. L. Ogden, Penshurst, Lincoln-drive, Liscard, Cheshire.

This device is a trap for draining water out of air or gas pipes, where condensation of the vapour cannot be depended on to work the apparatus. The trap is much the same as the open bucket type sometimes used for draining steam pipes, with the addition

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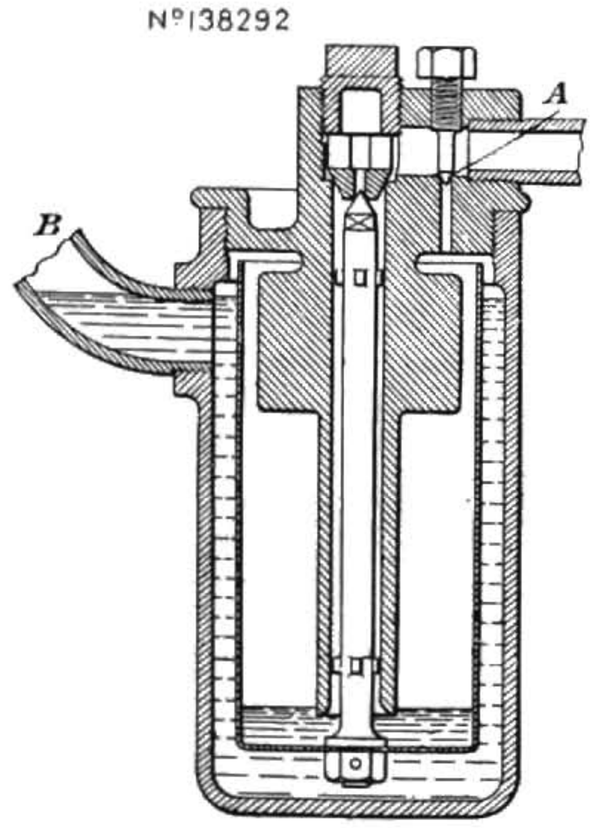

of a small leakage vent A. The inlet B is arranged below the lip of the bucket, and thus forms a seal between the air main and the leak A when the trap is full. The leak reduces the air pressure above the water in the trap, which then rises over the lip of the bucket and is discharged in the usual manner.—*February 5th*, 1920.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Over 400 members and guests attended the annual dinner of the Institution of Electrical Engineers held at the Connaught Rooms on Thursday last, the 4th inst. Appropriate greetings were received from the sister society in America and the Italian Electro-Technical Association. The chair was occupied by the President, Mr. Roger T. Smith, and among the guests were General Sir C. F. N. Macready, the Dean of Westminster, Rear-Admiral Sir W. C. M. Nicholson, Sir Gregory Foster (Provost of University College, London), Major-General G. D. Jeffreys, Lieut.-Colonel Sir F. Younghusband (President, the Royal Geographical Society), Sir Charles Parsons, Professor W. H. Bragg, Sir Frank Heath (Secretary of the Department of Scientific and Industrial Research), Captain H. Riall Sankey, and Messrs. W. H. Booth, W. W. Lackie, and A. Page (Electricity Commissioners). The President, in responding to the toast of the evening, proposed by Sir Gregory Foster, said that the Institution would have this month a membership of 8800—a greater membership than any other engineering institution in the United Kingdom. Next year it would celebrate its fiftieth birthday, and that event, coupled with its great membership, ought to stimulate members to determine that the education of engineers and research workers should go forward in order to produce the best results. The greatest electrical event during the present session was the passing of the Electricity Supply Act, and the most important provision under that Act was the appointment of five electrical Commissioners, four of whom had been elected and three of whom were their guests that night.

Forthcoming Engagements.

TO-DAY.

PHYSICAL SOCIETY OF LONDON.—Imperial College of Science, Imperial Institute-road, South Kensington, S.W. Papers: (1) "The Absorption of Gases in a Discharge Tube," by Mr. F. W. Newman; (2) "A Directional Hot-wire Anemometer of High Sensitivity, especially Applicable to the Investigation of Slow Rates of Flow of Gases," by Mr. J. S. G. Thomas. Dr. Hans Pettersen will exhibit a new micro-balance. 5 p.m.

THURSDAY AND FRIDAY, MARCH 11TH AND 12TH.

INSTITUTE OF METALS.—Institution of Mechanical Engineers, Storey's Gate, St. James' Park, S.W. 1. Annual general meeting. 4 p.m. and 10.30 a.m.

FRIDAY, MARCH 12TH.

UNIVERSITY OF LONDON ENGINEERING SOCIETY.—University College, Gower-street, W.C. 1. Annual public meeting. Address on "Coal Conservation," by Sir Dugald Clerk, F.R.S. 5.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Lecturette: "Chain Helice Pumps," by Mr. F. A. Simpson. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse on "String Figures," by Mr. W. W. Rouse Ball. 9 p.m.

SATURDAY, MARCH 13TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. "Positive Rays," IV., by Professor Sir J. J. Thomson. 3 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—Grand Hotel, Manchester. Paper: "Manufacturing Engineering at the Ford Motor Works," by Mr. Henry Hudson. 7 p.m.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Assembly Room, Cycling Club, Keighley. "Nitrogen and its Uses," by Dr. A. Bramley. 6.30 p.m.

TUESDAY, MARCH 16TH.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.—House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. Paper: "Plant Used in the Rotary System of Drilling Oil Wells," by Mr. Maurice A. Ockenden and Mr. Ashley Carter. 5.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Lantern Exhibition of Views taken throughout the War Areas in France and Flanders, by Sir Alexander B. W. Kennedy. 5.30 p.m.

WEDNESDAY, MARCH 17TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "Street Passenger Transport of London," by Mr. W. Worby Beaumont. 4.30 p.m.

LIVERPOOL ENGINEERING SOCIETY.—Royal Institution, Colquitt-street, Liverpool. "Bricks and Brickmaking from a Geological Standpoint," by Professor P. G. H. Boswell. 8 p.m.

ROYAL METEOROLOGICAL SOCIETY.—Rooms of the Royal Astronomical Society, Burlington House, Piccadilly, W. 1. Lecture: "Clouds as seen from an Aeroplane," by Captain C. K. M. Douglas. 5 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Sectional Meeting).—Institution of Civil Engineers, Great George-street, Westminster, S.W. 1. "Duplex Wireless Telephony: Some Experiments on its Application to Aircraft," by Captain P. P. Eckersley. 6 p.m.

THURSDAY, MARCH 18TH.

INSTITUTION OF MINING AND METALLURGY.—Rooms, Geological Society, Burlington House, Piccadilly, W. 1. Paper to be submitted for discussion: "Tin and Tungsten Deposits: The Economic Significance of their Relative Temperatures of Formation," by Mr. William R. Jones. Lantern. 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Institution of Civil Engineers, Great George-street, Westminster, S.W. 1. Adjourned discussion on the following papers: "Notes on Operating a By-product Producer Gas Plant for Power and Heating," by Mr. W. H. Patchell; "Production of Power from Blast-furnace Gas," by Mr. S. H. Fowles. 6 p.m.

FRIDAY, MARCH 19TH.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, Westminster, S.W. 1. "Shipbuilding and Shipping Developments in Italy," by Mr. W. H. F. Robba. 8 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse: "Leonardo da Vinci," by Mr. Edward McCurdy. 9 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, St. James' Park, S.W. 1. Paper: "Exact Data on the Performance of Mechanical Stokers as applied to Lancashire or other Narrow-flued Boilers," by Mr. David Brownlie. 6 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. Indian Section. "The Indian Currency System and its Developments," by Sir William S. Meyer. 4.30 p.m.

ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.—Bothwell-street, Glasgow. "Oil Tankers," by Mr. C. R. H. Bonn. 8 p.m.

ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.—Applied Science Department, Sheffield University, Sheffield. "Some Steam Economies," by Mr. Gilbert Rowe. 7.30 p.m.

SATURDAY, MARCH 20TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—National Physical Laboratory, Teddington. Visit to N.P.L. 2.45 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. "Positive Rays," V., by Professor Sir J. J. Thomson. 3 p.m.

MONDAY, MARCH 22ND.

INSTITUTE OF TRANSPORT.—Lecture Theatre, Institution of Civil Engineers, Great George-street, S.W. 1. Opening meeting, presidential address by Sir Eric Geddes. 8 p.m. (Postponed from March 15th.)

TUESDAY, MARCH 23RD.

THE ENGINEERS' CLUB.—Manchester. Annual general meeting. 4.30 p.m.

WEDNESDAY, MARCH 24TH.

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

WEDNESDAY, THURSDAY, AND FRIDAY, MARCH 24TH, 25TH, AND 26TH.

INSTITUTION OF NAVAL ARCHITECTS.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Annual meetings. For programme see page 280. 11 a.m. each day.