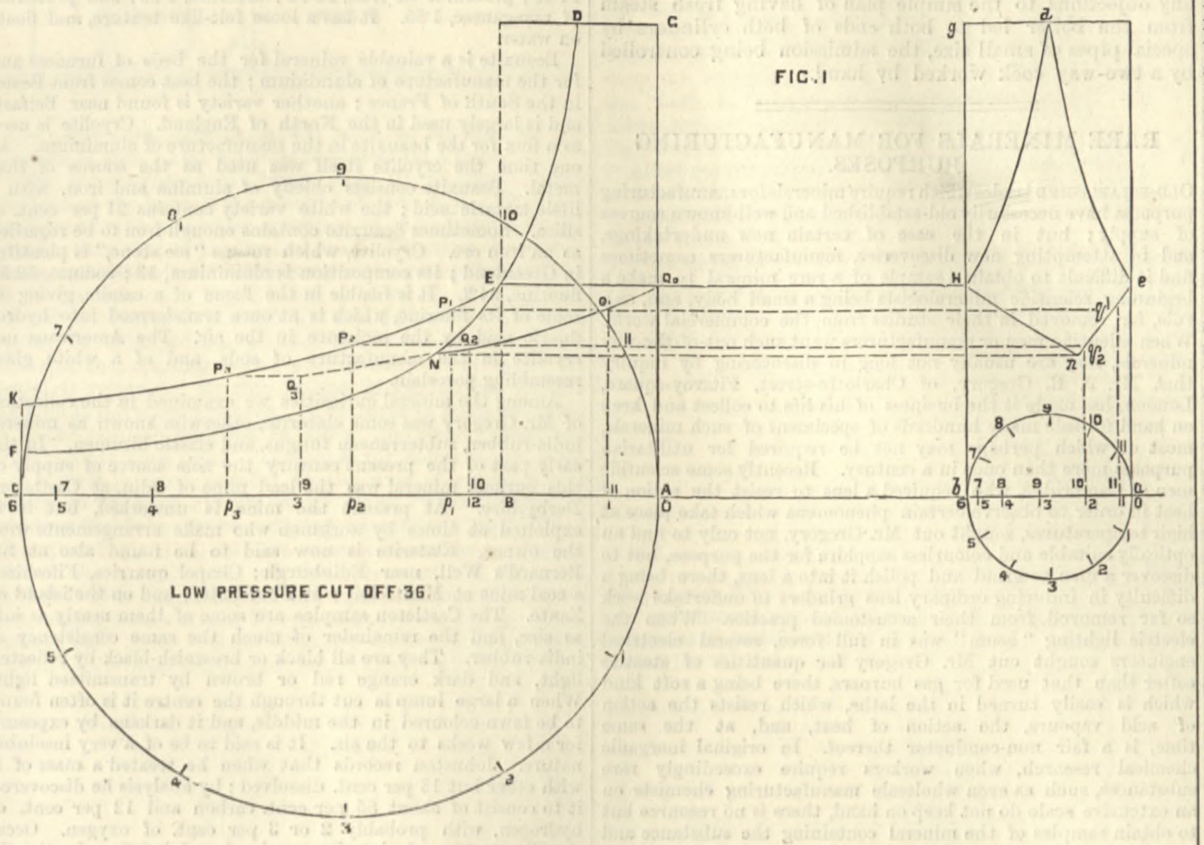
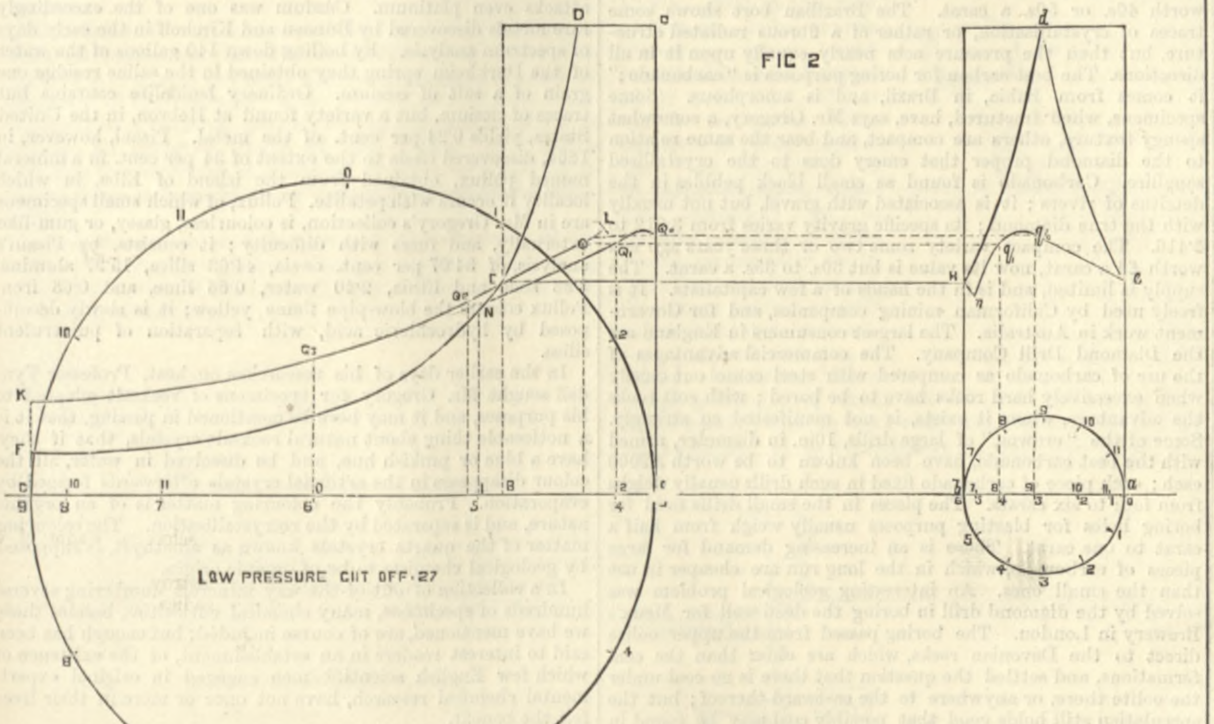
ON THE CUT-OFF IN THE LARGE CYLINDER OF COMPOUND ENGINES.

By Professor R. H. Smith.

It is well understood that for a given compound engine working under given conditions there is a certain cut-off in the low-pressure cylinder which is more advantageous than any other. The problem dealt with in this paper is to find, by graphic means, this best point of cut-off. It is sometimes said that this cut-off should be determined by the condition that equal amounts of work should be done in each cylinder. A little consideration, however, must show that the ratio of the two horse-powers developed in the two cylinders can be regulated within wide limits to anything desired by suitably adjusting the ratio of the



volumes of the two cylinders. This is the natural and readiest way of accomplishing this end. It will be seen from what follows that this adjustment cannot be effected without reference to other points, among which falls the low-pressure cut-off. For given relative cylinder and intermediate chamber volumes, no doubt the distribution of power between the cylinders depends on the cut-off adopted. But the cut-off may be designed on other principles and yet the designer be left full liberty to distribute



the power as he deems best by suitably choosing the cylinder diameters. The proper distribution of power is not the subject of this article. It is assumed here that in accordance with this and other considerations, such as approach to uniformity of driving moment throughout the revolution of the crank shaft, the engineer has already fixed upon certain sizes for high-pressure and low-pressure cylinders and for intermediate chamber.

These being settled, my object here is to advance the opinion that the low-pressure cut-off should be chosen so as to ensure maximum thermo-dynamic efficiency; that is, so as to ensure getting the largest amount of mechanical work out of the heat in the steam, or, the steam being supplied under given pressure, the maximum work per lb. of steam used.

The thermo-dynamic principle involved in the present problem is that "if two quantities of steam be supplied at different pressures and densities, and if they be used for mechanical work by expanding them down to a given common exhaust pressure, then more work will be got out of them if they be prevented from mixing while they are still at different pressures and densities than can be got if they be allowed so to mix." The same principle holds for gases as well as for steam. As applied to engines, it means that the working steam or gas should not during its expansion down to the final exhaust pressure be allowed to experience any sudden drop of pressure by intermixture with other steam or gas of lower pressure. Stated in this simpler form, the principle must seem almost self-evident to the practical engineer. It is not, however, so plainly true as it appears at first sight, because it must not be forgotten that steam exhausting from the high-pressure cylinder into an intermediate chamber at lower pressure raises the steam in that chamber to a higher pressure, and thus, although it loses some of its own power of work, imparts a greater power of work to this other quantity of steam. This increased power will be certainly developed in the low-pressure cylinder. The principle enunciated affirms that the loss of work-power in the steam that loses pressure during the intermixture is greater than the gain of work-power by the steam which is raised in pressure. It is not intended to prove here the truth of the principle. It is very much easier to prove for gases than for steam, but in both cases the proof is tedious and difficult. Suffice it to say that the author has deduced it from the fundamental thermo-dynamic laws believed in by every one, and from the well known experimental facts regarding the natures of gases and of steam.

Calling, for greater shortness of expression, the intermediate receiver the "middle chest" of the engine, the pressure in this chest is continually varying. Indicator diagrams have often been taken from the middle chest which show that its pressure varies through large ranges. A pressure gauge is permanently fixed upon it in the experimental engine at the Mason College, and the finger of this gauge oscillates sometimes so violently as to risk damage to the mechanism of the gauge. In order that there should be no drop of pressure at the exhaust of the steam from the small cylinder into the middle chest, the terminal pressure in the middle chest—*i.e.*, the pressure at end of each stroke in small cylinder—must be the same as that in the small cylinder at exhaust. Before cut-off in the large cylinder the pressure in the middle chest always falls below the small cylinder exhaust pressure. After this cut-off the small piston still sweeps more exhaust steam into the chest, so as to produce compression and a rise of pressure in the chest. The end of this compression curve in the chest should stand at the same height as the end of the expansion curve in the small cylinder.

If this condition be attained there will be no loss of power by the use of two cylinders as compared with that obtained from a diagram formed by the simple extension of the expansion curve in the small cylinder. Thus, referring to Fig. 1, if A B and A C represent the volumes of the high and low-pressure cylinders; if A G be the initial pressure, D the point of cut-off, and D E the expansion curve in the small cylinder; and if this same curve D E be extended to F; then, if there be no drop at exhaust from small cylinder, the whole power developed in the two cylinders will correspond with the diagram G D E F, and C F will be the terminal pressure in the large cylinder. It follows that the actual expansion curve after cut-off in the large cylinder should coincide with the lower part of the curve D E F.

One graphic method, therefore, of finding the proper low-pressure cut-off is to draw out the curve of pressures in the large cylinder from the beginning of the stroke onwards until it intersects the curve E F. This intersection gives the point of cut-off desired. This construction is illustrated in Figs. 1 and 2. In both of these the large cylinder is taken as having four times the volume of the small cylinder, and the middle chest as having twice the same volume. In both the cut-off in small cylinder is taken at half stroke, and the expansion curves are drawn out according to Rankine's formula for adiabatic steam expansion. The special expansion curve used in the construction should, of course, be adapted to the particular character of the engine as to clothing, steam jacketting, &c. The graphic method remains the same whatever expansion curve be adopted. In Fig. 1 the cranks are supposed to coincide—as in the common Woolf tandem—or to be opposite. In Fig. 2 the high-pressure crank is supposed to lead by 90 deg. In both figures A b represents the volume of the middle chest; $a\,b$ is made equal to A B, the volume of small cylinder, and on $a\,b$ and A C are described two circles to represent the two crank pin paths, the one four times as large as the other. These circles are divided into equal arcs, and simultaneous positions of the cranks are marked by similar numbers. The corresponding piston positions are projected down on the stroke lines $a\,b$ and A C by circular arcs of radius equal to the connecting-rod, this being taken as two and a-half strokes. The expansion curves $d\,e$ and d H are exact reproductions of D H, the former being reversed in position.

At the end of the high-pressure piston stroke the volume $a\,b$=A B of steam at pressure B E=$a\,e$ is combined by the opening of the exhaust port with the middle chest volume A b of steam, which is by hypothesis at the same pressure. This combined volume B b = E H is then expanded in Fig. 1 continuously down to cut-off in large cylinder. The expansion curve is drawn out to the same formula as that for D E F. In the figure it is (E K) extended to the end of the large cylinder stroke line, although practically it is not used beyond about five-eighths stroke. When the cranks are at right angles this volume E H is first compressed from end of the small cylinder stroke until shortly after the beginning of the low-pressure stroke, and then it expands once more. In Fig. 2, therefore, the curve K E is extended backwards to L.

In Fig. 1, at the dead-point O, there is the volume aA=bB of steam at pressure B E. When the cranks stand at point 1 this volume has increased by A 1, and has diminished by a 1. The distance b 1 is therefore taken in the dividers and plotted from 1 on line A C in the direction of C to the point p_1. The volume is thus $b\,p_1$, and the pressure therefore p_1 P_1. This pressure is plotted off as a vertical ordinate at points 1 and 1, which show the positions of the two pistons. Thus are obtained the points Q_1 and q_1 on the pressure curves for the working side of the low-pressure piston, and the back-pressure side of the small piston. By an exactly similar process the points Q_2 q_2 and Q_3 are found. The curve Q_0 Q_1 Q_2 Q_3 is then drawn through these points. This intersects the curve D E F in the point N. This is the desired proper cut-off. This is all that is required for the solution of the problem of this article; but to illustrate further the reasoning, the point n in the high-pressure diagram, corresponding to N in the low-pressure diagram, is plotted. From n forwards, the large cylinder being cut-off, the steam in the middle chest and small cylinder is compressed until the end of the small piston stroke. The compression curve is shown as n H, terminating at the same level as the end of the expansion curve d H. In the example taken the low-pressure cut-off is found to be ·36 by measurement to the point N on the diagram. The indicator diagram of the small cylinder is $g\,d\,e\,n$ H. That of the large cylinder is Q_0 Q_1 Q_2 N F with the back-pressure line, which is not drawn in the diagram, as it has nothing to do with our construction. If an hyperbolic expansion curve had been used instead of Rankine's adiabatic curve, the cut-off found would have been ·33. This is very little different from that obtained in Fig. 1, namely, ·36.

If the cranks are at right angles (see Fig. 2) when the dead point O of small piston is reached, the large piston is at half-stroke, and the valve to large cylinder is—or ought to be—already closed. We, therefore, start with the volume Aa at pressure $a\,e$ = B E, which is gradually compressed by the back stroke of small piston until this reaches mid-stroke at point 3. The compression curve $e\,q_0$ is plotted out by taking the volumes A1 A2 A3 —1 2 3 on line a b—and finding the corresponding pressures from curve E L. The steam now flows into the large cylinder, and the arrangement of the diagram renders it easy by following the same method as explained in Fig. 1 to find the pressures for the successive simultaneous positions occupied by the pistons. The pressure continues to rise for a short period—about 15 deg. rotation of the cranks—in consequence of the slowness of the motion of the large piston and the relatively rapid motion of the smaller piston. When the velocity of the large piston has become ¼th that of small piston, the highest pressure is reached, and it then rapidly lowers. The curves $Q_0 Q_1 N\ Q_4 Q_5$ and $q_0 q_1 n$ are thus obtained, the former intersecting D E F in N, and n being deduced from the position of N. The compression curve n H may then be drawn in. The desired low-pressure cut-off is at N, and measures on the diagram ·27 of the stroke. If the hyperbolic curve had been used the cut-off ·26 would have been obtained.

Another obvious graphic method of solving the problem is to draw in the compression curve H n *backwards*, starting from H with the volume Q_0H of the middle chest to its intersection n with the curve $e\,q\,q\,n$. This intersection being found, the corresponding position of the large piston is found, and this taken as the point of cut-off. This latter construction is in two respects preferable to the first: Firstly, because the intersection of n of the two curves is a more sharply defined one than that of N; secondly, because the first process tacitly assumes that the expansion curves occurring are "*reversible*" ones; that is, that the compression curves follow the same general law as the expansion curves. This would be true if the expansions and compressions were really adiabatic, that is, if the steam did not give and take any heat from the cylinder walls. Such is not the actual case, however. The second construction does not depend for its accuracy on any such assumption. The compression curves H n and $e\,q_0$—Fig. 2—may be drawn in according to a different law from that of the expansion curves D E F and E P K, the difference being an allowance for the non-reversal of the conducting action of the cylinder and middle-chest walls during expansion and compression. The conduction to and from these walls has probably the effect of always placing the proper point of cut-off later than that obtained by means of the adiabatic curve.

The draughtsman using these constructions will at once recognise that for the simple finding of the point of cut-off it is quite unnecessary to draw in the complete curves as in the illustrations, where they are only inserted for the sake of explanation. Only those small portions of the curves near where the intersection is guessed to lie need be drawn in. It is better to draw in those small portions accurately than the complete curves inexactly.

If the hyperbolic expansion curve be assumed as approximately correct, it is not difficult to solve this problem algebraically. The following two formulas are deduced. In these r means the reciprocal of the cut-off in the large cylinder; m the ratio of large cylinder volume to that of small cylinder; and n the ratio of middle chest volume to that of small cylinder. The effect clearance volumes is neglected in the formulas.

For cranks in line or opposite each other,

$$r = \frac{n\,m + 1}{n + 1}$$

For cranks at right angles,

$$r = \frac{2}{1+2\,n}\left\{m\,n + \frac{1}{1+2n} + \sqrt{\frac{2\,m\,n}{1+2\,n} + \frac{1}{(1+2n)^2}} - 1\right\}$$

Or for easier calculation of the curves in Fig. 4,

$$n = \frac{r - 2\sqrt{r-1}}{2\,(m - r)}$$

The results of these two formulas are contained in the diagrams Figs. 3 and 4.

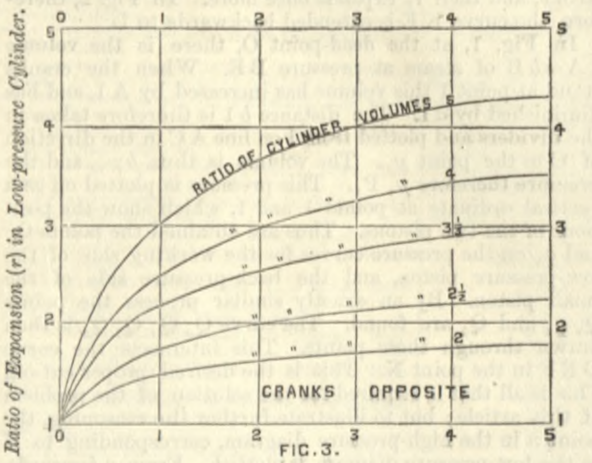


FIG. 3.

Ratio of volume of middle chest to that of small cylinder.

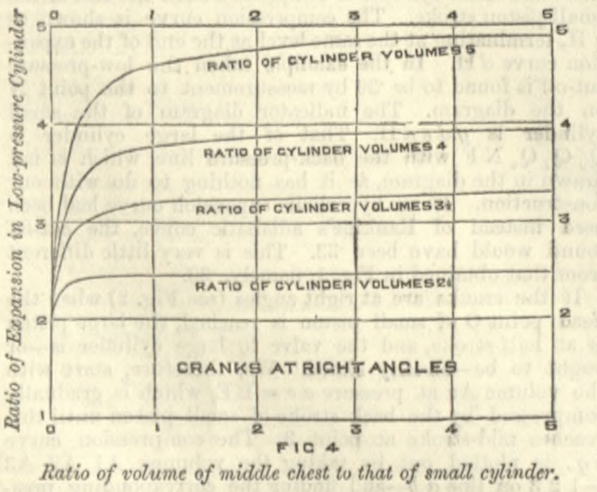


FIG. 4.

Ratio of volume of middle chest to that of small cylinder.

The vertical heights of the curves give the reciprocals of the low-pressure cuts-off. The horizontal ordinates give the ratios of volumes of middle chest and high-pressure cylinder. As the volume of the middle chest becomes larger, the cut-off becomes earlier, and approaches the limit (small cylinder volume ÷ large cylinder volume). This is also evident from Figs. 1 and 2. As the chest becomes larger, the curve $Q_0\,Q_1$ N becomes more and more nearly coincident with the horizontal line Q_0 E, and the point N approaches the limiting position E.

The question of ease of starting has not been noticed here, as it does not bear directly on the problem in hand. It is to be noticed, however, that the constructions explained always give the cut-off in the large cylinder earlier than half stroke. This cut-off again, it should be observed, is entirely independent of the cut-off in the high-pressure cylinder. A glance at the diagrams will also show that, with the cylinder ratio 4 and a small cylinder cut-off as early as one-half, the horse-power of the large cylinder is greatly in excess of that of the small cylinder, unless the condenser back-pressure be unusually high.

For starting the writer has not seen anywhere stated any objections to the simple plan of having fresh steam from the boiler led to both ends of both cylinders by special pipes of small size, the admission being controlled by a two-way cock worked by hand.

RARE MINERALS FOR MANUFACTURING PURPOSES.

OLD-ESTABLISHED trades which require minerals for manufacturing purposes have necessarily old-established and well-known sources of supply; but in the case of certain new undertakings, and in attempting new discoveries, manufacturers sometimes find it difficult to obtain a sample of a rare mineral to make a beginning, scientific mineralogists being a small body, and, as a rule, far removed in their studies from the commercial world. When scientific men or manufacturers want such out-of-the-way minerals, they are usually not long in discovering by inquiry that Mr. J. R. Gregory, of Charlotte-street, Fitzroy-square, London, has made it the business of his life to collect and keep on hand for sale many hundreds of specimens of such minerals, most of which perhaps may not be required for utilitarian purposes more than once in a century. Recently some scientific men at Cambridge, who required a lens to resist the action of heat in order to observe certain phenomena which take place at high temperatures, sought out Mr. Gregory, not only to find an optically suitable and colourless sapphire for the purpose, but to discover a man to grind and polish it into a lens, there being a difficulty in inducing ordinary lens grinders to undertake work so far removed from their accustomed practice. When the electric lighting "boom" was in full force, several electrical engineers sought out Mr. Gregory for quantities of steatite softer than that used for gas burners, there being a soft kind which is easily turned in the lathe, which resists the action of acid vapours, the action of heat, and, at the same time, is a fair non-conductor thereof. In original inorganic chemical research, when workers require exceedingly rare substances, such as even wholesale manufacturing chemists on an extensive scale do not keep on hand, there is no resource but to obtain samples of the mineral containing the substance and to extract the latter therefrom themselves.

Recently we inspected Mr. Gregory's museum-like establishment, and among other matters he stated his experience in regard to carbon for diamond drills. The crystalline diamond is not good for boring purposes, because it has cleavage planes, and splits along those planes in boring operations. There is an inferior South African diamond which in the rough is rounded outside, so as to resemble real bort, and it is known as "Cape bort." In use its rounded surface begins to split off, and the ill-effects of the cleavage planes become manifest. It is worth 5s. or 6s. a carat, whilst real bort, which comes from Brazil, is worth 40s. or 50s. a carat. The Brazilian bort shows some traces of crystallisation, or rather of a fibrous radiated structure, but then the pressure acts nearly equally upon it in all directions. The best carbon for boring purposes is "carbonado;" it comes from Bahia, in Brazil, and is amorphous. Some specimens, when fractured, have, says Mr. Gregory, a somewhat spongy texture, others are compact, and bear the same relation to the diamond proper that emery does to the crystallised sapphire. Carbonado is found as small black pebbles in the detritus of rivers; it is associated with gravel, but not usually with the true diamond; its specific gravity varies from 3·012 to 3·416. The compact variety some two or three years ago was worth £4 a carat, now its value is but 30s. to 35s. a carat. The supply is limited, and is in the hands of a few capitalists. It is freely used by Californian mining companies, and for Government work in Australia. The largest consumers in England are the Diamond Drill Company. The commercial advantages of the use of carbonado as compared with steel come out chiefly when excessively hard rocks have to be bored; with soft rocks the advantage, where it exists, is not manifested so strongly. Some of the "crowns," of large drills, 10in. in diameter, armed with the best carbonado, have been known to be worth £2000 each; each piece of carbonado fixed in such drills usually weighs from four to six carats. The pieces in the small drills used for boring holes for blasting purposes usually weigh from half a carat to one carat. There is an increasing demand for large pieces of carbonado, which in the long run are cheaper in use than the small ones. An interesting geological problem was solved by the diamond drill in boring the deep well for Meux's Brewery in London. The boring passed from the upper oolite direct to the Devonian rocks, which are older than the coal formations, and settled the question that there is no coal under the oolite there, or anywhere to the eastward thereof; but the speculation still holds good that possibly coal may be found in Kent or Surrey. Carbonado is specially useful in dressing millstones, and it is reported that it is getting into use in America for turning steel tools. Once a Birmingham firm consulted Mr. Gregory about using a tool for special turning purposes in the place of steel. He recommended a tool made of carbonado, but there were two difficulties in the way. In the first place, the problem of grinding the tool had to be faced; and in the second, it was necessary to build it up of small parts because of the minute dimensions of the pieces of raw material. One or two regular diamond polishers were applied to, but would not undertake work so much removed from their ordinary practice, so the manufacturing firm which required the tool put one of their own men at the work for some months; in the end he overcame the difficulties of his unaccustomed task, a carbonado tool was built up of small segments, and in use it was found to be admirably adapted to the purpose for which it was constructed.

Of late years there has been a greatly increased demand for asbestos; the sources of supply are abundant, especially in Australia, but of late much has been sent to England from the United States which is not really asbestos, but chrysotile, which is fibrous serpentine; it includes most of the silky amianthus of serpentine rocks. It is either used by itself, or to adulterate asbestos. Chrysotile is a silicate of magnesia, and asbestos is a silicate of alumina; the former occurs in fibres about 2in. long, and the latter in fibres sometimes as much as 30in. long; chrysotile contains 12 to 14 per cent. of water. The Greeks named asbestos "amianthus," or "the undefiled," because it could be cleansed by the simple device of throwing it into the fire. At one time asbestos cost about £6 per cwt.; now it can be had from £10 per ton, the difference in price being the result of the operation of the law that supply meets the demand. Mountain leather and mountain cork are varieties of asbestos. Mountain leather occurs in flexible flat pieces, in which the fibres are interwoven; it has much the aspect of leather, and when very compact is known as mountain wood. A sample of mountain leather analysed by Dr. Thomson was found to consist of silica, 57·65; magnesia, 2·06; lime, 10·0; alumina, 9·5; protoxide of iron, 5·8; and water, 21·7. A sample of mountain wood from the Tyrol consisted of silica, 54·92; magnesia, 26·08; alumina, 1·64; protoxide of iron, 12·6; and water, 5·28. Mountain cork from Piedmont—silica, 57·75; magnesia, 10·85; lime, 14·05; protoxide of iron, 18·90; alumina, 1·95; and protoxide of manganese, 1·85. It has a loose felt-like texture, and floats on water.

Beauxite is a valuable mineral for the beds of furnaces and for the manufacture of aluminium; the best comes from Beaux in the South of France; another variety is found near Belfast, and is largely used in the North of England. Cryolite is used as a flux for the beauxite in the manufacture of aluminium. At one time the cryolite itself was used as the source of that metal. Beauxite consists chiefly of alumina and iron, with a little tartaric acid; the white variety contains 21 per cent. of silica. Sometimes beauxite contains enough iron to be regarded as an iron ore. Cryolite, which means "ice stone," is plentiful in Greenland; its composition is aluminium, 13; sodium, 32·8; fluorine, 54·2. It is fusible in the flame of a candle, giving off some of its fluorine, which is at once transformed into hydrofluoric acid by the moisture in the air. The Americans use cryolite in the manufacture of soda, and of a white glass resembling porcelain.

Among the mineral curiosities we examined in the collection of Mr. Gregory was some elaterite, otherwise known as mineral india-rubber, subterranean fungus, and elastic bitumen. In the early part of the present century the sole source of supply of this curious mineral was the lead mine of Odin, at Castleton, Derbyshire. At present the mine is unworked, but it is exploited at times by workmen who make arrangements with the owner. Elaterite is now said to be found also at St. Bernard's Well, near Edinburgh; Chapel quarries, Fifeshire; a coal mine at Montrelais; at Neufchatel; and on the island of Zante. The Castleton samples are some of them nearly as soft as size, and the remainder of much the same consistency as india-rubber. They are all black or brownish-black by reflected light, and dark orange red or brown by transmitted light. When a large lump is cut through the centre it is often found to be fawn-coloured in the middle, and it darkens by exposure for a few weeks to the air. It is said to be of a very insoluble nature. Johnston records that when he treated a mass of it with ether but 18 per cent. dissolved; by analysis he discovered it to consist of about 85 per cent. carbon and 12 per cent. of hydrogen, with probably 2 or 3 per cent. of oxygen. Occasionally samples of elaterite are hard and brittle. In the old lead mine of Settling Stones, Northumberland, a mineral resin somewhat resembling elaterite is found in drops more or less rounded or flattened; these drops incrust the rocky walls of the vein. It is hard, brittle under the hammer, does not melt at 205 deg. Cent., burns in the flame of a candle, varies from pale yellow to deep red in colour, and consists of carbon, 85·133; hydrogen, 10·853; ash, 3·256; total, 99·242.

Cæsium is the most electro-positive of all the metals, its affinity for oxygen is stronger than that of potassium, its basic oxide cæsia is a most powerful caustic, which, when heated, attacks even platinum. Cæsium was one of the exceedingly rare metals discovered by Bunsen and Kirchoff in the early days of spectrum analysis. By boiling down 140 gallons of the water of the Durkheim spring they obtained in the saline residue one grain of a salt of cæsium. Ordinary lepidolite contains but traces of cæsium, but a variety found at Hebron, in the United States, yields 0·24 per cent. of the metal. Pisani, however, in 1864, discovered cæsia to the extent of 34 per cent. in a mineral named pollux, obtained from the island of Elba, in which locality it occurs with petalite. Pollux, of which small specimens are in Mr. Gregory's collection, is colourless, glassy, or gum-like externally, and fuses with difficulty; it consists, by Pisani's analysis, of 34·07 per cent. cæsia, 44·03 silica, 15·97 alumina, 3·88 soda and lithia, 2·40 water, 0·68 lime, and 0·68 iron. Pollux colours the blow-pipe flame, yellow; it is slowly decomposed by hydrochloric acid, with separation of pulverulent silica.

In the earlier days of his researches on heat, Professor Tyndall sought Mr. Gregory for specimens of rocksalt adapted to his purposes, and it may here be mentioned in passing, that it is a noticeable thing about natural rocksalt crystals, that if they have a blue or pinkish hue, and be dissolved in water, all the colour disappears in the artificial crystals afterwards formed by evaporation. Probably the colouring matter is of an organic nature, and is separated by the recrystallisation. The colouring matter of the quartz crystals known as amethyst, is supposed by geological chemists to be of organic origin.

In a collection of out-of-the-way minerals numbering several hundreds of specimens, many chemical curiosities, besides those we have mentioned, are of course included; but enough has been said to interest readers in an establishment, of the existence of which few English scientific men engaged in original experimental chemical research, have not once or more in their lives felt the benefit.

KING'S COLLEGE ENGINEERING SOCIETY.—At a general meeting held on Tuesday, November 17th, Mr. A. Collins read a paper on "Well Sinking." The author alluded slightly to the geological points of the subject, referring chiefly to the machinery used in boring wells. He pointed out the utility of the various slide joints and free falling tools, and described several artesian wells, and the tools used in boring, with the patent tube wells used in the Soudan. In conclusion, he gave a brief description of the wells in Trafalgar-square. The paper was illustrated by coloured diagrams.

STEAMERS IN BURMAH.—The line of steamers which navigate the Irrawaddy are known as the Irrawaddy Flotilla, and comprise about 40 steamers and 50 large cargo and passenger flats. A writer in the *Nautical Gazette* says the Flotilla Company has now twelve large mail steamers running the mails to Mandalay, the capital of Upper Burmah and 670 miles from Rangoon, while each tow two large cargo flats of 600 tons burden, one on each side. The steamers are about 275ft. long, with a mean draught of 4ft. 6in., hurricane deck, and fitted with paddle engines 700 indicated-horse power. They do the whole distance to Mandalay in about 100 steaming hours with flats in tow against the stream, and in 65 hours on the return trip. A new steamer has just been put together and launched by the Flotilla Company at its dockyard at Dalla Rangoon, which is a splendid advance on anything hitherto working on the river. The new boat named the Mindoon, was built firstly by Messrs. Denny and Co., of Dumbarton, taken to pieces and shipped to Rangoon, where native rivetters, under European superintendence, speedily put her together.

TELEGRAPHY BY SIGHT SIGNALLING, OR "TELEGRAPHIE OPTIQUE."

No. II.

A FIELD instrument consists essentially of the following parts: (1) An "objective of emission" or lens; (2) a manipulator; (3) glass for observation of signals received;

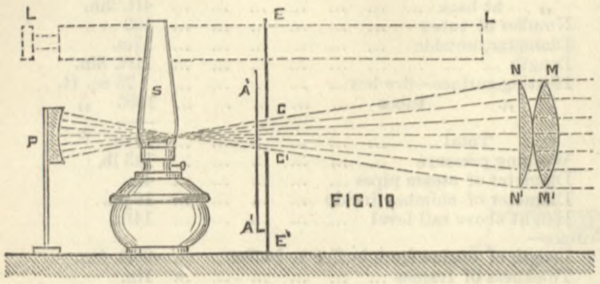


FIG. 10

(4) a petroleum lamp with flat wick to be used in the absence of sun. The whole is mounted on a tripod.

The Manipulator.—At about 8 or 10 cm. (3in. to 4in.) in front of the lamp S is a shutter of iron E E—Fig. 10—perforated with a circular opening of a diameter slightly greater than that of the conical beam of light at this point. Between this shutter and the lamp is the manipulator A A$_1$. It is formed—*vide* Fig. 11—of a plate F of platinum, moved by a lever G worked by a pedal acting against a spring R. The pedal is pressed to allow the beam to pass through the opening. The spring shuts it off when the pedal is released. By this means Morse signals of long and short duration are sent. The lever G holds the plate F in the position required to allow the beam to pass and give a continuous light. The glass for receiving or reading signals is fixed parallel to the axis of emission, and ought to be kept exactly in its place. This is done by holding the tube by two sliding pieces, one vertical and the other horizontal, and two micrometer screws. Fig. 12 shows the arrangement of the apparatus. A tube and socket D D is placed behind the light containing, first, two converging lenses A and B, and secondly, a glass *m m* with micrometer lines. Some distinct object about 2 kilos. (1¼ miles), is observed and brought exactly on the cross lines

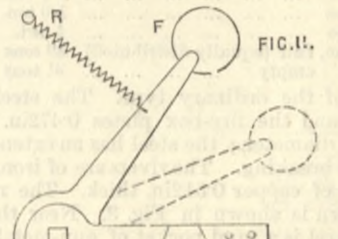


FIG. 11.

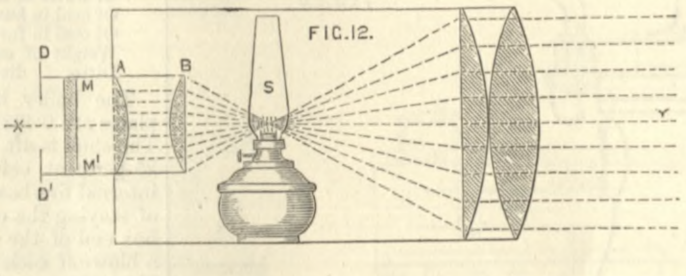


FIG. 12.

of the micrometer of the mirror *m m*^{1}. This determines the optical axis of the instrument; the observing glass must be brought to agree with this, and then fixed by its screws.

Regulation or adjustment of the light.—The petroleum lamp for signals may be adjusted by the tube D D, which is pushed in or drawn out until the flame occupies the vertical diameter of the reticule. This tube is now removed and replaced by a concave mirror P, Fig. 10, which gives, of course, an inverted image of the flame. By looking through the objective of emission, or large lens, the image of the flame is brought to be exactly covered by the flame itself.

Upon the source of light depends the efficiency of the communication by signals. The best result is obtained by cutting the wick of the lamp slightly convex with scissors, removing all corners.

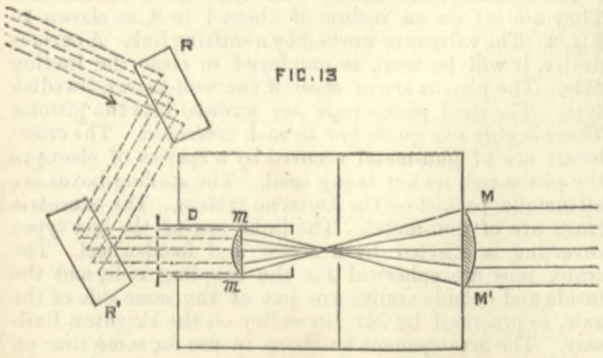


FIG. 13

A petroleum lamp with flat wick can almost always be used, that is, by night, or on a cloudy but clear day. When it is possible the sunlight is used with the increased range of signalling, indicated by the table before given. The solar light is received and projected by two means—first, by mirrors; secondly, by a heliostat. On the first system the sun's rays are received on a plane mirror R—Fig. 13—which is attached to the case of the instrument. The rays are reflected from R on to another mirror R^1—*vide* Fig. 13—which is fixed on a socket, of which the axis coincides with the optical axis of the instrument. The beam of solar rays are brought to converge by the lens *m m*^{1} in the socket, and then directed on the objective of emission or principal lens M M^1. In its passage it passes the slide and manipulator above described, when the rays are brought in near the focus. To follow the movement of the sun the mirror R^1 ought to be moved about every three minutes by hand. The mirror R fixed on the instrument may be dispensed with if necessary. The heliostat consists of two circular mirrors of the same diameter, centred exactly on the axis of a system of clockwork—*vide* Fig. 14 and 15. The axis A A^1—Fig. 16—is set at an angle, as in Fig. 15, equal to the latitude of the place of observation with the straight edge A B, which forms the base of the heliostat. This is placed in the meridian, or true north and south line, by means of a compass. The instrument is then, of course, placed so as to enable it to be made to follow the apparent movement of the sun by clockwork like an equatorial telescope. Thus the solar rays are constantly reflected from the first to the second mirror, and then directed as a beam of parallel rays by the object of emission or principal lens towards the desired point.

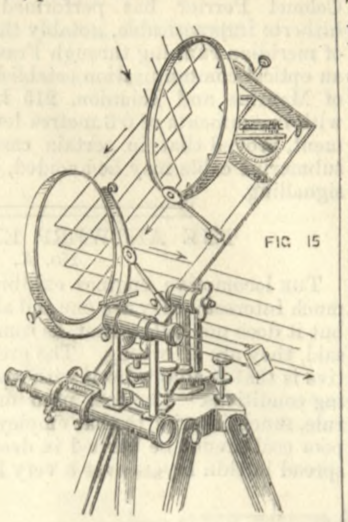


FIG. 15

Signal instruments in masked positions differ from the above only in the fact that, being concealed in shadow, they ought to offer the smallest possible surface and visible parts beyond the edge of the luminous beam thrown. They are constructed so as to diminish as much as possible the front parts so as to enter a loophole, and to place in the hinder portion all the working parts. Thus, in these instruments the observing glass, instead of being fixed on the upper part of the case, is in the interior. The lamp is placed in a cage or lantern in a case, which is fixed on the hinder end of the frame. Lastly, the little mirror for the concentration of the rays of the light is fixed—*vide* Fig. 17—inside the case. Fig. 18 shows a similar instrument worked by solar light. These instruments for masked positions actually form part of the stores provided for the defence of the country, and would render in

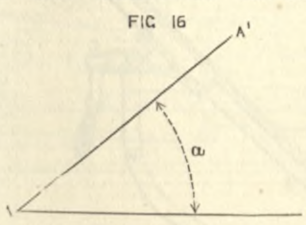


FIG. 16

war service of the highest importance. They put fortresses in communication with one another so as to prevent any surprise. The smallest instruments of 0·350 metre—13·8in.—with an objective of 67 mm.—2·6in.—in the observing glass, could communicate at a distance of 50 to 60 kilos.—31 to nearly 38 miles. The pattern of 0·45 metre, with an objective of 81 mm.—3·1in.—is effectual generally up to 90 kilos.—nearly 56 miles—and occasionally up to 130 kilos.—nearly 81 miles. The large pattern of 0·60 metre diameter, with object glass of 108 mm.—4·25in.—diameter, has a range generally of from 120 to 130 kilos.—74 to 81 miles nearly—and in very clear weather to over 200 kilos.—124 miles. It is unnecessary to add that these great

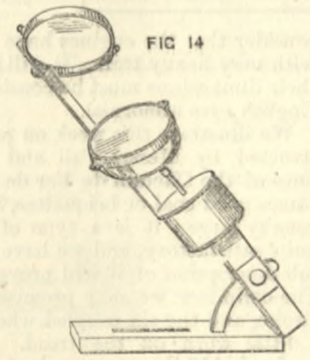


FIG. 14

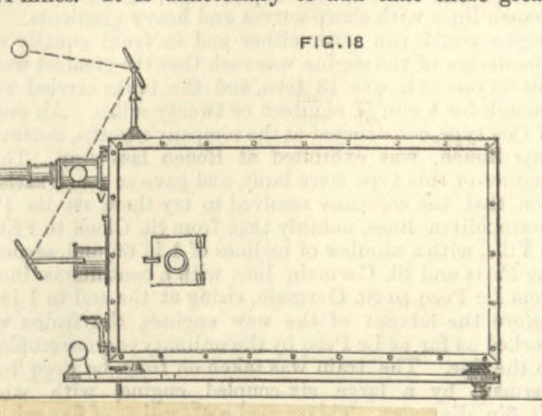


FIG. 18

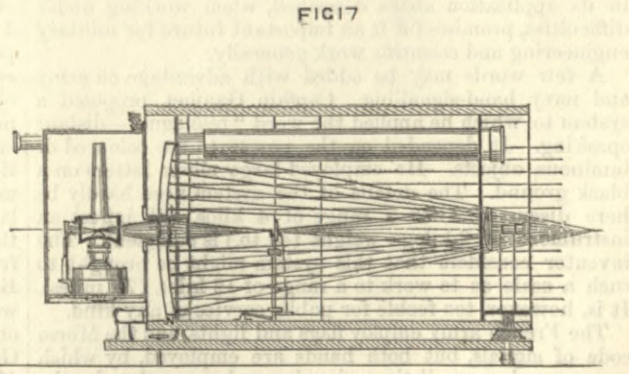


FIG. 17

ranges call for well-trained operators, and that the instruments at each station should be of the same diameter. Otherwise the effective range is intermediate between those which correspond to the greater and smaller instrument. This system of signalling, as above said, is liable to interruption by fog and smoke, however thin. Also the petroleum lamps require great care. They may form smoke sufficient to interrupt communication of signals.

For the working of each instrument two telegraphists are required; one makes and calls out the signals as fast as he receives them, and the other writes them down. Two field telegraph stations come into communication by first establishing a line of intercommunication. This is not always easy, and in the face of an enemy demands a coolness and courage of which numerous examples have been given by our French telegraphists during the late wars. When two stations are brought into communication, each of them shows a continuous light by means of the manipulator as above described. The station which wishes to signal then begins employing the Morse alphabet so soon as the receiving station has replied by masking its light. The manipulation should be slow and well marked, and the intervals between the words purposely exaggerated. When a mistake or difficulty arises, the receiving station stops further communication by showing a continuous light for about ten seconds. The sender, who always keeps an eye to the receiving glass, stops as soon as he perceives the continuous light, and repeats the word thus interrupted. As soon as the transmission is ended, the receiving station repeats a sort of summary of the message with the numbers, the proper names, and most important words employed. At the conclusion of the transmission both stations show continuous light. If one shuts off its light it is taken as an indication that it has a message to communicate; the other station replies by shutting off also, and then the work of transmission begins. After each letter the receiving station sends a flash to indicate that it has been properly read. Should one escape, the correspondence is interrupted by the receiving station making a continuous light, when the sender repeats the word in progress as noticed above.

These rules, with other minor ones, prevent confusion and delay. It is difficult to exaggerate the national importance of such work on service. In war, the constant change of position of the divisions to which the telegraph corps belong demands great judgment on the part of those who have to select the best signal stations while conforming to the movements of their corps. Each station should be furnished with a map, a compass, and a reporter. When an operative learns the position of a station with which it is desired to discover and to communicate with, he begins to get his map oriented, *i.e.*, placed truly with regard to the points of the compass. To do this, he places the compass on one of the sides of his map, and by it bring the meridian lines in his map truly N and S, by which he is able, with the help and information of the reporter, to calculate and trace the direction in which he should point his instrument so as to discover his correspondent. When the posts are shifting ones the operation becomes more difficult. The two correspondents divide the ground to be scanned in sections, and each sweeps his glass over the points where he supposes the other station to be established. The instrument is in the meantime kept turning on its axis, the beam of light being made to sweep the ground. The field of the glass being double, about double that required for working, the two posts sooner or later discover each other by dividing the ground carefully. In order to avoid loss of time, the stations called to exchange messages frequently adopt certain hours for the work. Under opposite conditions coloured lights and other similar means may be employed.

Signal telegraphy, from its nature, presents an advantage, and on the other hand inconvenience, in the fact that it leaves no automatic trace or record of its messages. The advantage is obvious in the case when captured by the enemy. The inconvenience is felt when telegraph messages are sent or read badly. Even a summary still leaves some ambiguity. It is to be feared also that an enemy might cause confusion by sending false messages. The remedy for this must be sought in the cryptograph system, being employed, at all events, in case of suspicion arising based on words previously chosen of which the enemy can have no knowledge.

As to the automatic record of messages, which if not employed in the first line of an army, might render great service in the signalling between observatories of strong places, no satisfactory solution of the question has yet been arrived at. It has been proposed that the sender should, by the manipulator, work the key of a Morse recorder, by which a trace of the message sent would be preserved on a strip of paper. The time required for transmission would, of course, be thus greatly increased, but the principal objection lies in the fact of the increase of muscular work thrown on the telegraphist. Obliged to have his eye at the receiving glass with constant attention at the same time that he works the manipulator, or that he calls out loudly the signals read, the operator requires a simple manipulator, and to escape all unnecessary work of any kind. Also no great success has been achieved by this class of instrument.

Two French officers independently arriving at similar ideas, have hit on a better notion in proposing to receive directly on their course the signals of a beam of light. This is done by using the peculiar property of selenium of becoming a good conductor of a current of electricity under the action of light, while it resists it absolutely in darkness. This effect also is produced without any sensible development of mechanical work. If, then, in the path of a beam of light, or even a part of this beam, is interposed a fragment of selenium placed in the short or local circuit of a battery, it is easy to see how a sensible form of Morse recorder may be worked. Practically many difficulties arise, the selenium rapidly loses its property; nevertheless, we may hope eventually for the success which such an invention well deserves. Again, the ray of light may be received on a band prepared in gelatine with bromide of silver. This sensitive band or strip is worked, that is unrolled and rolled, by means of clockwork and a dark box chamber. Very satisfactory results, however, have not been obtained owing to the length of the signals and the necessary mechanism. The projectors used for distant signalling from fortresses or ships have also received an application of the sight telegraphy. For this purpose Messrs. Sauter, Lemonnier, and Co., the ingenious Paris manufacturers, have added to the usual instruments turned out of their factories special arrangements for shutting off the light. *Vide* Figs. 19 and 20 below.

The principle is as follows. When the projector has its axis directed towards clouds in the direction of the receiving station, the light signals act on the cloud, which forms a kind of screen for them to play upon. By this means Morse signals can be seen a long distance. This system, of which the chief drawback is the necessity for a cloudy sky, enables two observing stations, whose direct view is impeded by the curve of the earth, to communicate easily at a distance of 60 to 80 kilos.—38 to 50 miles. Of course a high command is a great advantage to a telegraph station.

The apparatus shown in Figs. 19 and 20 allows signals to be made in three ways. (1) On clouds, the mirror is elevated for this, and the projector so directed as to light up the most distant clouds. The movement of the shutter E placed between the lamp and mirror of the projector stops the rays of light, lets them pass, and thus produces on the clouds the long or short Morse signals. (2) Communication with isolated stations. When two isolated posts a short distance apart—say, 3 or 4 kilos. (2 or 2½ miles)—wish to communicate, the mirror A is placed on its support B; the beam of light reflected by the mirror forms a luminous vertical brush. In turning the mirror A through about 90 deg. on a horizontal axis, the brush becomes horizontal. It is thus possible to signal at unequal intervals, and to so supply the usual signs. (3) Communication at night over entire horizon for a short distance, say, 3 kilos. (2 miles), as often happens with ships at sea. The mirror A is fixed to throw a beam of light vertically upwards on a white balloon about 15 metres (50ft.) above it. This is visible everywhere, and on it, by working the shutter, the necessary light signals may be made. This ingenious device, however, is dependent on a favourable state of the atmosphere, and could hardly be executed outside the fleet. To sum up, the important work done by signal telegraph in its application above described, when working under difficulties, promises for it an important future for military engineering and scientific work generally.

A few words may be added with advantage on army and navy hand-signalling. Captain Gaumet proposed a system to which he applied the word "télélogue"—distant speaking. It depended on the power to see coloured or luminous objects. He employed large silver letters on a black ground. The details of the system need hardly be here discussed. For a range of 4 kilos. (2½ miles) an instrument of 2 kilogs. weight (4½ lb.) is sufficient. The inventor considers that this system might be brought to such a scale as to work to a range of 12 kilos. (7½ miles). It is, however, too feeble for public service of any kind.

The French army employ flags and lights, and the Morse code of signals, but both hands are employed, by which means much more distinct signals can be sent than by the single-hand system. At night lanterns shown for long and short times are used.

Signals with illuminated captive balloons have been tried, and success may be achieved on the system of illuminating them from below. If, however, a light be placed in the car of a balloon it is impossible to control the direction in which it is projected owing to the constant rotation of a captive balloon.

In the Navy, signal flags on the usual system are employed, and between ships and land, semaphore signals are employed. The combinations are analogous to the Chappe system. Hand signals are also employed in the Navy. In future, doubtless, the telephone and the signal system described above will modify the old signal system. The constant movement of ships at sea, however, must always cause difficulty in directing signals. At night signal lights take the place of flags, and also lamps and reflectors are employed.

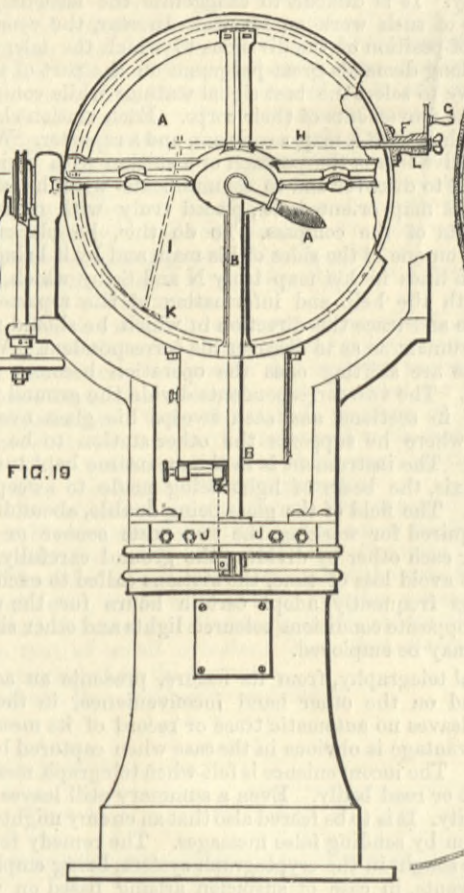


FIG. 19

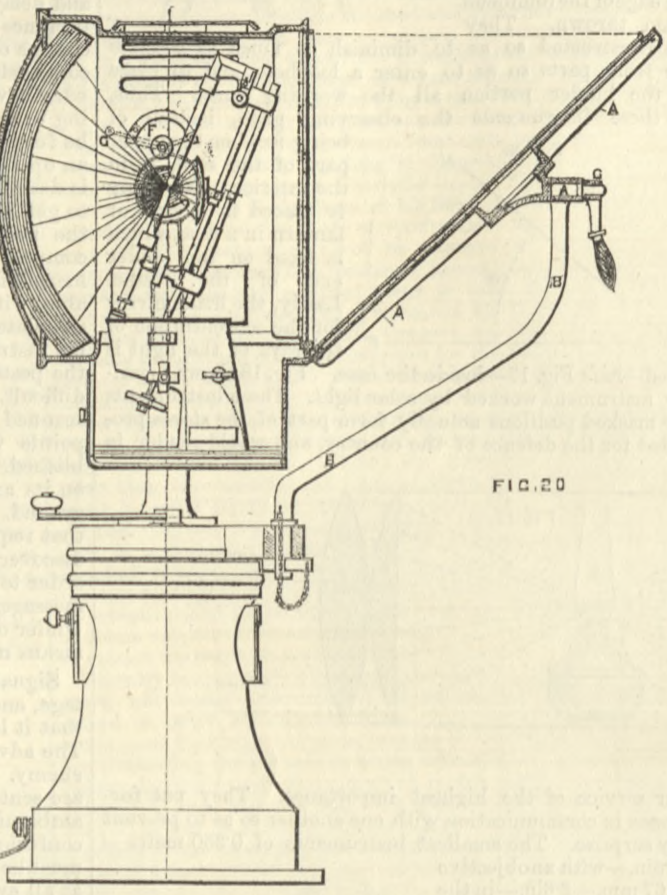


FIG. 20

Altogether it may be said that telegraphy by optical instruments has developed rapidly during the last few years, and has taken a remarkable place in military and scientific operations. Thanks to his work in this way, Colonel Perrier has performed operations of geodesy hitherto impracticable, notably the measurement of an arc of meridian running through France and Spain. Recently an optical communication established between the islands of Maurice and Réunion, 215 kilos.—134 miles—apart, with instruments of 0·6 metres lent by the War Department, proved that in certain cases the costly laying of a submarine cable may be avoided, being replaced by light signalling.

THE ANTWERP EXHIBITION.

No. X.

The locomotive engines exhibited at Antwerp possess much interest; they are one and all unlike English engines, but it does not follow that, as some persons have unwisely said, they are all wrong. The great virtue of the locomotive is that it adapts itself with wonderful ease to very varying conditions. The fuel used on the Continent is, as a rule, much inferior to that employed in England. A small poor coal cannot be burned in deep fire-boxes; it must be spread in thin layers over a very large grate; and when we consider that the engines have to surmount steep inclines with very heavy trains, it will be readily understood that their dimensions must be considerable, and their design to English eyes abnormal.

We illustrate this week on page 411 a tank engine constructed by Messrs. Cail and Co., for the Metropolitan lines of the Chemin de Fer de l'Ouest. This engine consumes good coal or briquettes, and the fire-box is not unusually large; it is a type of engine which has proved quite satisfactory, and we have no doubt that a tolerably full description of it will prove acceptable to our readers. The cylinders we may premise are 17in. diameter, 23½in. stroke, and the six coupled wheels are 5ft. diameter, when a little worn on the tread. The tractive effort of the engine is 113 lb. per pound of average cylinder pressure. This represents a very powerful machine.

The Western Railway Company designed and constructed in 1883 and 1884 a six-coupled tank engine, for working branch lines with sharp curves and heavy gradients. The engine could run with either end in front equally well. The design of the engine was such that the greatest weight put on one axle was 13 tons, and the tanks carried water enough for a run of eighteen or twenty miles. An engine of this type, constructed at the company's works, Sotteville, near Rouen, was exhibited at Rouen last year. Thirty engines of this type were built, and gave so much satisfaction that the company resolved to try them on its Paris metropolitan lines, notably that from St. Cloud to l'Etang la Ville, with a number of inclines of 1 in 66, and, secondly, the Paris and St. Germain line, with a continuous incline from Le Peeq to St. Germain, rising at the end to 1 in 29. Before the advent of the new engines, the trains were worked as far as Le Peeq by the ordinary engines employed on the line. The train was taken on from Le Peeq to St. Germain by a large six-coupled engine, with wheels 4ft. 3in. diameter. This caused a detention of five minutes at least, and was very inconvenient in various ways. It became highly desirable to run the whole trip with one engine. As the branch line engines to which we have referred were deemed to have wheels rather too small for a speed of 36 miles an hour—that attained on the Paris and St. Germain line—a new design was got out, almost identical with that of the branch line engines, but with wheels 5ft. high instead of 4ft. 8in. The result is the engine shown at Antwerp. Furthermore, the engine is fitted with the Westinghouse brake, in use on all the Western Company's trains. The conditions could not be satisfied without adding a little to the weight of the engine. To keep down weight, ingot iron plates—*tole de fer fondu*—were used in the construction of the boiler instead of iron. By this about half a ton was saved. Very careful draughtsmen got out designs, which were prepared both in the company's own drawing-offices and those of Messrs. Cail, in order that the weights might be distributed to the best advantage. The principal dimensions are given in the accompanying table :—

Grate—	
Length	4ft. 9in.
Width	3ft. 3½in.
Surface	17 sq. ft.
Fire-box—	
Height in front	4ft. 9in.
,, at back	4ft. 2in.
Number of tubes	192
Diameter, outside	1¾in.
Length	11ft. 8in.
Heating surface—fire-box	75 sq. ft.
,, tubes	1035 ,,
Total	1110
Working pressure	143 lb.
Diameter of steam pipes	4in.
Diameter of chimney inside	16½in.
Height above rail level	14ft.
Frames—	
Length of engine from buffer to buffer	26ft. 5in.
Thickness of frames	1in.
Wheels—	
Diameter	5ft. 0½in.
Journals—	
Leading, diameter	6·69in.
Length	9·44in.
Middle, diameter	7·48in.
Length	7·67in.
Trailing, diameter	7·48in.
Length	9·44in.
Crank pins—	
Main, diameter	7·48in.
Length	4·17in.
Coupling rod do.	3·54in.
Length	3·50in.
Wheel base—	
Leading to middle	7ft. 0½in.
Middle to trailing	6ft. 1in.
Total	13ft. 1½in.
Springs—	
No. of leaves	16
Length	33½in.
Deflection per ton	0·276in.
Cylinders—	
Diameter	17in.
Stroke	23½in.
Diameter of piston-rod	2½in.
Length of connecting-rod	5ft. 8·8in.
Stroke of slide valves	4·64in.
Lap	1in.
Weight—	
Of water in tanks	3·8 tons
Of coal in bunkers	1·0 ton
Of coal in furnace	4 cwt.
Weight of engine, full (equally distributed)	39 tons
Ditto, ditto, empty	31 tons

The boiler is of the ordinary type. The steel shell plates are 0·433in. and the fire-box plates 0·472in. thick. The shell is 4ft. in diameter; the steel has an extension of 25 per cent. before breaking. The rivets are of iron. The internal fire-box is of copper 0·512in. thick. The method of staying the crown is shown in Fig. 3. Near the fire-box end of the barrel is a mud pocket of gun-metal, with a blow-off cock which can be worked from the foot-plate. The tubes are brass. The grate consists of two sets of bars, one horizontal at the back end of the fire-box 35in. long, and a second set 24in. long fixed on an incline of about 1 in 4 at the leading end of the box. The bars are of wrought iron, grouped in threes, and 0·4in. thick with 0·25in. spaces. The safety valves are Ramsbottom-Webb. There is no steam dome; steam is taken from the boiler in the way devised by Mr. Crampton many years ago, and fully shown in Fig. 3. A close-ended steam pipe, with slots in the upper side, is carried through to the upper part of the fire-box shell. This pipe opens into a valve box on the top of the boiler near the leading end, from which two steam pipes lead down to the cylinder, as shown in Fig. 7. The regulator is shown in Fig. 4, it explains itself. Motion is imparted to the valve spindle by a somewhat complex arrangement of levers, the details of which are shown in Figs. 5, 6, 7, and 8. The smoke-box is of steel 0·31in. thick.

The cylinders are inside with the valves underneath. They are set on an incline of about 1 in 8, as shown in Fig. 9. The valves are worked by a shifting link. A curious device, it will be seen, is employed to clear the leading axle. The pistons are of steel of the well-known Swedish type. The steel piston-rods are screwed into the pistons. There is only one guide bar to each crosshead. The crossheads are of gun-metal secured by a species of sleeve to the piston-rod, no key being used. The stuffing-boxes are all metallic packed on the Duterne system. The eccentric rings are of gun-metal. The links are of the box type; reversing is effected by a screw and hand-wheel. The crank pins are spherical for the coupling rods, and the inside and outside cranks are put at the same side of the axle, as practised by Mr. Stroudley on the Brighton Railway. The arrangement has been in use for some time on the Western Railway, and is found to greatly reduce the wear of journals and axle boxes. The lubricators are all constructed on the Austrian system; they work by capillarity without wicks. The cylinder lubricators can be worked from the foot-plate. The springs are of fluted steel, placed above the two leading axles and under the trailing axle. The axles are of steel, as are the tires. The boiler is fed by two Friedman injectors. The foot-plate is fitted with a cab.

If we compare Fig. 1 and Fig. 3, it will be seen that the boiler is only apparently flush. The effect is produced by the lagging which is some distance from the boiler; the space is partly filled with fine clean sand, which is of course quite dry; suitable appliances are provided by which it can be put on the rails when necessary. The whistle is of a type known as "Couronne." The blast pipe is fixed, the diameter is 5in. All the fittings have been designed to reduce to the smallest possible number the holes in the boiler. The tool-boxes and the compressed air reservoir are worked into the water tanks. These last do not come quite to the front of the engine, a space being left by which access can be got to the mechanism.

The workmanship of the engine is very good, its external appearance is pleasing, and its performance has been, in all respects, quite satisfactory.

THE ANTWERP EXHIBITION—TANK ENGINE, PARIS & ST. GERMAIN RAILWAY.

MESSRS. CAIL ET CIE, ENGINEERS.

(*For description see page 410.*)

FIG 1.

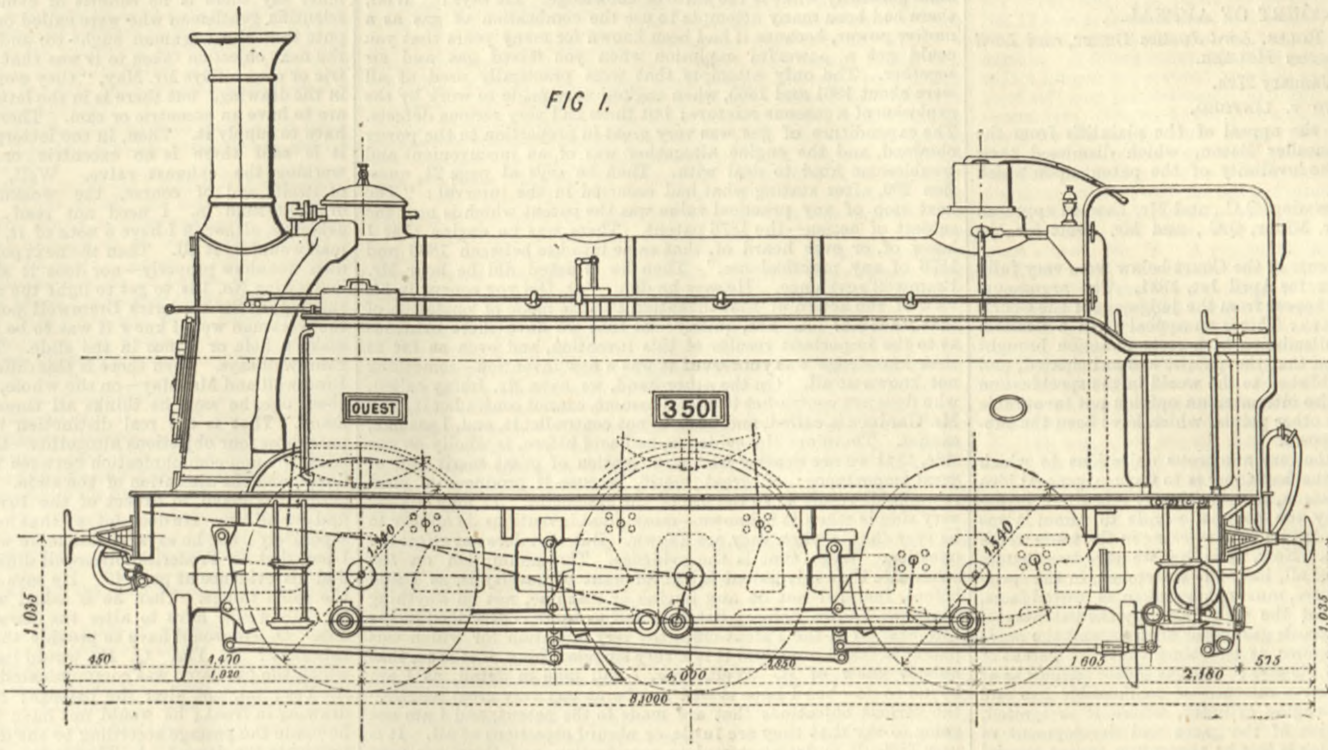


FIG 2.

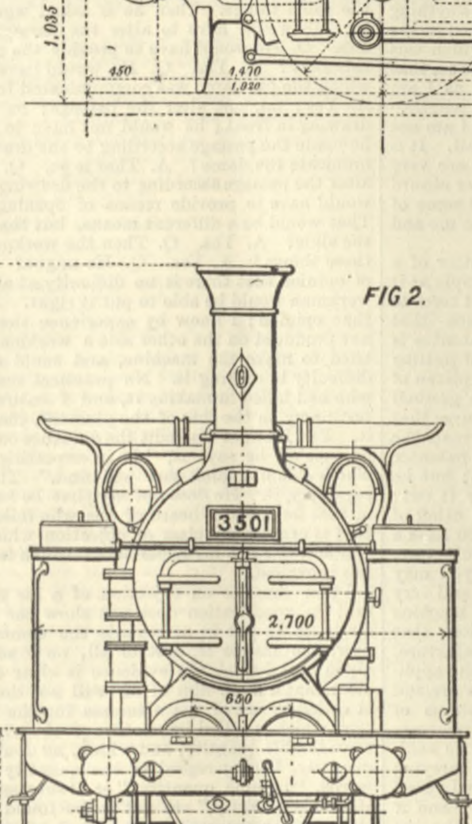


FIG 3.

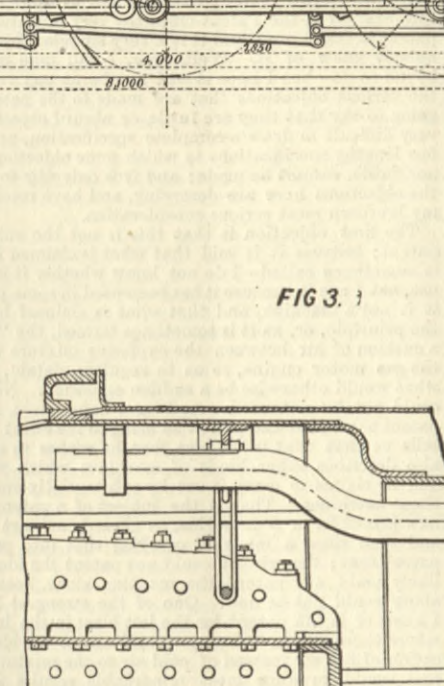


FIG 4.

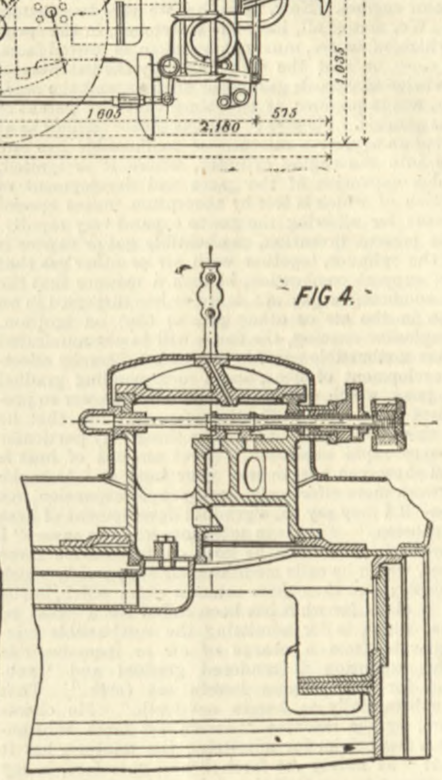


FIG 5.

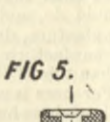


FIG 6.

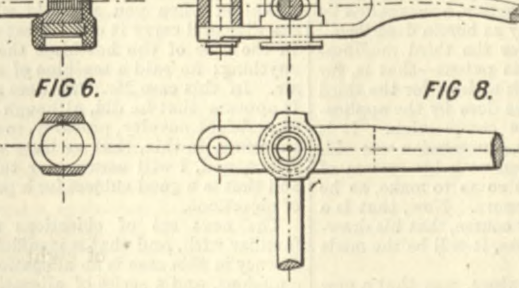


FIG 7.

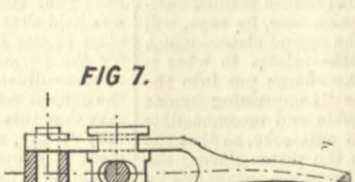


FIG 8.

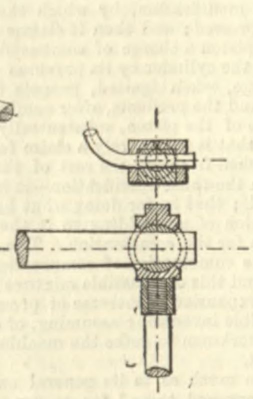
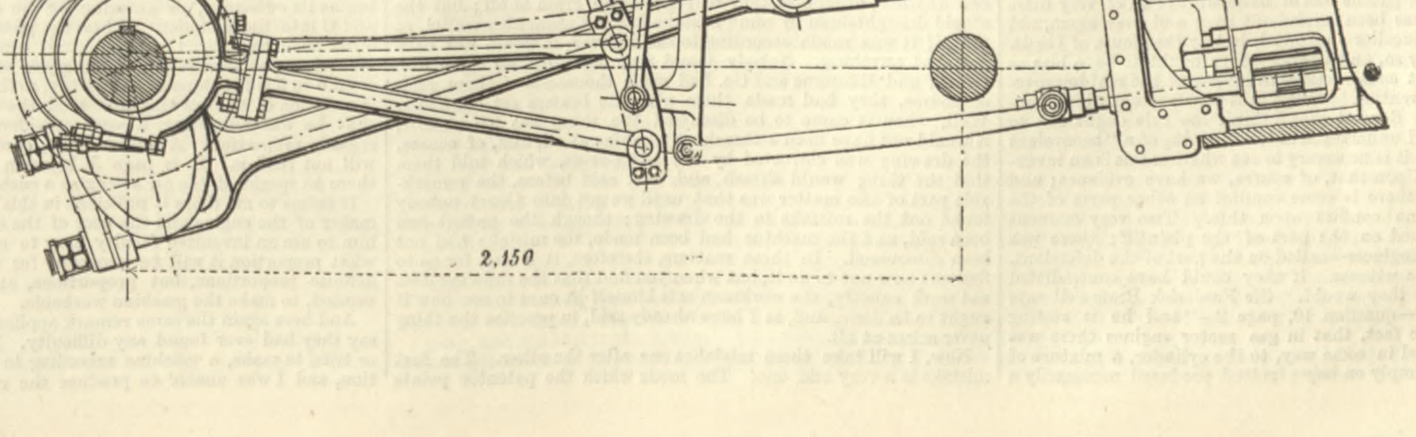


FIG 9.



OTTO *v.* LINFORD.

For some unexplained reason the judge's decision in the appeal case Otto *v.* Linford never was fully reported, except in The Engineer for February 3rd, 1882. That impression has long been out of print. We have had so many applications for it that we have decided to reprint the decision, believing that especially at present—while the case Otto *v.* Steel is pending—it will be of great interest to many of our readers.

IN THE COURT OF APPEAL.

(*Before the* Master *of the* Rolls, *Lord Justice* Brett, *and Lord Justice* Holker.

January 27th.

OTTO *v.* LINFORD.

This was the hearing of the appeal of the plaintiffs from the decision of the Vice-Chancellor Bacon, which dismissed their action on the ground of the invalidity of the patent upon which they were sueing.

Mr. Aston, Q.C., Mr. Hemming, Q.C., and Mr. Lawson appeared for the plaintiffs; and Mr. Millar, Q.C., and Mr. Brett for the defendants.

The evidence and arguments in the Court below were very fully reported in The Engineer for April 1st, 1881. The arguments upon the appeal sufficiently appear from the judgment of the Court.

The Master of the Rolls: This is an appeal from a decision of Vice-Chancellor Bacon dismissing with costs an action brought by a patentee, on the ground that the patent was anticipated, and the subject matter of it published to the world in the specification of another patentee. He also intimated an opinion not favourable to the plaintiff on various other points, which have been the subjects of discussion in this appeal.

Now, before going into the very numerous objections to which we have listened in detail, the first thing is to have a general idea of what the invention consists in, and whether it was a new invention, and was so accepted by the body of people to whom it was addressed, namely, the people who were working in the trade which employed gas motor engines. Now, upon that we have two sources of information. We, first of all, have the statement, in the specification itself—which, of course, must not be taken as proved facts, but still they do show us that the view taken by the patentee of the state of knowledge as regards gas motor engines, and the mode of working them, was in practice at the time that the patent of the plaintiff's was granted. He says: "In gas motor engines as at present constructed an explosive mixture of combustible gas and air is introduced into the engine cylinder, where it is ignited, resulting in sudden expansion of the gases and development of heat, a great portion of which is lost by absorption unless special provisions are made for allowing the gas to expand very rapidly. According to the present invention, combustible gas or vapour is introduced into the cylinder, together with air or other gas that may or may not support combustion, in such a manner that the particles of the combustible gas are more or less dispersed in an isolated condition in the air or other gas, so that on ignition, instead of an explosion ensuing, the flame will be communicated gradually from one combustible particle to another, thereby effecting a gradual development of heat, and a corresponding gradual expansion of the gases, which will enable the motive power so produced to be utilised in the most effective manner." So that he tells you shortly this: "Unless you use something very particular and special for very rapid expansion, a great amount of heat is lost. Now, I will show you how to save your heat and to make your machine to work more effectively, not by rapid expansion, but by slow expansion—if I may say so, a gradual development of heat and a gradual expansion." That is in substance what he says—"I will show you how to do it." Then he goes on to describe three kinds of machines, which he calls modifications 1, 2, and 3, which will effect the objects; and then there comes a claim which, in the first instance, is a claim for what has been called No. 1—that is, the first machine, which is for admitting the combustible mixture with air separate from a charge of air or incombustible gas, so that the expansion is rendered gradual and "substantially as and for the purpose herein set forth." That is the claim, "substantially as herein set forth." He claims to do it, therefore, by the machine "herein set forth substantially." It is not a mere claim for admitting the mixture, but it is for admitting it "as herein set forth;" and therefore, in my opinion, it is not correct to say that the claim is merely for a principle; it is for a principle together with a mode of carrying out, the principle being the putting in a cushion of air between the explosive mixture and the piston, which will produce gradual combustion, and thereby save the heat, and which also, he says, will make the machine more effective. Then the second claim—which is the only other one we have to do with—relates to what is called the third modification, by which the charge put into the machine is compressed; and then it claims "compressing by one instroke of the piston a charge of combustible and incombustible fluid drawn into the cylinder by its previous outstroke, so that the compressed charge, when ignited, propels the piston during the next outstroke, and the products, after combustion, are expelled by the next instroke of the piston, substantially as herein described." Now, of course that is not merely a claim for the third modification as distinguished from all the rest of the patent—that is, for what is added in the third specification—it is a claim for the third modification itself; that is, for doing what he does by the application of the cushion of air, adding to it the compression. It is therefore a claim for the combination. The compression was old, but he claims the combination of compression with his system of introducing air and this combustible mixture so as to make, as he says, a gradual expansion or increase of pressure. Now, that is a perfectly intelligible invention; assuming, of course, that his drawing enables the workman to make the machine, it will be the mode of carrying it out.

Having said so much as to its general nature, was that a new thing and an improved thing? for, to my mind, that makes the greatest possible impression. I have heard judges say myself—for I argued several patent cases at the bar—and I have read what other judges say, that there should be a benevolent interpretation of specifications. What does that mean? I think, as I have explained elsewhere, it means this, when the judges are convinced that there is a genuine, great, and important invention, which, as in some cases, one might almost say produced a revolution in a given art or manufacture, the judges are not to be astute to find defects in the specifications; but, on the contrary, if it is possible, consistently with the ordinary rules of construction, to put such a construction on the patent as will support it; they are to prefer that construction to another which might possibly commend itself to their minds if the patent was of little worth and of very little importance. That has been carried out over and over again, not only by the Lord Chancellor on Appeal, but by the House of Lords. There is, if I may say so, and I think there ought to be, a bias as between two different constructions in favour of the real improvement and genuine invention to adopt that construction which supports an invention. Beyond that I think the rule ought not to go; but that is what I understand is the meaning of a "benevolent construction." Then it is necessary to see whether this is an invention of that kind. Upon that, of course, we have evidence; and I may say, although there is some conflict on other parts of the evidence, there is no conflict upon this. Two very eminent engineers are examined on the part of the plaintiff; there was at least one eminent engineer—called on the part of the defendant, and another scientific witness. If they could have contradicted this I have no doubt they would. Sir Frederick Bramwell says that "up to 1876"—question 10, page 2—"and he is stating generally as was the fact, that in gas motor engines there was drawn in, or admitted in some way, to the cylinder, a mixture of gas and air, which simply on being ignited produced necessarily a great deal of heat." Then he goes on to say that "that heat was lost by absorption;" and he quotes the words. Then in answer to questions 13 and 14, he says there were defects in those engines which it was considered a desideratum to somebody to remedy in 1876—defects of such importance, that the doing away with them would be a step in advance. He says, "a very great step in advance—a step which made the gas engine from a thing which was very little used into that which has been used to a very large extent. It made the whole difference." That is the main effect of the plaintiff's invention. The other eminent engineer called was Mr. Imray, and what he said is this. At 281 he is asked to state generally what is the state of knowledge. He says: "Well, there had been many attempts to use the combustion of gas as a motive power, because it had been known for many years that you could get a powerful explosion when you mixed gas and air together. The only attempts that were practically used at all were about 1861 and 1865, when engines were made to work by the explosion of a gaseous mixture; but these had very serious defects. The expenditure of gas was very great in proportion to the power obtained, and the engine altogether was of an inconvenient and troublesome kind to deal with. Then he says at page 21, question 299, after stating what had occurred in the interval: "The next step of any practical value was the patent which is now the subject of action—the 1876 patent. There was no engine that I know of, or ever heard of, that came into use between 1866 and 1876 of any practical use." Then he is asked did he hear Mr. Bramwell's evidence. He says he did. "Q. Did you concur in his view of the action of that invention and the mode of operation of that machine? A. Yes, quite." So that we have there evidence as to the important results of this invention, and even as far as their knowledge was concerned it was a new invention—something not known at all. On the other hand, we have Mr. Imray called, who does not contradict it, and, I assume, cannot contradict it; and Mr. Gardner is called, and he does not contradict it, and, I assume, cannot. Therefore the evidence, as I said before, is wholly on one side, that we are dealing with an invention of great merit and of great importance; of great merit, because it produces a most remarkable result as to the use of the gas engine. It may appear very simple when it is known—most great inventions do appear to be very simple when they are known. But that does not affect the question. Well, that is the evidence. The assumption on the other side that this patent is bad for want of novelty is, as I said before, founded not on any engine or machine, not on anything that was known before; but they tell us there is described in the specification in the Patent-office the very invention for which this patent is taken out; and it is a very singular thing, if it is so, that nobody knew of it. Well, now, I will take in detail, as I am bound to do—but I hope it will not be at any very great length—the various objections that are made to the patent, and I am not going to say that they are futile or absurd objections at all. It is very difficult to draw a complete specification, and there are very few lengthy specifications to which some objections, neither absurd nor futile, cannot be made; and it is only fair to say that some of the objections here are deserving, and have received from me and my brethren most serious consideration.

The first objection is that this is not the subject matter of a patent; because it is said that what is claimed is a principle as it is sometimes called—I do not know whether it is the best term to use, but I use it because it has been used in some patent cases—that it is not a machine, and that what is claimed by the patentee is the principle, or, as it is sometimes termed, the "idea," of putting a cushion of air between the explosive mixture and the piston of the gas motor engine, so as to regulate, detain, or make gradual what would otherwise be a sudden explosion. Now of course that could not be patented. As I have before said, I do not read the patent so; I read the patent as being to the effect that the patentee tells us that that is the idea that he wishes to carry out; but he also describes other kinds of machines which will carry it out; and he claims to carry it out by substantially one or the other of these machines. That is the subject of a patent. If you have a new principle, or a new idea, as regards any art or manufacture, and then show a mode of carrying that into practice, you may patent that; though you could not patent the idea alone, and very likely could not patent the machine alone, because the machine alone would not be new. One of the strongest illustrations that I know of is the patent for the hot blast in the iron manufacture, where there was nothing new at all except the idea that the application of hot air instead of cold air to the mixture of iron ore and fuel would produce most remarkable results in the shape of economy in the manufacture of iron. The inventor or discoverer of that could not patent that, but what he did was this: he said, "I will patent that idea in combination with the mode of carrying it out—that is, I tell you you may heat your air in a closed vessel next your furnace, and then that will effect the object;" and it was held that that would do, and that nobody could use the hot blast in the iron manufacture, during the period of that patent, for the purpose of manufacturing iron. Now, that is a much stronger illustration than this of the validity of a patent, as regards the subject matter. For here is a complicated machine. Nobody says that this identical machine has ever been seen before, but what they do say, and what I have no doubt is true, is that, given the state of knowledge as regards mechanics, you do not want much invention when you are told what the idea is to find out this machine and carry it out. That did not require invention at all. In the case of the hot blast the man did not pretend to invent anything; he said a machine of any shape in which you can heat air. In this case Mr. Otto does allege he has invented a machine. It appears that he did, although a machine which, *per se*, was not of sufficient novelty, probably, to support a patent alone. It comes, therefore, to this, that we have a principle and a mode of carrying it out, and, I will assume for this purpose sufficiently described; and that is a good subject for a patent. I now pass to the next set of objections.

The next set of objections are objections which I am very familiar with, and that is insufficiency of specification. The insufficiency in this case is an allegation, or a series of allegations, as to omissions, and a series of allegations as to mistakes in the drawings. They are both classes of objection which are quite familiar to those who have had to do with patent cases, and are always remarkable in this way, that they are never found out until the action is brought. The workman always makes the machine, and the machines are made in hundreds or in thousands, and nobody has found them out. But when you come to study the specification, and then to study the machine, you find them out. I recollect many years ago I was counsel in a case which is not reported, but which is a very good illustration for all that. I was counsel for some machine makers who made a thrashing machine, and a very clever thrashing machine it was, and they sold thousands of them. The beaters, as everybody knows, of a thrashing machine are both cut across, and the cuts should be set opposite to one another, otherwise they will not thrash grain at all; but the stupid draughtsman by some mistake had put them all parallel, so that, if it was made according to the drawing, it would not have thrashed anything. Nobody found that out until we came into Court; and Ransome and Co. had made thousands of them, and, of course, they had made them with the beaters set crosswise. Well, when it came to be discussed the thing was too absurd; it would not have been a thrashing machine at all, and, of course, the drawing was corrected by the letter-press, which told them that the thing would thrash, and, as I said before, the remarkable part of the matter was that until we got into Court nobody found out the mistake in the drawing; though the patent had been sold, and the machine had been made, the mistake had not been discovered. In these matters, therefore, it is not for us to find out how not to do it, but when you find that the drawing does not work exactly, the workman sets himself at once to see how it ought to be done, and, as I have already said, in practice the thing never arises at all.

Now, I will take these mistakes one after the other. The first mistake is a very odd one. The mode which the patentee points out to work out his machine is that he is to admit air, and then gas and air, into his cylinder, and his drawing is so constructed that it will not admit either the one or the other. In fact, the slide as put into his drawings instead of admitting air, as it ought to do, will not admit it—shuts it off when it comes to the point. Well, of course, when the workman found out he would say, "There is some mistake in this slide," and it turns out that by a very simple thing indeed—simply enlarging it at one end—it will work, and do exactly that which the patentee says it ought to do. We have the usual evidence in this case. Engineers are called who say that a workman will find it out and put it right, and on the other side I must say there is no conflict of evidence on this point, for the scientific gentlemen who were called on the other side do not dispute that the workman ought to, and could, put it right. Then the next objection taken to it was that they say there is no excentric or cam. Says Mr. May, "they work a slide, while there is none in the drawing," but there is in the letterpress. They are told they are to have an excentric or cam. There, again, the workman will have to supply it. Then, in the letterpress, there is none. Then it is said there is no excentric or cam in the drawing for working the exhaust valve. Well, the valve will not work of itself, and of course, the workman would put something of that kind in. I need not read Sir Frederick Bramwell's evidence, although I have a note of it, in which he says the workman would do it all. Then the next point is, that they think that it does not show properly—nor does it show properly—how the fire in drawing No. 1 is to get to light the mixture; it requires a slight shifting, as Sir Frederick Bramwell points out. Well, of course, the workman would know it was to be lighted, and he would easily make a hole or orifice in the slide. That is what Sir Frederick Bramwell says. Then there is this difference between Sir Frederick Bramwell and Mr. May—on the whole, although he does not differ about one, he says he thinks all these together would make too many. That is the real distinction between their evidence; he puts those four objections altogether—the want of the two excentrics, the non-communication between the charge chamber and the flame, and the alteration of the slide. Then he thinks it is altogether too much to expect of the British workman that he will find out all four. He does not say that he would not find out each one separately; but he says he thinks he would not find out all four. Upon that Sir Frederick Bramwell differs from him, and you will find his evidence at page 45. He says he would have to do exactly the same things. Then he is asked what he would have to do. Q. He would have to alter the passage D, would he not? A. Yes. Q. He would have to provide the cam or excentric to work this slide? A. Yes. Q. He would have to alter the passage by which the gas flame was communicated to the combustible charge? A. Yes; no, not alter the passage; he would have to alter the drawing in front; he would not have to alter the passage. Q. If he made the passage according to the drawing he would not communicate the flame? A. That is so. Q. Then he would have to alter the passage according to the drawing? A. Yes. Q. Then he would have to provide means of opening valve F. A. Yes. Q. That would be a different means, but the same thing as opening the slide? A. Yes. Q. Then the workman would have to do all these things? A. Yes. Q. He might? A. Yes." So that he is of opinion that there is no difficulty at all in the matter, and the workman would be able to put it right. As I said before, I prefer that opinion; I know by experience that that is so, and there is not produced on the other side a workman who said he had ever tried to make the machine, and could not, or that he had any difficulty in making it. No practical man was brought forward who had failed in making it, and I entirely give credence to the testimony on the side of the plaintiff, that the workman would do it. But I do not discredit the evidence on behalf of the defendant, because all he says is, "It is expecting an amount of intellect which I do not think you will find." That is all that Mr. May says upon it. He does not say that he has ever tried a workman, or that he has ever heard of one who failed. It seems to me that that is exactly the class of objection which ought not to prevail, and according to my experience—which is very great—which never has prevailed.

I now come to an objection of a far more serious kind. It is said the specification does not show the proportion in which the air is to be put in as regards the combustible mixture. Well, now, the answer is, first of all, no exact proportion is wanted. Upon that I think the evidence is clear enough; but it is equally clear that a mere film of air will not do. You must have what is called by one of the witnesses for the plaintiff a notable quantity, which is called by another of the witnesses for the plaintiff a considerable quantity, and which, no doubt, must be a substantial quantity, having regard to the quantity of mixture. Now these words, "notable quantity," or "substantial quantity," or "considerable quantity," are not to be found in the specification; and the question one has to consider is whether the specification tells you fairly enough to inform a person about to make the machine, that there must be this quantity, or, I should rather say, a person about to use the machine. Well, I think it does. The first thing to be remembered is, in specifications of patents, that they are addressed to those who know something about the matter. A specification for improvement in gas motor engines is addressed to gas motor engine makers and workers, not to the public outside. Consequently you do not require the same amount of minute information that you would in the case of a totally new invention, applicable to a totally new kind of manufacture. In this case the inventor says this: "I am going to turn that which was a sudden explosion of gas into a gradual explosion of gas, and I am going to do that by the introduction of," what he calls, "a cushion of air, in one place between the piston and the combustible mixture." Well, now, if a man is left without any more information, he asks, "How much air am I to let in?" He lets in a little air, and he finds that the thing explodes as before; and he lets in some more, and he finds directly, on the mere regulation of his stop cock, how much is required; and he finds very soon that he has let in enough, and now there is a gradual expansion, and no longer a sudden or explosive expansion. It does not appear to me that that requires invention. It requires a little care and watching, and that is all. If a man told you to mix a glass of brandy and water, and to use brown brandy, and that you were to mix it until it was pale yellow, the exact quantity need not be told to you. You would soon find out when it was pale yellow. That is the object to be achieved. Nobody would say it requires invention, and that is what this man tells you. But he does tell you a great deal more; he does not leave you there. When you come to look at his specication he has drawings, and his drawings, with the letter-press, shows that he really does put in nearly as much air as explosive mixture. You will find that in the description at page 4, where he describes the Fig. 1, and shows, between lines five and ten, "When the piston is at the end of its instroke, its inner surface being at A, the slide D is in such a position that, as the piston begins its outstroke, air entering by the aperture D^2 passes by D and C into the cylinder. When the piston has reached the point *b* the slide has moved so as to admit combustible gas or vapour," and when you look at the drawing you will see that the distance from *a* to *b* is the same as from *b* to *c*, so that the man who read the description of the drawing and read the letter-press would know that he was admitting a very considerable quantity of air as regards proportion. A similar thing occurs as regards Fig. 3. I will not read it. It is page 5, between the lines 15 and 25, and there he speaks of the air acting as a cushion.

It seems to me there is sufficient in this specification to tell the maker of the engine and the user of the engine, without requiring him to use an inventive faculty, how to make the engine, and in what proportion it will be necessary for the air to be let in—not definite proportions, but proportions, as far as proportions are wanted, to make the machine workable.

And here again the same remark applies. Nobody was called to say they had ever found any difficulty. Nobody said, "I made, or tried to make, a machine according to the plaintiff's specification, and I was unable to produce the result, because I did not know the proportions." Nothing of the sort. Those are theoretical difficulties suggested by the defendants to defeat the patent. No practical worker or practical user of a gas motor engine was called as a witness to give any evidence on any of these points.

Well, then, a suggestion was made at the bar that as regards machine No. 3 (I notice it because it was urged upon us with some force—I will not explain it in detail, because the parties are perfectly aware what it is) that the compression of the air would blow out the simple gas flame and prevent ignition. There was no evidence upon that point, and I decline to admit the assertion of counsel that it would have that effect. I am by no means convinced that it would. In fact, I think it would not. I decline to be asked such a question. A matter of that kind requiring scientific knowledge should be brought forward in the ordinary way by evidence. It is not sufficient for counsel to assert that that would be the effect, and especially to bring forward a point of that kind in the Court of Appeal for the first time, when it cannot be met by evidence on the part of the plaintiff.

That, I think, disposes of all the objections as regards the specification. Then it was said that the gradual expansion of gas did not apply to the machine No. 3.

Now, the only evidence on the point—if I may call it evidence—is to be found in this way. First of all, the inventor thought it did, and says so. Then Mr. Imray is cross-examined, and he is shown a series of diagrams marked on an indicator card; he is asked what those mean, and he says: "Those appear to me to be produced by a gas motor engine similar to plaintiff's." He says that "it is as nearly like those I have seen taken from the out-stroke engine as possible." They are said to be taken from the defendants. Then he is asked, "From which one? A. From the plaintiff's. Q. Which of the plaintiff's. A. The plaintiff's compression engine. Q. Made under the patent? A. Yes. Mr. Aston: Modification No. 3? A. Modification No. 3." Then he is asked what it shows, and his answer is, "It shows distinctly a gradual combustion and a gradual increase of pressure."

Now, that is the only evidence upon that, and upon that we are asked to say that Mr. Imray did not understand his business; that the thing was hopelessly opposed to the first principles of mechanics, and I do not know what. All I can say is, I go upon the evidence, and I am not going to take upon myself to say that Mr. Imray did not understood what he was about; and if he had said anything to which all these adjectives ought to be applied, it was very easy to ask Mr. May or Mr. Gardner to say something to the contrary, which they were not asked to do.

Well, that disposes of all that class of objections. The next objection is that there was no evidence of utility. Now, that is an objection of the most moderate kind. It is quite true that it has been said that it is *primâ facie* evidence of want of utility if you do not make and vend your machine, but that is subject to this observation, that you may make and vend an improvement upon it, and if you have found out immediately after you have patented your invention that it can be improved, it does not by any means show that the first invention was useless.

(*To be continued.*)

CONTRACTS OPEN.

THIRD-CLASS CARRIAGES, INDIAN STATE RAILWAYS.

The Indian State Railways invite tenders for underframe and body ironwork, roofing, iron and brass fittings, lavatory and bed fittings, trimmings, and window glass for first-class, composite, second-class, and third-class bogie carriages with end doors. Bodies 46ft. 8in. long, underframes 51ft. 8in. long; and horse-boxes and brake vans, bodies 20ft. long; underframes, 19ft. 10in. long. We illustrate the third-class coach on page 414. We give the specification at some length as it will be found instructive.

1.—The work required under this specification comprises the construction, supply, and delivery in England, at one or more of the ports named in the conditions and tender, of iron underframes, bogie trucks, underframe, bogie truck, and body ironwork, roofing, iron, gun-metal, and brass fittings, lavatory fittings, trimmings, and window glass, with all requisite bolts and nuts, rivets, washers, panel pins, coach and wood screws both iron and brass, for putting the work together in India and fixing the bodies to the underframes, for—four first-class bogie carriages, four composite—first and second-class—bogie carriages, twelve second-class bogie carriages, forty third-class bogie carriages, thirty horse boxes, forty brake vans. All vehicles are to be provided with brake gear, brake blocks being applied to all the wheels, and all the underframes of the bogie carriages are to be provided with truss rods and stays.

2.—All fastenings, bolts, nuts, washers, iron and brass wood-screws, coach screws, rivets, and copper panel pins, &c., are to be supplied in numbers and weights requisite for securing the ironwork and fittings to the bodies and underframes, and for putting the bodies and underframes together, together with an allowance of 20 per cent. extra for waste. The contract does not include wheels and axles, axle-boxes, bearing springs, india-rubber draw and buffer springs, Attock's blocks, and window cushions. These parts will form the subjects of separate contracts. No woodwork, except for the commode lids and looking-glass frames, is required to be sent to India.

3.—The contractor whose tender is accepted must make all such copies of the drawings exhibited as are necessary, and must prepare, at his own cost, from the specification, and from the instructions of the Inspector-General of Railway Stores, a complete set of working drawings of the underframes, bogie trucks, underframe, bogie truck, and body ironwork and fittings, which are to be in every respect approved by the Inspector-General, and must be completed before the work of any part is commenced, or any of the material for them is ordered.

5.—*Materials.*—The whole of the materials used for this contract are to be of the best quality, and subject to the approval of the Inspector-General. No other material than wrought iron or steel is to be used, except where specified otherwise or shown on the drawings. All draw bars, with their hooks and nuts complete, safety chains, with their hooks, eye-bolts, and nuts complete, screw couplings complete, and coupling shackles, are to be made of Lowmoor iron, supplied direct by the Lowmoor Iron Company, cut to suitable lengths and sizes for each article, and each piece is to bear the stamp or brand of the Lowmoor Iron Company. All other wrought iron is to be of some best best brand, of a quality to be approved by the Inspector-General, and to be specially suited for smithing purposes. No iron of foreign manufacture is to be used for any part of the work under this contract. All wood screws are to be of Messrs. Nettlefold's or other approved manufacturer's, best make.

6.—The steel or iron is to be well and cleanly rolled, and free from scales, blisters, laminations, cracked edges, defects, and blemishes of every sort, and the name of the maker must be stamped, or where practicable, rolled, on every piece. When scrap iron is used it must be cleaned in a properly constructed machine before being used for the manufacture of forgings. The iron must be of such strength and quality that it shall be equal to the under-named several tensional strains, and shall indicate the several rates of contraction of the tested area at the point of fracture that follow, namely:—

	Tensional strains per square inch.	Percentage of contraction of fractured area
	Tons.	
Bars and rods	24	20
Plates	21	10
Channel, angle, and T-iron	22	15

All the channel irons in the underframes, bogie trucks, and bolsters of the bogie carriages are to be made of steel; the channel bars of the horse boxes and brake vans, angle bars and plates, may be made of steel; the steel is to be of such strength and quality that it shall be equal to a tensional strain of not less than 27 tons or more than 31 tons per square inch of section, and shall indicate a contraction of 30 per cent. of the tested area at the point of fracture, and must be capable of being bent double on itself without showing any signs of fracture. The spelter used for galvanising the roof sheets and other work is to be the "best Silesian spelter." The tests are to be conducted by some person approved by the Inspector-General, who will report the results of them to him. No steel or iron is to be used which, in the opinion of the Inspector-General, falls short of the tests and other requirements of this specification. The cast iron used for the work is to be made of a strong mixture of metal of such quality that bars of it 3ft. 6in. long, 2in. wide, and 1in. deep, when placed edgeways on bearings 3ft. apart, will stand a weight of 30 cwt. suspended from the centre without breaking. Bars for making these tests must be cast before the commencement of and at such intervals throughout the contract as the Inspector-General shall direct. Should any of these bars fail to stand the required test the castings from the same mixture of metal will be rejected. The expense of all tests of every kind will be borne as provided for in the conditions of contract. The Inspector-General is to have power to adopt any means he may think fit, in order to satisfy himself that the kinds of materials specified are actually used throughout the contract. The names of the makers from whom it is proposed to obtain the materials are to be submitted to the Inspector-General for approval before the commencement of the work. Should the contractor proceed with any part of the work before receiving from the Inspector-General the approval of the names of the makers and the class and quality of the materials proposed to be used for the execution of the contract, and should the materials be subsequently found, in the opinion of the Inspector-General, to fall short of the tests or other requirements of this specification, or to have been obtained from other than the approved makers, the whole of the work thus manufactured will be rejected.

7.—*Manufacture.*—The intention of this contract is that every piece of steel or iron shall be manufactured with such accuracy that any piece may be used without dressing of any kind in the place for which it is designed in any of the vehicles. To ensure this every piece must be made from a carefully prepared metal template or gauge, and all holes in it, whether hereafter specially mentioned or not, must be drilled. It must further be drilled through the holes in the template, so that the corresponding parts in the different vehicles may, without doubt, be exact duplicates of each other. All templates and gauges must be provided by the contractor at his own expense, and must be of such material, and made in such a manner, and be renewed as often as the Inspector-General shall desire.

8.—*Underframes and bogie trucks.*—All channel bars are to be made perfectly straight and square over the flanges, by pressure and not by hammering, before being used for the underframes or bogie trucks. The ends of all the channel bars must be finished by machinery to the exact shape and dimensions shown on the drawings. The iron casting for the bogie centres, sliding blocks, spring sockets, and brake blocks are to be sound, sharp, and perfectly clean on the surface. The brake shaft levers, brake spindle, brake spindle hangers, brackets for brake blocks, suspending links, brake thrust rod, and connecting-rod ends, brake screw, nut, links, bell crank, bell crank brackets, scroll iron and spring shackles for the horse boxes and brake vans, and the axle box bearing bar central fulcrum pin, swing beam brackets, suspending bar bottom supports, and all jaws and eyes of the brake gear of the bogie carriages must be forged out of the solid; all holes in them are to be drilled and the pins turned. All the working parts of the brake gear and of the bogie trucks must be planed, bored, or turned, so as to make good machine work. The underframes of all the bogie carriages are to be trussed as shown on the drawings, or in such manner as the Inspector-General may direct. All holes in the pieces of iron which form the bogie trucks and underframes for all vehicles must be drilled. The buffer heads must be forged solid on the rods, and not dabbed on to them under a steam hammer. The buffer faces must be turned to a perfectly spherical or flat surface, as shown on the drawings, and the edges and back of the flanges on the plungers must be faced up true. The buffer rods must be drawn down under a steam hammer true to the form shown, and turned. The buffer plungers must be turned and the buffer eases bored out so as to be a proper sliding fit. The knees connecting the channel bars forming the underframe and bogie trucks may be made out of angle bar, but the edges of the angles must be neatly dressed off and the holes through them drilled. Great care must be taken that these knees are so fitted that the whole breadth of each side bears against the parts which they connect. Great care is to be taken to cut the threads of the screw couplings accurately to the dimensions given on the drawing exhibited, and generally to finish them up in the best and most accurate manner. Each of these couplings must be fixed as if in actual practice, and screwed both in an out to the full length of travel.

9.—*Body and roofing ironwork and fittings.*—All knees are to be neatly squared up at the angles, the edges chamfered, and the ends drawn down. The panel plates for the body of the carriages are to be rolled to a weight of 2·5 lb. per square foot. They must be perfectly flat and level, and finished by planishing or straightening with the hammer. The edges of all the plates must be planed accurately square. The eyes of both hinges and hinge feet for the horse-box and brake van doors are to be forged out of the solid and welded on to the arms not less than 6in. from centre of eye, and the eyes of both hinges and hinge feet are to be faced on both sides, all holes of every kind in them being drilled and the pins turned. All fastening bolts, guides, eyebolts and pins, halter rings and check chain bolts are to be forged out of the solid. The roofing sheets are to weigh before galvanising $1\frac{3}{4}$ lb. per square foot, and after galvanising 30 oz. per square foot; the whole are to be galvanised in the most careful manner. The roofing sheets are to be corrugated after they are galvanised to a pitch of 3in. from centre to centre of flutes and $\frac{3}{4}$in. deep; they are then to be curved accurately to the radius shown on the drawing, and given in the schedule attached to this specification. They are to be delivered with the adjoining edges of each sheet perfectly square with the sides. After these sheets are finished they are to be stacked on the contractor's premises for a month before they are finally inspected and approved. The threads of the bolts are to be cleaned out by means of a revolving brush immediately after being galvanised, and the nuts are then to fit so tightly that they cannot be turned by hand. Any galvanised sheet which is not absolutely covered with spelter, or which shows the slightest evidence of acid spot, crack, or blister in the spelter, or spot of iron showing through the spelter, will be rejected. It is to be in the power of the Inspector-General to adopt such means as he may think necessary to test whether any of these sheets fall short of the requirements of this specification. All the fittings for the vehicles, which are of brass or gun-metal, with the exception of the lamp rings and hinges, are to be polished and lacquered. All the other fittings, with the exception of tanks, commodes, and wash-basins, are to be finished bright. All the ironwork for the bed fittings, not turned or otherwise fitted must be filed up to a smooth surface and then black japanned. The gun-metal hinges are to be cast solid, sufficient metal being left on the joints to allow of their being cut out perfectly clean and true by cutters revolving in a machine. The pin holes are to be drilled and not cast in the hinges, and care must be taken that these pin holes are in the centre of the joint; they must be drilled perfectly straight and the pins cleaned up. The hinges must open perfectly square, and bear truly at every point of contact. The screw holes are to be drilled and countersunk, and not cast in the hinges. The wrought iron hinges for the end platforms of the carriages and the dung flaps of the horse boxes are to be made similar to the gun-metal door hinges. The side door handles are to be neatly got up with the necks square and true. The plates, which are to be of malleable cast iron, are to be recessed; the guides and stops are to be cast solid with the plates, and not brazed on. The friction roller and the parts of the door bolt against which it revolves must be case hardened. The rings for the roof lamps are to be cast and turned out and not spun. The cocks for the lavatory fittings are to be of the best gun metal, and ground perfectly tight. They are to be fitted with stuffing boxes and screwed glands. Each end of the tap is to be fitted with a gun-metal union and nut. The piping is to be the best lead piping, $1\frac{1}{4}$in. diameter in the bore, and is to weigh $2\frac{3}{4}$ lb. per lineal foot. The tanks are to be made of wrought iron plates, No. 12 b.w.g. in thickness, and angle irons $1\frac{1}{4}$in. by $1\frac{1}{4}$in. by $\frac{3}{16}$in. The angle iron frames are to be welded up complete, and fixed outside. A filling opening is to be formed on the top, 9in. diameter, with a hinged lid, secured by a bolt and handle. The rivets are to be of soft iron $\frac{1}{4}$in. diameter, and the pitch of the rivets is not to exceed $1\frac{1}{2}$in. The tanks are to be completely rivetted up and finished ready for placing in their proper position in the carriages; after they are finished they are to be galvanised inside and out with the best Silesian spelter. The wash basins are to be of cast iron 1ft. 3in. diameter outside, and the inside diameter of flange 1ft. 1in. by 5in. deep inside by $\frac{3}{16}$in. thick. They are to have vertical flanges on the two sides, 2in. wide, with twelve countersunk holes for $1\frac{1}{2}$in. wood screws, No. 16. A gun-metal union screw and strainer is to be fitted to each basin, and an india-rubber ring, $\frac{1}{4}$in. thick, is to be placed between the top flange of union screw and the basin, to prevent leakage. The flanges top and interior of basin, and all the front flange or bead are to be enamelled white with best glass enamel. The exterior of the basin is to be glass enamelled grey. Each basin is to be fitted with a wrought iron pipe of $1\frac{1}{4}$in. bore, secured to the basin in the manner shown on the drawing, and fitted with a gun-metal gland cock and wrought iron unions to suit pipe and cock. The commodes are to be made of wrought iron, No. 14 b.w.g. thick, 2ft. 4in. long, and $12\frac{11}{16}$in. outside diameter; they are to be welded up the seam or they may be drawn from a solid tube. A cast-iron top $\frac{3}{16}$in. thick, as shown on the drawing, is to be fitted and attached to the wrought iron body by four $\frac{1}{4}$in. brass bolts and nuts. An angle iron ring, $1\frac{1}{2}$in. by $1\frac{1}{2}$in. by $\frac{3}{16}$in., is to be fitted 12in. from the bottom by twelve $\frac{1}{4}$in. rivets countersunk on both sides, and eight countersunk holes for $1\frac{1}{2}$in. wood screws, No. 12, are to be drilled in the horizontal flange of this angle iron. A teak wood top and lid, each 1in. thick, are to be fitted to each commode, both of these are to be well fitted and French polished on both sides. A zinc ring, $1\frac{1}{4}$in. wide and $\frac{1}{8}$in. thick, is to be let into the underside of the teak top, and fixed by sixteen $\frac{5}{8}$in. brass wood screws, No. 8, and two brass strips, $1\frac{1}{8}$in. wide by $\frac{3}{16}$in. thick, are to be let in on the underside of the lid and fixed by ten $\frac{3}{4}$in. No. 8 brass wood screws in each; these are to be let in across the grain of the wood, which must run in line of hinge or from A to B, as marked on the drawing. An india-rubber pad is to be fixed to the top lid as shown. The top and lid are to be fitted with a gun-metal hinge fixed to each by five $\frac{3}{4}$in. brass screws, No. 12, and jointed to the cast iron tops so as to allow of both being raised. The exterior of the cast iron top, the inner and underside of the inner flange of the same, and the interior of the commode are to be white enamelled with the best glass enamel, and the remainder of the cast iron top and the exterior of the commode are to be glass enamelled grey. The looking-glass is to be of the best cast plate, 18in. by 18in. by $\frac{1}{4}$in. thick, ground and polished. The frames are to be of teak, $1\frac{1}{2}$in. wide and $\frac{7}{8}$in. thick; a small brass plate, with a countersunk hole for No. 16 wood screw, is to be fixed at each corner for securing the frame to the end of the carriage. The top bed frames are to be made of wrought iron piping with solid gun-metal corners; the ends of the corner pieces are to be turned to fit the piping, and are to be secured by iron rivets $\frac{1}{4}$in. diameter, countersunk in the piping; the wrought iron chain brackets are to be bored to fit the piping, and, together with the other bed fittings, are to be finished in the same manner as the other carriage fittings.

10.—*Carriage Window Glass and Trimmings.*—The white and ground glass must be the best quality of cast plate, ground and polished. The tinted glass must be the best quality of glass that can be manufactured, of the requisite shade. It must be perfectly free from scratches and every other defect and blemish, and must be accurately cut to the requisite sizes. To ensure uniformity in size each sheet of glass must be cut to template. The tinted glass must be of the exact shade of the sample, which may be seen at the office of Mr. A. M. Rendel, 8, Great George-street, Westminster. A specimen sheet of glass of each description required is to be submitted for approval, and the manufacture of the remainder of the glass is not to be proceeded with until these specimen sheets have been approved; the glass throughout the contract must correspond exactly with the approved specimen sheets. Patterns of the carriage trimmings may be seen at the India Store Department, Belvedere-road, Lambeth. Where patterns are exhibited they are not necessarily to be considered as samples in regard to qualities, it being the intention of this contract that in every case the articles supplied under it should be the very best manufactured, even if the patterns should be defective. The floor-cloth and roofing canvas are to be of the same description as the samples exhibited, and are to be well seasoned and thoroughly dried before being packed. The floor-cloth is to be of the same pattern as the sample exhibited.

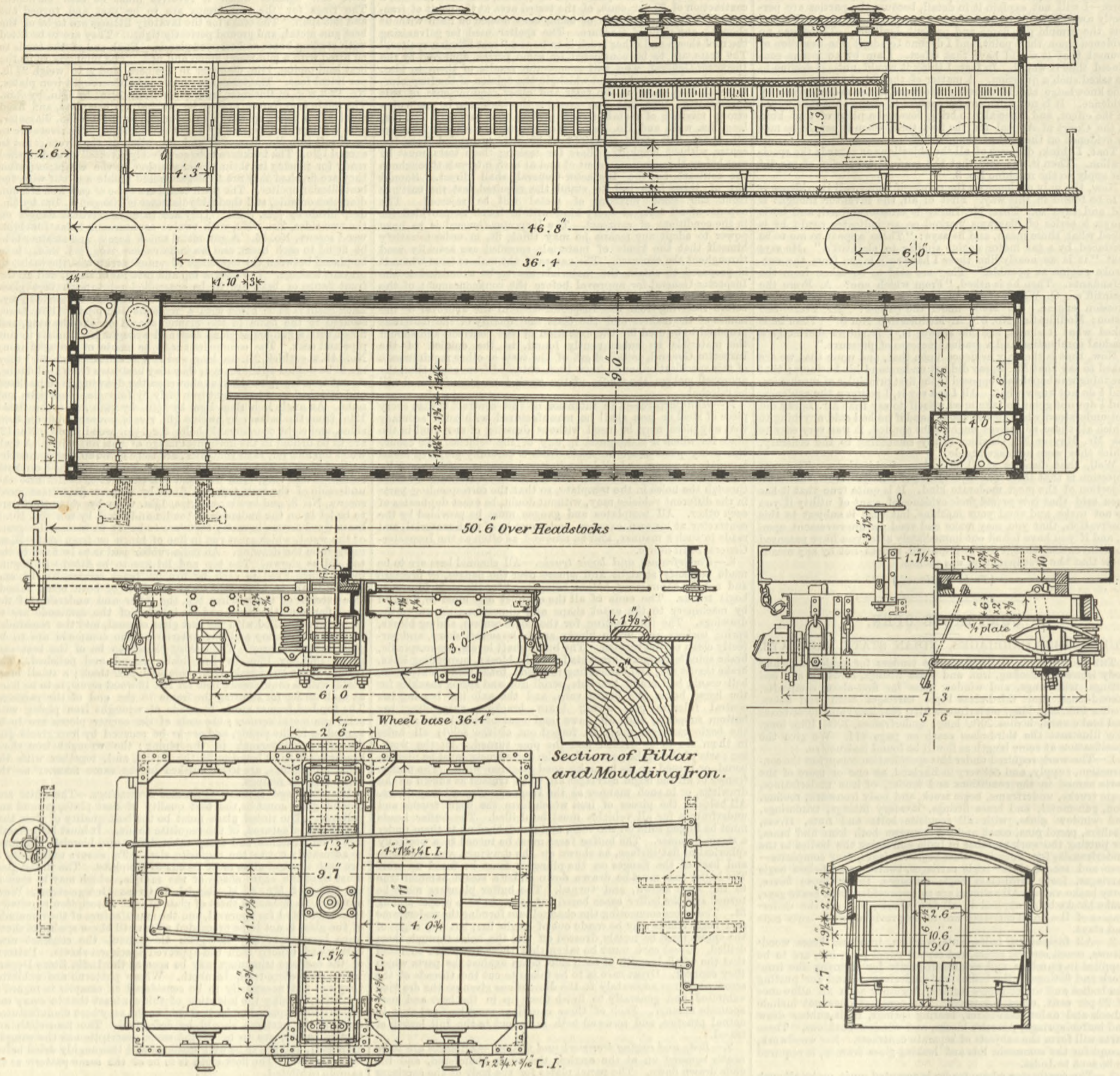
11.—*General.*—All surfaces tinted red on the detail drawings are to be bored, turned, or planed, and finished up smooth and bright, whether mentioned in this specification or not, and all pieces of iron or steel not so bored, turned, or planed must be thoroughly cleaned and dressed up, and finished off in the best style of carriage work. All nuts are to be hexagonal, and must fit so tightly on their bolts that they cannot be turned by hand. Whitworth's standard gauges must be used in turning all pins, boring all holes, and forging or finishing all bolt-heads and nuts, and all bolts and nuts must be screwed to his standard pitch, and the bolts to a length of three diameters. All rivetting is to be done in this country that is compatible with the mode of delivery hereafter specified. All rivets that are rivetted up in this country which are found to be loose, or to have cracked heads, or to be in any other way defective, must be cut out and replaced by others. All workmanship and materials must be of the very best class of their respective kinds.

12.—All fittings, trimmings, glass, brass, and iron wood screws, copper panel pins, bolts and nuts, washers, and coach screws, are to be provided up to the numbers, quantities, and weights named in the schedule attached to this specification.

13.—*Erection.*—One underframe of each class of carriage, with its bogie tracks, is to be rivetted up complete and fitted with all its ironwork, as a sample, and a sample of every article required under this specification must be made and finished complete, and approved by the Inspector-General, before any similar part of the rest of the work under this contract is proceeded with. Should an examination of any of these samples lead the Inspector-General to order any alterations in the design of any of the parts, he is to be at liberty to do so, without claim on the part of the contractor for loss on any of the parts which he may have made prior to the approval of the samples, or for any extra payment, except in regard to weight at the schedule rates. All the underframe and bogie trucks are to be completely rivetted together and tried upon a standard set of wheels and axles, axle-boxes, and springs, so that the accuracy of all the parts may be ascertained. The wheels and axles, axle-boxes, bearing, draw, and buffer springs necessary for erecting these underframes will be supplied to the contractor. Every detail must be tested by gauges at each stage of its manufacture, and be to the satisfaction of the Inspector-General. The buffers and axle guards for each vehicle must be bolted to the underframes, and, after being inspected and approved, are to be marked and stamped to their places before being taken down and packed.

14.—*Inspection.*—No article is to be painted or packed before it

CONTRACTS OPEN—THIRD-CLASS CARRIAGE, INDIAN STATE RAILWAYS.



has been inspected and approved by the Inspector-General. Any article which is found to be in any way defective, or which is not in accordance with the tests or other requirements of this specification, will be rejected. The contractor must provide, free of charge, all tools, labour, and gauges required by the Inspector-General for the inspection, and for such testing of the work as may be carried out on the contractor's premises.

15.—*Painting, packing, and marking.*—After the ironwork has been inspected and approved, it is to be carefully cleaned from all rust, and then painted with one coat of red lead and linseed oil, and afterwards it is to have two coats of good oil paint of different colours, the last coat being of a colour to be approved by the Inspector-General, proper time for drying being allowed between the application of each coat. Every piece of iron, brass, and gun-metal work must have the letters "I.S.R." stamped or cast on it, with the exception of the galvanised sheets, on each of which the same letters must be stencilled. The channel bars must have the same letters, the name of their manufacturer, and the date of their manufacture rolled on them.

16.—The underframes and bogie trucks are to be completely rivetted up, and protected by as many 3in. planks, not less than 6in. wide, as may be directed by the Inspector-General, placed crossways above and below them, and secured in their places by bolts and nuts and hoop iron. The ends of these planks and the corners of the underframe must also be protected by wood secured to the channel bars. All the rest of the work under this contract, except the trimmings, is to be packed in cases, two or more cases containing all the iron and brass work, roofing, bolts and nuts, wood-screws, fittings, glass, &c., requisite for the carriage complete, with 20 per cent. extra bolts and nuts, washers, wood-screws, panel pins, rivets, and coach screws. The extra percentage of fittings, roof sheets, and other parts for all vehicles, must be packed in one or more cases separate from the work required for the complete sets. The step brackets and buffers are to be detached from the underframes, and delivered packed in cases. The trimmings are to be packed in cases by themselves, and not packed with the other work. The canvas, linen, netting, wire gauze, and green baize cloth are to be delivered in rolls, and not cut to lengths. The roofing canvas is to be packed in cases by itself, and not packed with the other work; it is to be delivered in pieces, each of the size required for one carriage, and rolled up. The cases, with the exception of those which contain the glass, are to be made of 1¼in. thick well seasoned deal boarding, with 1¼in. thick elm ends, the whole nailed together with wire nails 3½in. long. They are to be strengthened by battens pitched at a proper distance along the sides, tops, and bottoms, each set of which is to be entirely surrounded with one strap of hoop iron. The cases are to have outside and corner posts, and the ends are to be tied with hoop irons, each stretching across the end and along the sides to meet the first side battens. The hoop iron is to be 1½in. wide, No. 18 B.W.G. thick. Except the outside roofing canvas, all the trimmings and iron and brass fittings for the carriages are to be packed in cases similar to the above, and lined with tin or zinc sheeting, the joints of which are to be soldered so as to be waterproof. The cases, when filled, must not weigh more than 7 cwt. each. The cases which contain the glass are to be made of sound well-seasoned deal 1in. thick, and are to be made to contain fifteen sheets, and must be fitted with two partitions ¾in. thick the full depth of the case. The compartments must have sufficient space to admit of five sheets in each being securely packed with not less than 1½in. of good wheat straw all round. Each pane of glass is to have a sheet of coarse flannel, not paper, on either side of it, and projecting half an inch all round the edge. The tinted glass is to have hay packed between the sheets in addition to the flannel. The quantity of glass to be placed in each compartment, after being protected as specified above, is to be bound together with neatly made thin straw bands and placed in the case on a bed of straw, the remaining space being properly filled in with good wheat straw distributed equally throughout. Each of the cases containing the glass is then to be packed in an outer case made of sound deal 1in. thick sides and ¾in. thick tops and bottoms. The ends to be of 1in. elm. The external cases to be made of such dimensions as will allow of 2in. of wheat straw to be carefully and evenly distributed all round the inner cases. The whole of the lids to be screwed down, the screws to be carefully turned in, and all partitions to be grooved into the ends of the cases. No package containing glass must weigh more than 3 cwt. when ready for shipment. The joints of all cases of every description are to be tongued and grooved. Great importance is attached to the whole of this packing, which must be done in a manner completely to the satisfaction of the Inspector-General.

17.—Every piece or bundle of iron is to have such descriptive and shipping marks painted on it, or punched, and all cases are to be clearly branded or cut, not merely painted, with such descriptive and shipping marks as the Inspector-General may require.

Tenders addressed to the Secretary of State for India in Council, with the words "Tender for Ironwork, &c., for Bogie Carriages and Horse Boxes" on the envelope, must be delivered at the India Office, Westminster, S.W., before 2 p.m. on Tuesday, the 8th December, 1885. If delivered by hand, they are to be placed in a box provided for that purpose in the store department.

STRATFORD-UPON-AVON WATER SUPPLY.*

By J. EDWARD WILLCOX, Assoc. M. Inst. C.E.

THE question of a water supply for the town of Stratford-upon-Avon is one which has for some time past engaged the attention of the local authority, so that it may perhaps be well to preface this paper with a few remarks as to the existing supply, and also to briefly enumerate the events which led to the adoption of the scheme which is now being carried out.

The borough of Stratford-upon-Avon has an area of 3865 acres, a population, according to the census of 1881, of 8053, showing an increase of 831 during the last decade, the present population being 8400; the rateable value is £31,710. The present supply of water for domestic purposes is wholly obtained from wells, the majority of which are shallow and sunk in the gravel beds overlying the red marls of new red sandstone formation on which the town is situated; but in the higher portion of the town towards Clopton the wells are deeper. Complaints have from time to time been made regarding the water from the wells, both as to its excessive hardness and also its impurity; the latter is not surprising, bearing in mind the gravelly substratum and in many instances the close proximity of the drains to the wells, the supply from which in not a few cases has been condemned.

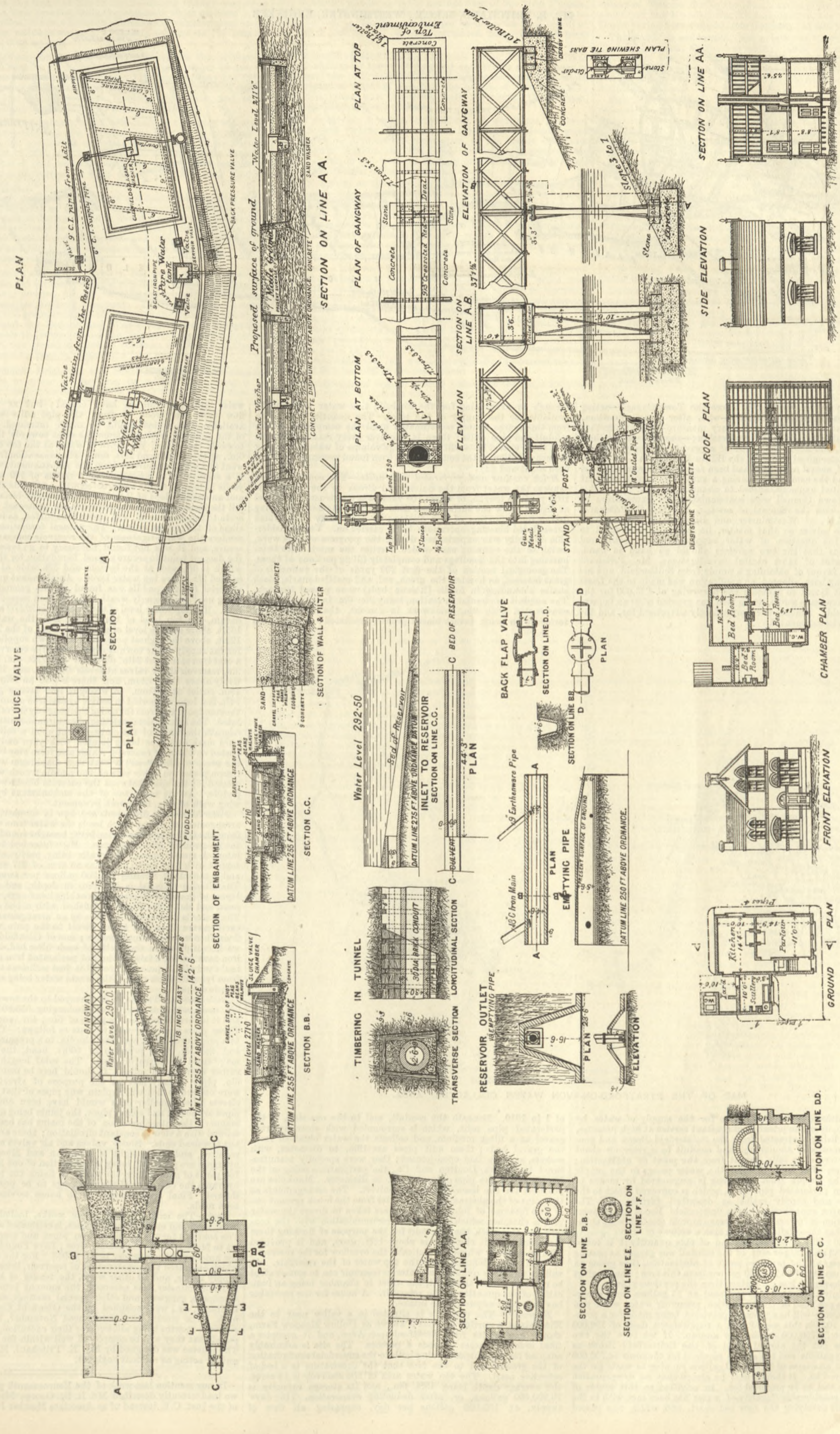
In addition to the supply from the wells, there is, for the purpose of street watering and the flushing of sewers, a 6in. main laid through a few of the principal streets, which is fed by the Birmingham and Stratford Canal, the sum of £70 per annum being paid for the accommodation. Although the question of a water supply had been mooted for some time previously, the first definite step taken in the matter was in 1881; in this year a company was formed, and application to Parliament was made for power to supply not only Stratford-upon-Avon, but also Bearley, Wotton Bassett, and several surrounding villages with water. This

* Paper read before the Association of Sanitary and Municipal Engineers, on the 14th inst.

THE STRATFORD-ON-AVON WATERWORKS—DETAILS OF RESERVOIRS AND EMBANKMENT.

MR. E. PRITCHARD, M.I.C.E., WESTMINSTER, ENGINEER.

(For description see page 414.)



THE STRATFORD-ON-AVON WATERWORKS.

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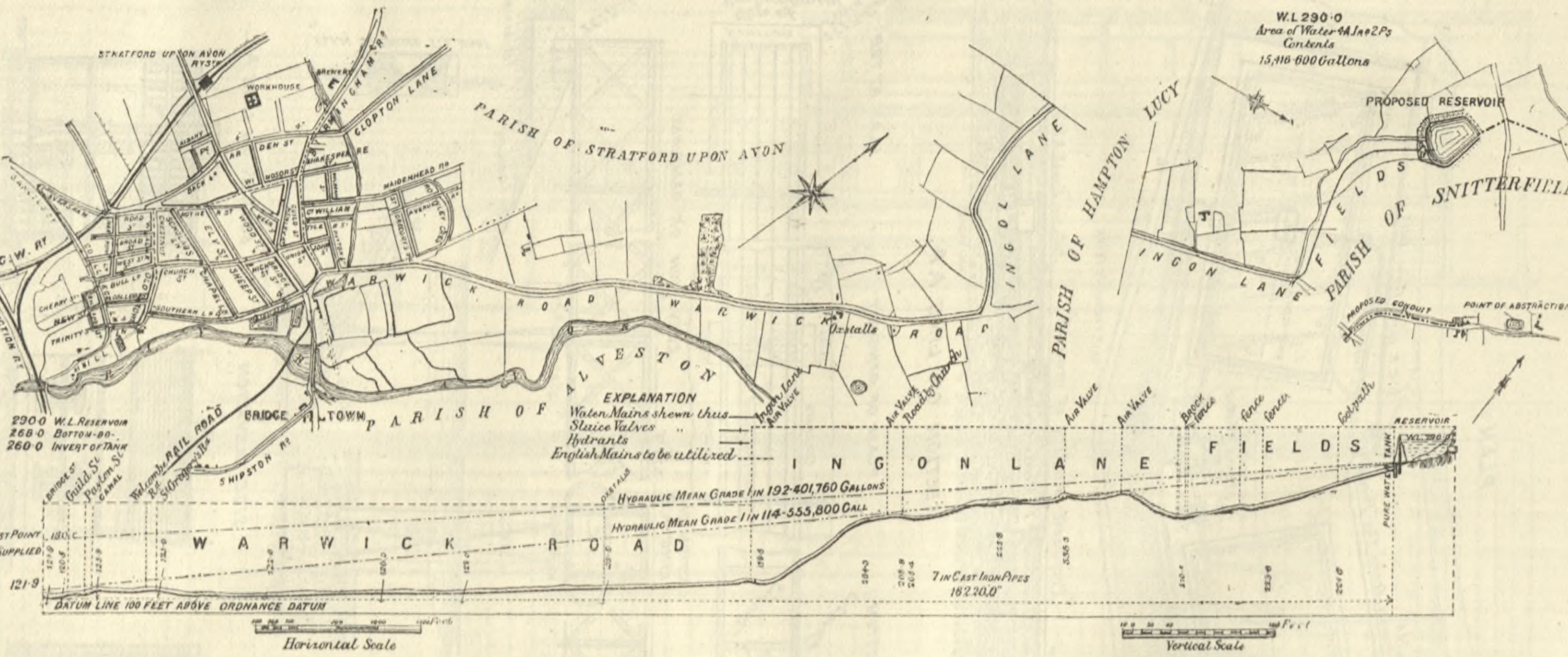
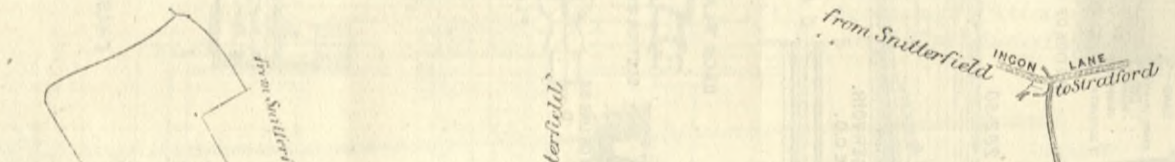


brought the matter prominently before the Town Council—acting as the Urban Sanitary Authority—who, after some opposition, decided that so important a sanitary measure—apart altogether from its value as a financial undertaking—should be under their sole control, and not in the hands of a private company. It was therefore determined to oppose the Bill in Parliament; but before the stage of actual opposition had been reached a compromise was effected, and the company, receiving a sum of money in payment of their initial expenses, agreed to abandon the Bill. As at this time the Town Council were contemplating an expenditure in connection with the disposal of sewage, and Mr. E. Pritchard, M. Inst. C.E., of Westminster and Birmingham, having been called in to advise on that matter, he was also instructed to report on the question of water supply, it being considered advantageous that the two schemes should go hand in hand. After a series of most careful investigations, Mr. Pritchard reported in favour of obtaining a supply from Snitterfield, and his report having been adopted, an application was made to the Local Government Board to sanction the borrowing of £23,000 for the water and sewerage works, which loan was granted after an inquiry had been held. Tenders were immediately advertised for, and the present works commenced.



MAP OF THE STRATFORD-ON-AVON WATER COLLECTING AREA.

The Snitterfield scheme is one for the supply of water by gravitation, upon the principle of constant service at high pressure, the water being abstracted from the Snitterfield Brook and conveyed by means of an underground conduit to a reservoir about three-quarters of a mile distant from the point of abstraction; from thence, after being filtered, the water passes to the supply mains. The supply from the brook is augmented by means of water from perforated pipe adits, which is conveyed direct to the filter beds and supply mains as described further on. The drainage area contributing to the Snitterfield Brook at the point of abstraction is 700 acres, the average annual rainfall being about 27in., so that there falls upon this area a volume of water equal to 428,793,750 gallons per annum; and of this quantity it is found that in 1883 only 20 per cent. of the rainfall was gauged as passing over the weir at the proposed point of abstraction, thus giving an average quantity of 85,758,750 gallons from this area; the gaugings for 1884 showing a less percentage than the previous year.

The supply to the town is proposed at 15 gallons per twenty-four hours per head of the population, assuming water waste prevention fittings will be adopted; provision being made for a population of 10,000, this would give a requirement daily of 150,000 gallons, or 54,750,000 gallons per annum. If we take the two results we get the annual yield of the Snitterfield Brook as 85,758,750 gallons and the supply required for the town 54,750,000 gallons, or an excess of 31,008,750 gallons running to waste for the year referred to. It should here be stated that no compensation water has had to be provided for. In addition to this source of supply, a considerable quantity of water has been met with in the gravel drift overlying the new red marl, and which was passed through in excavating for the conduit; this water will also be available for the supply of the town. The quantity obtainable from this source cannot be estimated until the completion of the conduit and pipe adits; there is, however every reason to believe that these gravel beds will yield a large volume of water, as during the construction of the conduit it has been found necessary to pump both night and day.

Brick conduit and perforated pipe adits.—The conduit which conveys the water from the Snitterfield Brook to the reservoir is 1080 yards in length, of which 700 yards was constructed in tunnel at depths below the surface from 20ft. to 65ft., the headings being driven for a portion of the distance in hard rocky marl, which necessitated blasting operations being carried on. Very considerable difficulty was experienced during the progress of this work, owing to the running sand which overlies the marls here twice bursting into the headings and completely filling portions of them. The geological section of the first 200 yards of the tunnel is of great interest, as besides the green, red, and mottled marls, black shales abounding in fossils (Rhætic beds) were passed through. The conduit is circular in section, being 2ft. 6in. in diameter, and constructed with 9in. brickwork in cement, the invert being formed with brick invert blocks properly radiated: it has a fall of 1 in 1610. Beneath the conduit, and to the one side, is the perforated pipe adit, which is surrounded with clean assorted gravel as a filter medium, and collects the water obtained from the gravel beds; these adit pipes are 12in. in diameter, with sockets, and are laid open-jointed; they were specially manufactured by Messrs. Doulton and Co., the perforations being on the top portion of the pipe only, and ½in. in diameter. Manholes are provided for the inspection of the culvert. The arrangements at the point of the abstraction of the water from the brook present one or two features of interest. Means are taken to divert the water into a chamber which is in direct communication with the conduit and also with the pipe adit for the purpose of flushing them if necessary; this chamber is about 12ft. deep, and is provided with an overflow which is practically the overflow for the reservoir, its level being identical with the top water of the reservoir. As will be seen, the quantity of water in reservoir can to some extent be regulated from this point, the water in chamber being an indication of the quantity in the reservoir. A house for the caretaker has been built adjoining the intake.

Reservoir.—The reservoir is situated in a valley near to the King's-lane, a portion of what is known as Hollow Meadow Farm, about three miles from Stratford-upon-Avon, and it occupies a total area of 7 acres 3 roods 4 perches. The site is admirably adapted for the purpose, owing both to the superficial configuration of the ground and to the fact that the substratum is a bed of retentive marl. The top water area of the reservoir is 4½ acres, the average depth being 18ft. 6in., and its storage capacity is 19,200,000 gallons, or, after deducting evaporation, 116 days' supply, at 150,000 gallons per day, supposing all flow of water into reservoir to have ceased; but as the minimum flow from the brook or from the pipe adits will be always available, this period would be much increased. The bottom of the reservoir is sloped from the sides towards the centre, and towards the outlet, the depth of water at the top end being 14ft. 6in., at the bottom end 24ft. 6in. The excavation from the bottom went in a great measure to form the embankment, which on plan is a segment of a circle having a radius of 100 yards; it is 212 yards in length, and is constructed with an inside slope of 3 to 1 and an outside slope of 2 to 1, with a roadway formed at the top. All the inside slopes of the reservoir are protected by 6in. of concrete to top water level, and above that turfed, as is also the outer slope of the embankment. The natural formation of the ground renders the water-tightness of the reservoir comparatively easy to secure, and it was not found necessary to go lower than 10ft. at the deepest point to secure a good foundation for the puddle wall, which is 6ft. wide at the bottom and 3ft. wide at the top, and is carried 2ft. above top water level. An abundant quantity of good material for the puddle was found on the ground, which before being used was properly weathered and then passed through a pug mill. The top water level of the reservoir is 292·50 above Ordnance datum, the top level of bank being 297, the water level being 165ft. above surface level of ground in front of the Town Hall, and 122ft. above the highest portion of the town supplied. The water for the supply of the town is drawn from the reservoir by means of a cast iron standpost 24in. diameter and 27ft. 6in. high, with two 9in. reservoir sluice valves at levels 9ft. 6in. and 18ft. 6in. respectively above the bottom, and there is also an 18in. valve and an 18in. outlet at bottom. A wrought iron lattice girder gangway, 74ft. 3in. long, supported in centre by cast iron columns, leads out to the standpost, and from the end of this gangway the valves are manipulated. The 18in. outlet consisting of cast iron socketted pipes is taken beneath the centre of the embankment upon a solid foundation of hard marl, each pipe being jointed with yarn and lead, and supported on blocks of concrete, which also form stop blocks to prevent the creep of the water; a cast iron diaphragm was for the same reason placed on either side of the puddle trench where the outlet crossed it; the space between the concrete blocks was filled in with puddle. At the inner toe of the embankment by the outlet are wing walls of 18in. brickwork in cement.

Filter beds.—The filter beds are two in number, and fed by an arrangement of piping which leads the water from the reservoir or from the adit pipes, the latter being brought round the outside of the reservoir by 12in. iron pipes. Each filter bed is 65ft. by 30ft. internal measurement, the walls being partly of concrete and topped with brickwork; each has an area of 217 superficial yards, and is capable of filtering 151,900 gallons per twenty-four hours. The filtering material is 5ft. 6in. in depth, and consists of five layers of gravel of all sizes approaching hens' eggs, walnuts, beans, peas, and shot; the whole is finished with a bed of 2ft. of sand. The water is drawn off the filters by an arrangement of perforated earthenware pipes, and taken direct to the pure water tank, and from thence to the supply mains; one of Glenfield and Co.'s sand washers is placed in the centre of each filter bed, it consists of an iron tank having a false bottom of perforated iron plates; to wash foul sand all the pressure needed is just sufficient to keep the sand from lying on these plates, the waste water being carried off by an overflow pipe.

Distribution.—The water is conveyed to the town by means of a 7in. main, which is capable of discharging 555,800 gallons daily, and it is then distributed by pipes of 6in., 4in., and 3in. diameter. These pipes were subjected to tests as follows:—The 7in. and 6in. to a pressure of 400ft. per head, the 4in. to a pressure of 500ft. head, and the 3in. to a pressure of 600ft. head, the pressure being maintained for three minutes. The total length of pipes laid is rather over eleven miles. It should here be mentioned that the 6in. pipes already laid for the purpose of street watering, &c., were utilised, which will explain why pipes of that size are used in streets where smaller ones would have been amply large. All pipes are socket and spigot pipes, the joints being made in the usual manner; the interconnection of the mains has been carefully considered with a view to constant circulation; there are in consequence but few dead ends. Sluice valves and air valves are placed where required, and eighty-eight of Bateman and Moore's patent ball hydrants are provided, being a proportion of one hydrant to every 160 yards of main laid in the town; in fixing the position of these hydrants the character of the buildings to be protected was considered. Final arrangements as to house services have not yet been made.

Cost.—The entire cost of these works, including purchase of land, legal and engineering expenses, is estimated at about £21,000. The contract for the supply of iron pipes and special castings was let to Messrs. C. E. Firmstone Bros., Lays Foundry, Stourbridge, the amount of their tender being £3063. For the second contract, which embraced the construction of reservoir, brick conduit, laying supply mains, and all other work, the tender of Mr. George Law, of Kidderminster, was accepted, the amount being £14,077. The standpost, gangway, and other special castings, as well as valves, hydrants, &c., were supplied by the Glenfield Company, Kilmarnock. The works were commenced November, 1884, a period of eighteen months being allowed for their execution, and it is anticipated that they will be completed well within the stipulated time. The scheme was designed by Mr. E. Pritchard, M. Inst. C.E., the author acting as resident engineer.

In our mention last week of the Bournemouth piers competition we inadvertently described Mr. R. St. George Moore as a student of the Inst. C.E. instead of as Associate Member Inst. C.E.

RAILWAY MATTERS.

The total number of personal accidents in the United Kingdom reported to the Board of Trade by the several railway companies during the nine months, including accidents which occurred upon their premises, but in which the movement of vehicles used exclusively upon railways was not concerned, amount to 710 persons killed and 5098 injured.

Referring to the paragraph which appeared in this column of our last impression on the lighting of railway carriages by gas, we are informed that the Pope's Patent Lighting Company has fitted a large number of carriages on the London and North-Western, the Hull and Barnsley, Great Western, Caledonian, and other lines, including in all nearly two thousand carriages.

The London, Chatham, and Dover Railway Company will apply for an Act extending the time for the compulsory purchase of lands and the completion of works authorised by their Further Powers Act of 1881 and their Maidstone and Faversham Junction Railway Act of 1881, and extending the time for the completion of the works authorised by their Act of 1879 and their Further Powers Act of 1881.

The Board of Trade summary of accidents and casualties which have been reported as having occurred upon the railways in the United Kingdom during the nine months ending 30th September, 1885, gives accidents to trains, rolling stock, permanent way, &c., causing the death of eighteen persons and injury to 379; as against fifty-three and 640 in the corresponding period in 1884. These figures include railway servants.

The London and South-Western Railway Company intends to apply for an Act for leave to bring in a Bill to transfer to them the undertaking, powers, &c., of the Wimbledon and West Metropolitan Junction Railway Company. Powers will also be asked for in the Bill transferring to the company the undertakings of the Swanage and the Bodmin and Wadebridge Railway Companies, and to enable the company and the Brighton Company to exercise the powers now vested in them in reference to the undertaking of the Southsea Railway by means of a joint committee.

The London, Brighton, and South Coast Railway Company notifies its intention of applying for an Act authorising it to make new junction railways at New-cross; to extend the time for the purchase of land for and the completion of the Oxted and Groombridge railway; to provide for or confirm the transfer to and vesting in the South-Western Company and the company jointly of the undertaking of the Southsea Railway Company; and to enable the company and the Isle of Wight Marine Transit Company to enter into agreements with respect to the working, management, &c., of the undertaking of the latter company. The Bill may contain power for the company to purchase or lease the undertaking of the Transit Company, and to admit the South-Western Company to join in any such arrangements.

The wooden viaduct which carried the Great Western Railway over Hoo Brook, near Kidderminster, has now been superseded by a structure of brick. The viaduct was the longest of those on the Oxford, Worcester, and Wolverhampton Railway, which Brunel planned, and it was at the time of its erection considered a wonderful piece of engineering skill. But of late fears were entertained regarding its stability, and upon the recommendation of the Board of Trade the new viaduct was commenced. Its length is 1100ft., and it is carried on twenty semicircular arches across the valley, in a curve corresponding with that of Brunel's viaduct. The parapet walls have a coping of stone, the structure itself being built of brindled bricks, of which 7,000,000 were required for the work. It is proposed to open the viaduct for traffic next week.

As the Midland Railway passenger train leaving Birmingham at 2.48 p.m. for King's Norton was rounding a sharp embanked curve, midway between New-street station and Camp-hill, the engine suddenly left the rails and went over the bank, dragging the tender with it. The composite carriage which followed, the front portion of which formed the guard's van, fortunately struck against a brick parapet which had been newly erected at this point, and the shock, besides displacing some of the masonry, caused the coupling to break, and prevented the train, in which there were some forty or fifty passengers, from sharing the fate of the engine. The latter toppled over and became embedded in the bank, while the tender rolled into the dry bed of the canal at the bottom of the embankment. The driver and fireman who went over with the engine escaped in a marvellous manner with comparatively slight injuries. The cause of the accident, it is believed, was the giving way of some part of the mechanism of the engine. There has never been, it is said, an accident on the curve before, and the rails themselves were not at all displaced.

On the Plymouth and Tavistock railway, on the 18th inst., a fatal and disastrous accident occurred to the London and South-Western train due at Devonport at 6 p.m. A report says: That about a mile from the Yelverton station the train was felt to be off the line, and after proceeding about 120 yards all the passenger carriages came to a standstill on the permanent way. The passengers, about 20, alighted, and were greatly dismayed at the wreck which surrounded them. The engine, tender, and guard's van lay about 20 yards down on the embankment, having turned over and been smashed to pieces. The guard, Alfred Edwards, of Exeter, found himself under his shattered van, but was able immediately to extricate himself, escaping with a severe cut in the hand. The stoker, John Wills, a single man, of Exeter, was thrown free of the engine down the embankment, and was so severely cut about the head that he had to be taken into the South Devon Hospital at Plymouth. The driver, John Milford, married, of Exeter, was found under the engine dead. It is noteworthy that the carriages were not overthrown or smashed, and no brake seems to have been employed, but the speed may have been small.

The report of the Board of Trade on the collision which occurred on Sunday, the 23rd August, at Warwick-road Junction, close to Earl's Court Station, on the Metropolitan District Railway, has been published. It will be remembered that we commented upon this accident at the time, and said that had the semaphores been properly arranged to go to danger when anything wrong happened or rods broke, or if the signals had been working by electro-magnetism, the accident would not have occurred. Major-General Hutchinson's report states that the immediate cause of this very serious collision was the fracture of the vertical rod working the Warwick-road Junction down home signal, applying to the line from West Brompton to the main down platform line at Earl's Court. It appears that in March, 1882, two 2-armed posts had been substituted at Warwick-road Junction for a 4-armed post for the down home junction signals on the line from West Brompton. The rod which failed was a portion of the rod which had worked the top arm of the 4-armed post, which had been put in in 1878, the lower part of the rod having been again used for the home signal on the northern of the two new posts. This rod is of wrought iron, 14ft. 9in. long and ⅝in. diameter. It was screwed at the bottom into a slot link, and just above the connection there is an adjusting nut for regulating the length of the rod. The fracture took place inside this nut in consequence of a flaw, which extended nearly throughout the whole surface of fracture. The requirement of the Board of Trade has long been that "any signal which is worked by a wire or rod should be so weighted as to fly to or remain at 'danger' on the fracture of the wire or rod," a requirement which was, of course, not fully carried out in the case of the signal which failed in the present instance. It is only within a comparatively recent period that the balancing of the arm, to overcome the weight of the rod in whatever part it may break, has received the attention which it deserves, and the Metropolitan District Company has been for some time engaged in substituting properly balanced arms for the original ones; and, strange to say, the arm of the home signal close to and on the right of the one which failed was a new arm of this description.

NOTES AND MEMORANDA.

In a paper read before the American Society of Civil Engineers, Mr. Benjamin Rhodes gives the average flow of the river Niagara, according to the many careful measurements of the United States Lake Survey, as 275,000 cubic feet per second; the total height of the fall is 230ft., and its total calculated power 7,000,000-horse power.

The deaths registered during the week ending November 21st in twenty-eight great towns of England and Wales corresponded to an annual rate of 19·8 per 1000 of their aggregate population, which is estimated at 8,906,446 persons in the middle of this year. The healthiest places were Bradford, Hull, Plymouth, Birmingham, Norwich, Brighton, and Oldham.

The twenty-six furnaces—only fifteen of which are, however, now in blast—whose owners compose the Comptoir Métallurgique de Longwy, or Ironmasters' Association, in the corner of France that adjoins Belgium and the Grand Duchy of Luxemburg, are capable, when in full work, of turning out 800,000 tons of forge pig, or 650,000 tons of foundry pig per annum.

Some remarks on the subject of M. Hirn's recent experiments on the velocity of gases, with a view to testing the truth of the kinetic theory of gases, were recently read before the Paris Academy of Sciences by M. Faye. The author infers from the results of these experiments that the kinetic hypothesis will have to be reconsidered, if not absolutely rejected. The limit which it imposes on the velocity of gases under certain conditions of temperature and pressure is shown to be imaginary.

In London last week 2682 births and 1557 deaths were registered. Allowance being made for increase of population, the births were 91 and the deaths 175 below the average numbers in the corresponding weeks of the last ten years. The annual death-rate per 1000 from all causes, which had been 17·5, 18·9, and 19·6 in the three preceding weeks, rose last week to 19·9. During the first seven weeks of the current quarter the death-rate averaged 18·3, and was 2·1 below the mean rate in the corresponding periods of the nine years 1876-84. In Greater London 3501 births and 1950 deaths were registered last week, corresponding to annual rates of 35·1 and 19·6 per 1000 of the population.

The proportion of organic matter present in the water supplied from the rivers to London during the month of October, though slightly in excess of that characterising the supply of the past three months, was found to be very small, and exceptionally small in view of the season of the year and of the swollen state of the river. The report of Mr. William Crookes, F.R.S., Dr. William Odling, and Dr. C. Meymott Tidy states that the average proportion of organic carbon in the Thames-derived supply of the month was ·128 part, and the maximum proportion in any one sample ·145 part in 100,000 parts of the water, as against an average of ·119 part, and a maximum of ·146 part, for the preceding three months. In respect to state of aeration, and degree of freedom from colour, and from any trace of turbidity, the quality of the water supplied by all the seven companies was unexceptional.

Alloys of copper with cobalt are readily obtained by melting the two metals together under a flux of boric acid and wood charcoal, or by melting copper with an alloy of copper and cobalt which is formed in the process of copper smelting. The alloy used by M. Guillemin for this purpose had the composition Co, 48·28; Ni, 1·0; Cu, 50·26; Fe, 0·46; = 100. The alloys investigated contained from 1 to 6 per cent. of cobalt. They have a red colour, and a fine, silky fracture, resembling that of pure copper. They have remarkable ductility, malleability, and tenacity, and can be worked and rolled in the cold, but they cannot be tempered. They break under a tensile strain of from 25 to 36 kilos. per square millimetre, with an elongation of 28 to 15 per cent. An alloy containing 5 per cent. of cobalt, after forging and rolling, broke under a strain of 40 kilos. per square millimetre, with an elongation of 10 per cent. This particular alloy, the *Journal of the Chemical Society* says, is as malleable and as little liable to oxidation as copper, and is as ductile and tenacious as iron.

The supply of potable water in the Roman Campagna is one of the most urgent necessities in the improvement of this vast district. In order to provide one of the forts recently constructed for the defence of Rome with water a boring was made by the military authorities for this purpose. This fort is situated near the tomb of Cecilia Metilla, on the Appian Way, about 2½ miles beyond the city walls, and at 70·30 metres—230·58ft.—above the level of the sea. The results—Proc. Inst. C.E.—are most interesting, and show the advantage that may be derived from boring, as water, both for irrigation and potable uses, may be obtained by this means, for at a depth of 42·12 metres—138·15ft.—or 28·18 metres—92·33ft.—above the level of the sea, the first water-bearing stratum was found in the volcanic deposits; whilst a second was reached at a depth of 83·30 metres—273·22ft.—or 13 metres—42·64ft.—below the level of the sea in the quartertiary formation. The bore hole, which was 32 centimetres—12·6in.—in diameter, was carried down to the depth of 90 metres—293·2ft.—below the surface. Kind's percussion boring apparatus was used.

Book printers gave up damp paper reluctantly: for the new method of printing dry compelled them to give up the woollen blanket which has been used between the paper and the pressing surface as the equaliser of impression ever since the invention of printing. That such an elastic medium was needed when types were old or of unequal height, or when the pressed and pressing surface of the press could not be kept in true parallel, needs no explanation; but the use of an elastic printing surface was continued long after these faults had been corrected. The soft blanket, or the india-rubber cloth often used in place of it, made an uncertain impression, which either thickened the fine lines of a cut, or made them ragged and spotty. It would have been useless to get smooth paper if the pressing surface behind the paper could be made uneven. To get a pure impression it was necessary to resort not only to the engraver's method of proving on dry paper, but to his method of proving with a hard, inelastic pressing surface. A substance was needed which could be pressed with great force, without making indentation, on the surface of the cut, and on the surface only. This substance was found in mill-glazed "press board," a thin, tough card, harder than wood, and smooth as glass, which enabled the pressman to produce prints with the pure, clean lines of the engraver's proof. *Scribner's Magazine* says: "Old-fashioned pressmen prophesied that the hard printing surface would soon crush type and cuts; but experience has proved that, when skilfully done, this hard impression wears types and cuts less than the elastic blanket.

In a paper read before the Société Internationale des Electriciens, M. Lazare Weiler gives the conductivities of different metals, as compared with silver and pure copper, as in the following table:—

Silver	100·00	Gold and silver alloy, equal parts	16·12
Copper, pure	100·00	Swedish iron	16·00
Copper, refined and crystallised	99·90	Tin, pure, banca	15·45
Bronze, siliceous, telegraphic	98·00	Antimony, copper	12·70
Copper and silver alloy, equal parts	86·65	Aluminium bronze	12·60
Gold, pure	78·00	Siemens steel	12·00
Copper with 4 per cent. of silicon	75·00	Platinum, pure	10·60
Copper with 12 per cent. of silicon	54·70	Copper with 10 per cent. of nickel	10·60
Aluminium, pure	54·20	Cadmium, 15; mercury, 85	10·20
Tin with 12 per cent. of sodium	46·90	Bronze, mercurial, dronier	10·14
Siliceous bronze, telephonic	35·00	Arsenical copper, 10 per cent. arsenic	9·10
Copper with 10 per cent. of lead	30·00	Lead, pure	8·88
Zinc, pure	29·90	Bronze containing 20 per cent. tin	8·40
Phosphor bronze, telephonic	29·00	Nickel, pure	7·89
Brass, siliceous, 25 per cent. of zinc	26·49	Phosphor bronze with 20 per cent. tin	6·50
Brass with 35 per cent. of zinc	21·50	Copper with 9 per cent. phosphorus	4·90
Tin phosphide	17·70	Antimony	3·88

MISCELLANEA.

Of the total quantity of fencing wire imported by the English colony of Victoria during the month ended July 18th, 1885, only about one third was of English manufacture, the remaining two-thirds having been shipped from Germany *viâ* Antwerp.

The death is announced, last month, at Stockholm, of Herr Fredrik Petersen, at the age of 82, lately owner of the great Robertsfors Ironworks, in the province of Vesterbotten. The deceased was formerly a partner in the well-known Norwegian firm Messrs. Köhler and Co., from which he retired some years ago and settled in Sweden.

The *American Manufacturer* says, an inventor of New York has recently patented a telegraph instrument by which messages are transmitted in *fac simile* almost as fast as they can be sent by a good operator in the ordinary way. The message is written upon thin tin foil, with an ink which forms a complete insulation wherever it makes a mark.

A Finnish engineer, Herr J. A. Lindholm, has invented a so-called "momentous patent log." A correspondents says:—"It has derived its name from the easy and instantaneousness with which, at any moment, when immersed in water, it gives the speed of a vessel." Truly the English language is difficult in its niceties. The log is said to cost only 15s.

The well-known Swedish engineer De Laval, constructor of the celebrated milk-separator of the same name, and other apparatus, is constructing a steamboat for the purpose of putting to practical test his invention for overcoming the friction of water on steamers by enveloping them, in an ingenious manner in air, whereby he claims to increase the speed four times. Only four times!

During the recent stay of the Russian Czar at Copenhagen, a gunboat was ordered at the well-known engineering works of Burmeister and Wain, at a cost of £60,000, and recently another has been ordered at the Nyland's Engineering Works in Christiania, at a similar price, together with a torpedo boat. The vessels are intended for the Pacific navy stationed at Wladiwostok, Russia's Portsmouth of the East.

The prospectus of a company proposing to act on behalf of inventors is being circulated, and contains a paragraph purporting to be indicative of the opinion of The Engineer on the development of inventions and assistance of inventors. We wish to point out that this paragraph is simply a quotation from a Letter to the Editor, and does not in any way represent the opinion of The Engineer.

Messrs. Fredrich Krupp and Co. are at present, a correspondent says, manufacturing for the Italian Government four guns for a shore battery which will be larger than any in the world. Each will weigh 120 tons, whilst a charge of 600 lb. of gunpowder will be required for the firing of the projectile of one ton. The guaranteed range is five miles. The first of these monsters will be tested at Meppen on the firm's firing grounds, and transported to Italy on specially built cars with sixteen axles, bridges and viaducts having to be strengthened in order to stand the weight.

An important addition was last month made to the Swedish Navy by the completion of the corvette Freja, built at the Kockum Engineering Works, Malmo. Her dimensions are:—Length over all, 221ft.; width, 41ft.; and depth in the hold, 29ft. She draws 19ft. of water aft and 16ft. forward. The vessel is built throughout of soft Swedish Bessemer steel and cased with a 3in. layer of teak and a 2¼in. one of fir. Her engines are of 2000-horse power, and manufactured in Sweden. She will be full rigged, the masts of iron, having been made in England, and armed with ten 12 centimetre guns on the 'tween deck and two 15 centimetre on the upper deck. The cost of the vessel is £85,000.

The following from the *Railway Register* is given by the *Journal of Railway Appliances* as "A St. Louis Bull." "Many iron boilers now in use have a record for efficient and continuous service extending over periods of time varying from a quarter to a third of a century. Iron can afford to stand by such a record as this. Are there any steel boilers with records that will compare favourably with these iron boilers?" As a comment the *Journal* adds:—"Show us the building of the present day," says the Hibernian orator, "which has lasted as long as those of antiquity." We may add that a quarter of a century of antiquity may be found in a steel fire-box in a boat on a Westmoreland lake, and described in The Engineer August 13th, 1880.

A telegram has been received by the Marine Insurance Company from its Captain, Stevens, s.s. Arabian, stating that the diver Lambert has recovered one box of gold and the recovery of the remainder of the treasure from the Lopez mail steamer Alphonso XII. The value of treasure is over £100,000. Much praise is due to the divers Lambert and Tester who had to work in the great depth of, 25½ fathoms. The upper and lower decks of saloon had holes made in them so that the bullion room could be reached. Special diving apparatus had to be constructed for the work by Messrs. Siebe, Gorman and Messrs. Heincke and Co. Lambert is the diver who so courageously walked up the Severn Tunnel when it was flooded, and succeeded in closing the iron door which enabled the pumps to overcome the volume of water, so that the work of constructing the tunnel could be proceeded with.

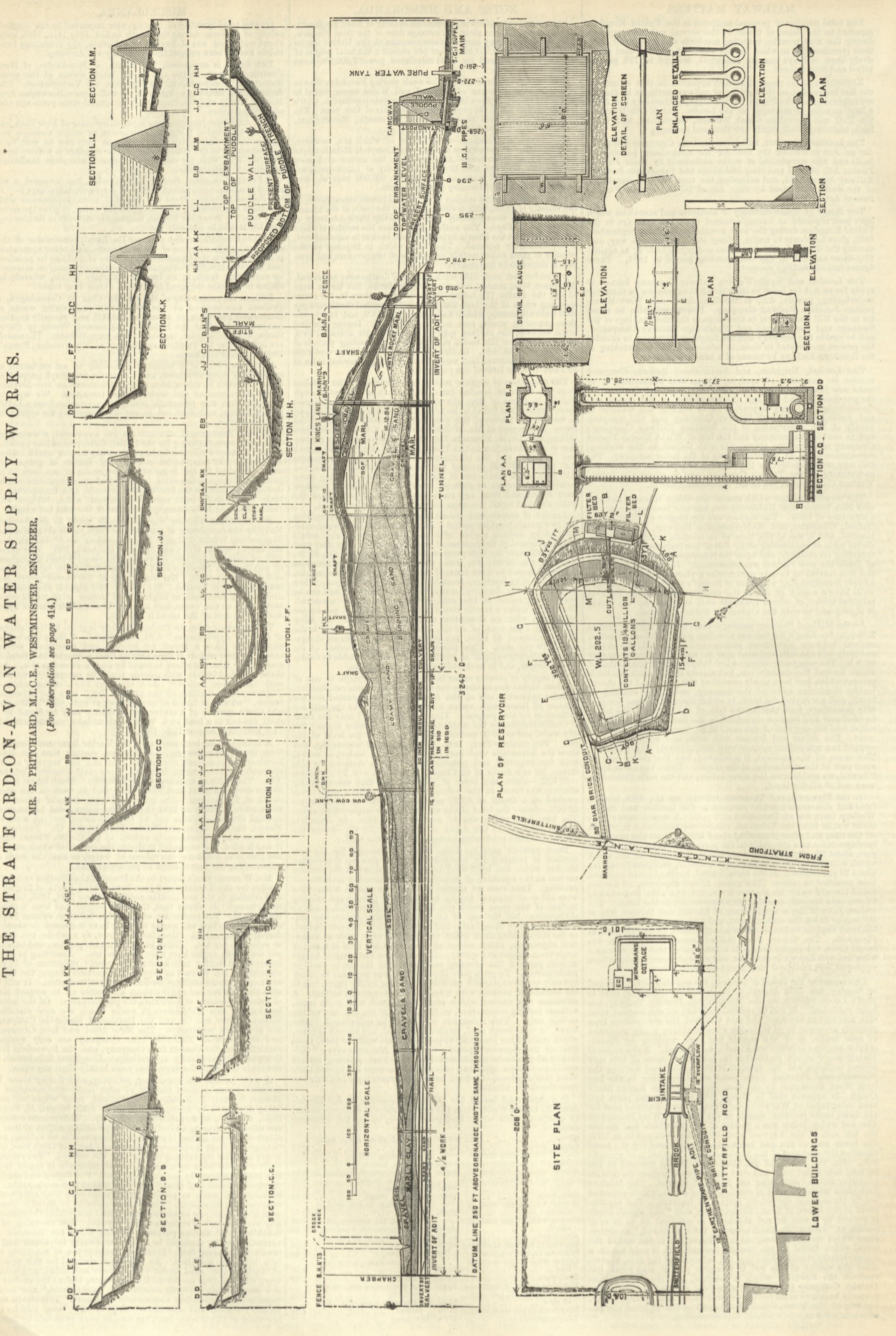
Mr. Waterhouse's report to the Board of Conciliation and Arbitration for the Manufactured Iron Trade of the North of England, and relating to the two months ending October 31st, 1885, has just been issued. It shows that the total output has been scarcely maintained. The production of plates has fallen in volume 10 per cent., whereas bars and angles together have increased to about a corresponding extent. Manufactured iron, as a whole, has fallen in value 6d. per ton. Plates have fallen 11d. per ton, and bars 1d. per ton, while angles have risen 14d. per ton. According to these returns, and taking into account the recent reduction of 2½ per awarded by Dr. Watson as regards ironworkers' wages, the latter are now 2s. above shillings for pounds of realised price. It will be seen that the bar and angle makers are better off in respect both of price and volume of work than the plate-makers. Of the latter besides the two Middlesbrough works which are now standing Messrs. Palmer and Co. and the Hartlepool Malleable Company, are absolutely inoperative. The Moor Steel and Iron Company, and the Stockton Malleable Iron Company are only working partially, and the Consett Iron Company, and the Bowesfield Iron Company, intermittently or partially. Altogether this branch of the trade is feeling the depression more keenly than any other.

A new process for smoothing, polishing, and fluting stone by machine power without the use of edge tools—the invention of Messrs. W. and T. Brindle, of Upholland, near Wigan—is now being developed by them, in conjunction with Messrs. M. Powis, Bale, and Co., of Appold-street, Finsbury. This process consists essentially in causing a revolving or reciprocating surface of iron to alternately bear against the surface of the stone to be worked, and then parted from it sufficiently to receive a layer of fresh sand and water between the rubbing surface and the rubbed. The rubbing surface is held down by a spring, but at intervals is raised from the rubbed surface by an eccentric cam. For fluting and similar operations a series of round bars of wrought iron are mounted in bearings and made to revolve; at the same time they are given a reciprocating movement. The block of stone to be fluted is placed on a trolley and run under the bars. Sand is sprinkled automatically over the bars or rollers as they revolve. For recessing, edge moulding, and similar purposes, rubbing discs are mounted on vertical spindles arranged to lift automatically for about half a revolution in every four. Several different types of machines are now in active operation. An advantage claimed for this process of working over hand labour with hammer and chisel, or machine work where cutters are forced into the stone, is that the surface of the stone is left perfectly smooth and "unstunned," and better capable of withstanding atmospheric influences. It is stated that fluted, recessed, and ornamental stone is now being sold by the inventors at 75 per cent. less than similar work produced by hand,

THE STRATFORD-ON-AVON WATER SUPPLY WORKS.

MR. E. PRITCHARD, M.I.C.E., WESTMINSTER, ENGINEER.

(For description see page 414.)



FOREIGN AGENTS FOR THE SALE OF THE ENGINEER.

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TO CORRESPONDENTS.

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

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

*** *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 bearing a* 1d. *postage stamp, in order that answers received by us may be forwarded to their destination. No notice will be taken of communications which do not comply with these instructions.*

A Sufferer.—*The subject has been fully discussed already in the columns of the daily press.*

F. S. (Keighley).—*No; you will find all the information available on such subjects in our columns.*

A. C. A. (Wakefield).—*No; longer service at sea will suffice. You can obtain full particulars by writing to the Secretary to the Board of Trade, Marine Department, Whitehall.*

COAL COMPRESSING MACHINERY.

(*To the Editor of The Engineer.*)

Sir,—Can any of your readers kindly favour me with the names and addresses of makers of machinery for converting coal dust into blocks, generally termed patent fuel? Coal Dust.

London, November 25th.

BRICK KILNS.

(*To the Editor of The Engineer.*)

Sir,—Would any reader conversant with the subject kindly tell me the best form of brick-burning kiln in use as regards economy of fuel where only one kiln is required? Is there such a kiln in practical working as a riddle-bottom up-draught circular kiln, and would such a kiln not be preferable to either the old-fashioned up-draught square kiln or down-draught circular? Brick Burner.

November 21st.

MEETINGS NEXT WEEK.

The Institution of Civil Engineers, 25, Great George-street, Westminster.—Tuesday, Dec. 1st, at 8 p.m.: Ordinary meeting. Papers to be discussed: "High-speed Motors," by Mr. John Imray, M.A., M. Inst. C.E. "Continuous-current Dynamo-electric Machines, and their Engines," by Mr. Gisbert Kapp, Assoc. M. Inst. C.E. Friday, Dec. 4th. at 7.30 p.m.: Students' meeting. Papers to be read and discussed: "The Foundations of the Forth Bridge," by Mr. Maurice Fitzmaurice, Stud. Inst. C.E. "The Building, Launching, and Sinking of the Queensferry Pneumatic Caissons at the Forth Bridge Works," by Mr. E. W. Moir, Stud. Inst. C.E. Mr. B. Baker, Member of Council, in the chair.

Chemical Society.—Thursday, Dec. 3rd, at 8 p.m.: Ballot for the election of Fellows. Papers to be read: (1) "The Sugars of the Cereals, and in Malted Grain;" (2) "On the Presence of Raffinose in Barley," by Mr. C. O. Sullivan. "On the Evidence of Constitution Afforded by Absorption Spectra," by Captain Abney, F.R.S.

Society of Arts, John-street, Adelphi, London, W.C.—Monday, Nov. 30th, at 8 p.m.: Cantor Lectures. "The Microscope," by Mr. John Mayall, jun. Lecture II.—Modern microscopes—peculiarities of construction (1) in general form, and (2) for special observations. Wednesday, Dec. 2nd, at 8 p.m.: Third ordinary meeting. "Technical Art Teaching," by Mr. F. Edward Hulme, F.L.S., F.S.A.

THE ENGINEER.

NOVEMBER 27, 1885.

THE DEPRESSION IN TRADE.

Among the various causes which have been urged for the existing depression in trade, one has been passed over almost in silence. That it exists, is felt. That it should be talked about is deemed inexpedient. We are not surprised by this reticence, because men are not prone to find fault with others for a sin which they may commit the next year or the next week themselves. There is, too, a good deal of *esprit de corps* among manufacturers which tends to close their mouths. Many of them hold, too, that although an evil exists, it is best to say as little as possible about it for fear of making matters worse. We think that this is a mistaken view to take of a very serious matter, and that silence represents the worst course it is possible to pursue. That to which we allude is the inferiority of goods made in England for foreign markets. That the goods are bad very few persons dispute; all manner of excuses are urged in defence of the manufacturers. One of them—the only one deserving notice—we shall consider in a moment. We must first insist on the existence of practices which many persons will not admit to obtain, and which greatly intensify the evil done by exporting rubbish.

A few days since a letter was placed in our hands which had been written by a highly respectable firm of metal brokers, carrying on business in London, to a firm celebrated for the excellent quality of their bar iron. The letter was short and to the point. It ran, "Will you brand your second quality bars 'best double refined'?" The proposition was indignantly rejected. The iron was required for export. Let us put on one side the inherent dishonesty of the proposed transaction, and see how it would affect trade. The iron would be bought by men who have a very clear knowledge of the difference between bad bars and good bars. As soon as they proceeded to work what they had purchased as the best English iron made, they would find out that it was not in any sense or way good. Then the German would appear on the scene, and point out that this "defective metal is really the best that England can make. The brand was enough to prove that." "Try," he would say, "our second-rate iron, which you can have at the same price; you will find it better than the best that England can produce. Only Germany can make really first-class iron." We assure our readers that this is not a fancy picture—it is a simple statement of facts. The impolicy of putting before the world second-rate wares as the best that England can produce is one of the most gigantic commercial blunders that it is possible to conceive. Let it not be imagined that such practices are new, or that they are confined to the iron trade. They exist in all English trades, and they are more or less rapidly sapping the foundations on which our commercial prosperity rests. Plenty of illustrations may be adduced. We have given one. Here is another supplied to us by a very well-known and eminent firm of boilermakers, who have forwarded to us a letter which recently appeared in a French newspaper, and of which the following is a translation:—

"In justice to the few Englishmen who are on the Continent, I send this letter to your journal in the hopes that it may be the means of opening the eyes of some of our countrymen as to the quality of work, &c., turned out by some firms that are considered above suspicion. A firm of Lancashire boiler-makers made one a short time ago and sent it to one of the principal seaports on the Continent, stipulating that it was of the dimensions which are required in these countries. It was put to work in the usual manner, but after a short time one of the circular seams in some part of the shell gave way, when, on its being examined by the Government engineer—all boilers here being under Government supervision, of which your readers are no doubt aware—it was found that the plate that had given way was $\frac{1}{16}$th of an inch thinner than the stipulated thickness; also there was conclusive evidence to prove that the cause of the seam giving way was the plate having been cracked for a considerable distance through the rivet holes, either by drifting or from some other cause, during the making of the boiler."

It unfortunately happened that this boiler was regarded as the work of the eminent firm bringing the matter under our notice, who justly feel aggrieved, and the event has done no small mischief to English boiler makers. We have already referred to the tool trade. England has succeeded in acquiring in Italy a reputation for producing the worst and dearest machine tools that can be had in the whole world. The tools are only dear because they are worthless—the price is very low. We do not think it is necessary to attempt to prove that such practices must be injurious, if not ruinous, to our foreign trade. It is not for us to suggest a means of putting a stop to them. All that we can do to neutralise the evil we do, when we tell our foreign readers that the rubbish which they are cozened into buying is not the best, nor nearly the best, that England can supply.

Now let us consider what is the excuse urged for the production of rubbish in the shape, let us say, of tools and steam engines. No excuse at all is put forward, we are happy to say, for selling worthless things as the best. Many firms make very cheap steam engines, or at least low-priced engines, which are a pain and a grief to the purchasers. The excuse is that the maker would starve if he did not cut down his prices, and that cutting down prices means cutting down quality as well. The excuse is, in short, that a good engine cannot be made for the only sum the purchaser is willing to pay. There are two sufficient answers to this argument. The first is that it should not be used at all until the engine builder or tool maker is quite certain that the engine he has designed is really made with the smallest possible quantity of labour and fitting. As a matter of fact, the result of observations carried on by ourselves for many years is, that the low-priced engines cost more to make, in proportion, than very good engines turned out by first-class firms. Before any man undertakes to make engines as a marketable commodity, he should get out standard designs, and work to these. No man ought to assert that he cannot make a good engine at a profit at a sum fixed until he is quite certain that the management of his shops, the quality of his tools, the characteristics of his men—especially foremen—and his methods of getting up work cannot possibly be improved upon. The reason why some engineers can never make a profit is simply that they do not understand their business. That the public will not buy good things at long prices is flatly contradicted by daily experience. The men who are suffering are the cheap-jacks. The few firms with a great reputation well maintained are busy. In some cases their shops are crammed with work; in all they have enough to keep them going. This is a lesson which ought to be taken to heart.

It has been urged that abroad we are beaten in what used to be our own markets by cheap labour. There can be no doubt but that this cause does operate to our detriment. We pay higher wages than any other nation on this side of the Atlantic, and the British workman on the whole lives now, and has done so for some time past, better than any other workman. His influence is very keenly felt when we attempt to push trade abroad, and no doubt high wages are responsible for scamped and defective work in many cases. If the engineer cannot get wages reduced he must, we fear, adopt the only other course open to him, and dispense with labour as much as possible by using tools instead.

TORPEDO BOAT CATCHERS AND DESTROYERS.

The latest ideas upon torpedo boats and torpedo attack, as evolved by our own and that of other Navies' evolutionary practice, seem to be leading to a definite system of attack and defence by torpedo boat squadrons. Speed, handiness, and smallness of target are the strong points of the class of boats which, in our Navy, are called first-class boats. Their speed is between nineteen and twenty knots in a normal fighting condition, their displacement is about 60 tons, their length is a little over 100ft., and their time for turning a complete circle about 1½ min. They usually carry two or three torpedo tubes, and in war time will have two torpedoes for each tube—one in the tube, the other in reserve. They also have one, and sometimes two, small machine guns. The weak points of these boats are their want of comfort for the crew at sea; their small radius of action or distance to which they can operate from any base; their complete want of protection from even the lightest machine guns, and their great loss of speed in rough weather. These boats are cheap, costing about £10,000 or £12,000 each when complete, and can be rapidly built. But it is now beginning to be seen that these small vessels are not all that is necessary for either attack or defence. The Admiralty have already, in the "Scout" class, produced vessels which remedy the defects of want of comfort for the crew, want of protection for the machinery and torpedoes, and small radius of action; but these defects have only been made good at the sacrifice of from two to three knots of speed. The Admiralty have, however, recently produced a design for a class of vessel which is called the torpedo-gunboat, and which appears to embody some of the good points of the first class, while avoiding some of their defects. Two of these vessels are to be built in her Majesty's dockyards, and one by Messrs. Laird, of Birkenhead. Their dimensions are—length between perpendiculars, 200ft.; breadth, 23ft.; depth, 13ft. The displacement is 450 tons; the torpedo armament is one tube through the bow and one through the stern in a fore and aft line, and one on each broadside on deck capable of training through 90 deg.; the speed is to be from 19 to 20 knots; the engines are two sets of triple expansion of the vertical type, and the boilers are four in number, of the locomotive type. The two engines are in one compartment, and the four boilers are in two compartments; the indicated horse-power is to be 2700, the cylinders are 18½in., 29in., and 42in., by 18in. stroke, and the grate surface of the boilers is 120 square feet. The boilers are to be protected at the forward end and at the sides by coal bunkers, and the engines have protection in the form of ¾in. plating in the ship's side. The gun armament is one 4in. breech-loading gun and four 3-pounder rapid-firing Hotchkiss. The steering gear and rudder head are under water. A forecastle and poop are to be fitted. The conning tower is formed of 1in. plating, and a conning bridge is to be fitted over it for navigation in ordinary times. An electric search light is to be fitted above this bridge. In the matter of speed and torpedo armament this type is at least equal to an ordinary first-class boat; in handiness, it is probably inferior, for though the vessel is to have twin screws, her much greater length will more than compensate for this. In gun armament the new type is very much superior, and has sufficient offensive power to do considerable damage to all but the most heavily armed ships. In seagoing qualities, and in comfort for crew, this type is a great improvement upon the smaller boats, but it is principally in the matter of protection that a great advance has been made. The coal bunkers abreast of the boilers, and the thick plating abreast of the engines, will go a long way towards keeping out the shot and shell of the rapid-firing and machine guns which have become the usual fitting in seagoing war ships. This type of vessel appears to be well adapted to act offensively against a squadron of first-class boats, for her gun armament could not fail to seriously cripple and probably rapidly destroy any torpedo boat, while she herself could not be readily injured either by shot or torpedo.

Other naval constructors have been working along similar lines, and it was some time since that Messrs. Thomson, of Clydebank, had signed a contract with Admiral Illeycas on behalf of the Spanish Minister of Marine, to build a vessel to act as a torpedo boat destroyer. She is to be 350 tons displacement, and her length is 180ft. Her torpedo armament is to consist of two tubes, through the bow and one through the stern; but none on deck. Her gun armament is one of 9 c.m. Hontario's gun in the bow, four 6-pounder Hotchkiss, and two four-barrelled Nordenfelts. She has triple expansion engines and locomotive boilers, the engines being in two separate compartments and the boilers in four. The power of the engines must be more than 4000, as the speed which is expected is twenty-two knots. Both boilers and engines are completely surrounded by coal, and there is in addition a shield of 1in. round the engines. The design of Messrs. Thomson provides fully for an end-on attack and defence, for a steel bulkhead 1¾in. thick extends across the ship before the boilers. The size of this vessel will necessarily give her much greater sea-going qualities than any torpedo boat. She will be faster and handier than the larger English boat, but her torpedo armament is not quite so powerful for broadside firing, but appears to be designed almost wholly for end-on attack. Her coal endurance is for 4000 knots at 10 knots per hour.

A third type of enlarged torpedo boat is the Swift, which was built by Messrs. White, of Cowes, and now belongs to the Admiralty. Detailed information has not been published, but from what has been, she appears to be 140ft. long, 17ft. beam, 1300-horse power, and 20 knots speed. She has a single screw, but is, as all Messrs. White's boats are, a very rapid manœuvrer. A boat of about the same size and speed as this, but having twin screws, is being built for a foreign Government by Messrs. Thomson, at Clydebank. These vessels will doubtless be fairly good seagoing boats, and will probably have a radius of action of about 3000 miles, but they will not be nearly so comfortable for their crews as the larger vessel described. They are protected by bunkers round the machinery space. All these vessels are distinct types from the first class-torpedo boats, and are intended to act as catchers or destroyers of the smaller vessels. This function they will be able to perform by their greater speed, handiness, gun power, and ability to maintain their speed in a seaway, whilst their greater protection will prevent their being seriously injured. The design of the Spanish vessel appears to us to possess these qualities in a high degree.

MINERAL ROYALTIES.

It is not surprising that at a time when the pinch of bad times is being felt by every other class of the community, the owners of coal and other mineral royalties, who have been very little affected by the conditions which so seriously affect all other sources of income, should be looked to for concessions towards their less fortunate neighbours. There can be little doubt that this question will in the near future, and especially in the event of the existing depression of trade being much longer continued, command an increasing amount of attention. At the first blush, it certainly seems as if a source of income that was neither toiled nor spun for; that is attended by none of the ordinary risks and responsibilities of trade; that is calculated by its nature and incidence to induce restraint of business, and with respect to which none of the statutory provisions and limitations imposed on other sources of income apply, should be so dealt with as to bring it under the same influences as the industries on which it may be said to form a tax. But the whole matter is vastly complicated and difficult to handle. There is, in truth, scarcely any two districts or descriptions of minerals in reference to which the same conditions apply. In one district the royalty payment is made in the form of a dead rent, which must be paid whether the minerals are worked or not; in another, the royalty is based on the tonnage of minerals produced; in a third, on the price at which the minerals are sold, and there are numerous modifications of each of these and other arrangements. The State could not be asked to interpose in order to reduce all these varying systems of agreement to order and uniformity. Many of the leases under which coal, for example, is worked are of considerable antiquity, and are either at the root of, or contingent upon, other arrangements, the disturbance of which would be likely to affect a variety of interests. Nor would it be much more feasible to impose a uniform rate of royalty payment varying according to the selling price of the minerals; while to adopt, as some have been bold enough to suggest, the drastic remedy of abolishing royalty rents altogether, would at once be denounced, and not unreasonably so, as one of the most gigantic acts of confiscation ever perpetrated. The royalty lessors are in the position of being simply one of the parties to a legal contract. When they have an offer made to lease their coal, the terms are distinctly specified and acquiesced in by the lessee. When there has been a large demand for royalties, consequent upon good prices being obtained for the minerals, rents have advanced. When, on the contrary, minerals have fallen greatly in value, and collieries or mines became unprofitable to work, rents have been reduced. The rents have, in short, been regulated by the ordinary laws of supply and demand, and if the lessee finds that he has made a bad bargain with respect to the terms of his lease, he must make the best of it, just as the lessor would have to put up with it if the arrangement had turned out badly for him. Legally and morally the lessee has no more right to expect that the lord of the soil will help him out the difficulty than he would have a right to expect the owner of a house taken at a high rent to make the same sort of concession; and it has no doubt been the keen competition for mineral royalties, more than any other cause, that has caused rents to rise; so that mineowners, like the cottiers of Ireland in regard to their holdings, have by their own competition, in times past, produced the evils of which they now complain.

Before proceeding further to consider the subject under review, it will be well to examine the amounts that are generally paid as royalty rents, and the effect of such payments upon the industries concerned; and, first, with regard to the coal trade. In the earlier years of the present century, royalty rents were for the most part extremely low. Many leases were secured at a rent of 1d. per ton of coal worked. In 1860, according to Fordyce, the average rent in the North of England was 6d. to 1s. per ton on round coal, and 2d. to 4d. per ton on small. Mr. G. B. Forster, a well-known authority, stated to the coal committee of 1873 that the average rent in the great northern coalfield would be about 6d. per ton on the sales as a whole. Another large coalowner, Mr. Lindsay Wood, stated at the same time that the royalties paid in Durham averaged from 6d. to 9d. per ton, and had in some cases gone up to 1s. per ton. Still another witness, Sir J. W. Pease, M.P., stated that royalty rents had within a then recent period increased from 100 to 150 per cent., and that where leases used to be taken at 4d. to 4½d. per ton, they could not then—1873—be secured under 1s. Since that date royalty rents have generally been reduced, at any rate in all cases of new leases; but it is more than probable that the lessor is reaping a much larger share of the joint profit when he receives 6d. per ton on a selling price of 6s. or 7s. than he did when he got 1s. on a selling price of 12s. to 15s. The latter range of prices, we need hardly add, only prevailed over a comparatively short period, and in a very great number of cases, if not in almost all, the leases that were entered into at the high rates of 1872-3 have been more or less modified since, as the only possible alternative to the closing of the pits. If the existing average rent is calculated at 6d. per ton, it will probably be as near the mark as it is possible to come. This, at any rate, will be fairly typical of the state of things in the great northern coalfield, by the usages and systems of which most other districts in the United Kingdom are guided.

If, then, we adopt 6d. per ton as the average payment made to the lord of the soil for the privilege of working our coal, it comes to this, that our coalowners pay to the lessors of these royalties about four millions sterling a year more or less. It may well be doubted whether the coalowners themselves, with all their tremendous risk and responsibility, are now in receipt of a larger net income. The income tax returns, in which mines are separately distinguished, show that the total net income from mineral workings of all kinds in 1884 was a trifle over seven millions, and if we give four millions of this amount to coalowners, it would leave three millions to divide among the owners of every other description of mineral working—lead, copper, iron, shale, limestone, &c.—throughout the United Kingdom. If this hypothesis—for it is nothing more—should approach the mark, it surely cannot but seem that "the times are out of joint" when the owner of the soil, without embarking any capital, without being subject to any risk of loss, of bad debts, of falling markets, of State interference, of claims for compensation, and of the thousand-and-one trials and worries that harass the coalowner, should be reaping so large a share of the proceeds of enterprise and effort towards which he does not in any way contribute. But so it is.

With regard to the next largest quota to the mineral produce of the United Kingdom—that of iron ore—the case is still worse. In the Cleveland district, in Northamptonshire, and in Lincolnshire, where the ore is cheaply worked, and does not exceed 2s. 9d. to 3s. 6d. per ton over all, the rents are what may be called fairly low. In the West Cumberland district, however, they rise as high as 2s. 6d. per ton, which means a sum of about 5s. per ton of iron made. Hence, Sir Lowthian Bell has accurately calculated that whereas in Cleveland the royalty charges upon a ton of pig iron amount to about 3s. 3d. per ton, they run up in the case of West Cumberland and North-West Lancashire to about 6s. 3d. per ton, an increase of about 100 per cent. The ironmasters of the West coast are now complaining, and not without good reason, of this condition of things. With their pig selling at only a little over 40s. per ton, they are irritated to find that about 15 per cent. of the total realised price is drawn into the coffers of the lords of the soil.

In the mining districts of Cornwall the "dish" or dues on the ores raised have been reduced considerably—in some cases from one-sixth to one-twentieth, and even to one-thirtieth; but until lately, at all events, the average rate ranged from one-sixteenth to one-eighteenth. In the case of coal mining, it may be taken that at the prices realised over the last few years about one-tenth, or rather more, of the gross amount received by the coalowner for his produce has taken the form of royalty rents; while in the hematite districts of Cumberland, &c., the proportion of the realised value of the produce taken by the lessor may be put down at about one-fourth. Having so far set forth the facts of the case, it is natural to inquire whether it is possible to provide or suggest a reasonable remedy. That the case is one urgently calling for remedial measures no one who has studied it can doubt. But it is to be feared that the only remedies practicable resolve themselves into the three following, viz.:—(1) Voluntary concessions by the lessor; (2) curtailment of production on a large scale; (3) legislative interference.

With regard to the first of these suggested means of relief, it ought to be mentioned, to the credit of not a few lessors, that they have been ready to discuss and arrange ameliorative measures with their lessees. There is probably no important mineral district in the country where this has not more or less been done. But in other cases, and probably the majority, no such compromise has been provided for. The lessor, in a general way, is the master of the situation. He knows, with regard to all our minerals, that the supply is limited, and the prospective demand unlimited. If he cannot get his terms now, he can in most cases afford to bide his time; and a landed proprietor could not bequeath to his posterity any more certain and assured source of income than mineral rents. Besides, a great part of the royalties on minerals, especially in the northern coal-field, takes the form of what are called "dead rents"—that is, the lessee must pay to the lessor a certain sum annually, in respect of the coal to be worked, whether a quantity corresponding to that sum is raised or not, the lessee being left at liberty to make up his "shorts" in his own time and way. This system has been found to benefit both parties. It enables the lessor to depend upon a certain annual income, which is thus rendered quite independent of the condition of the market, while it gives the coalowner the opportunity of arranging for a maximum output when trade is good and a minimum output when trade is bad. It is to be feared, however, that not much advantage has been taken of this liberty on the part of our coalowners. On the contrary, in spite of bad trade, and greatly attenuated profits, the volume of our coal output until last year had steadily increased, having risen from 132,607,000 tons in 1878 to 163,737,000 tons in 1883—an increase of over 31,000,000 of tons, or about 23 per cent., during a period of the most severe depression in prices that the trade has ever known. "Dead rent" is, of course, in the nature of a standing charge, and the importance of so keeping up production as to minimise standing charges is adequately understood by the merest tyro in industrial affairs. The serious character of this "dead rent" difficulty may be appreciated by the citation of a case mentioned by the author of a work on "The Northern Coalfield," in which the lessors received from five collieries the sum of £150,000 in respect of unworked royalties, which sum was calculated to have been increased by the addition of common interest to £250,000! It takes a strong lessee to support a burden of this kind, and it is scarcely a matter for wonder that not a few have found it insupportable.

The second remedy suggested—curtailment of output on a large scale—is one that does not commend itself to the judgment of lessees. It might, as the expression goes, "bring the coal lessors to their senses," but it is just as likely that it would do nothing of the kind; and in any case it might involve a great disorganisation of industry, loss of foreign markets, and serious curtailment of labour, with all its accompanying poverty, wretchedness, and even crime. The third remedy, State interference, would be opposed to the whole principle of Free Trade, and a direct reversion to feudal times. It is not to be thought of. Those who rent coal mines constitute as powerful a body as the lessors, and one quite as competent to take care of its own interests. The State has no more right to interfere in this case than it has in any other case of simple contract. It would be as politic to settle royalties by Act of Parliament as to determine the price of coal by the same means. The true remedy is to be found in mutual concessions. The lessors are presumably not fools, and will, if they are wise, go with the times. The lead mining of Durham and Northumberland, the iron industry of Lancashire and Cumberland, and in some districts the coal industry as well are severely depressed. The smallest modicum of relief in the matter of royalty rents would greatly help some of these trades. This is so far recognised that in some of our mining districts the subject of concessions of this kind has been raised to the importance of a test question. In these circumstances it would be well for lessors and lessees to take counsel together—all the more so that the payment of royalty rents to individuals is peculiar among European countries to our own, and that, to the extent of their influence, they are calculated to handicap Englishmen in the keen race that they are now compelled to run against their continental rivals.

HEAVY SHIP FORGINGS.

During the last three years, on the East Coast of England alone, about fifty stern frames of vessels have been reported by Lloyd's as broken, while in one week no less than seven steamers put into port on account of defects in this portion of their structure. This was the text of a communication lately made to the Cleveland Institution of Engineers by Mr. T. Putnam, managing director of the Darlington Forge Company, who truly remarked that, though a steamer with broken shaft may weather through, with her steering power gone she becomes a very helpless affair. Mr. Putnam first described the usual method of building up a large stern frame with three separate forgings, which are too often heated repeatedly, whereby the iron becomes granular in structure, and cold hammered, thus inducing brittleness. The following is the reason assigned why, at a bright white heat, the process of welding may be so successfully accomplished that it is impossible to discover the point of union, provided a suitable flux be used in the absence of sufficient silicon in the iron:—"In heating iron a certain amount of scale is formed through oxidation of the surfaces in contact with the atmosphere. This scale, when consisting of pure oxide of iron, is infusible at a temperature higher than the welding point, but if alloyed with silicon it is converted into an exceedingly fluid and fusible silicate of protoxide of iron, which under proper pressure, correctly applied, is readily expelled; the clean surfaces of iron are brought into contact, and molecular cohesion takes place." The three chief points to be aimed at in a weld are, therefore, to obtain an effective heat on the surfaces to be welded, to arrange the two parts so that the cinder may escape, and to apply sufficient power to expel the cinder. If the heat be insufficient the intervening cinder remains viscous, and is not entirely expelled, so that only the outer edges of the parts are welded together, the weld in the centre being unsound. On the other hand, if the iron is "burnt" through too high a temperature it cannot be worked or welded. In the usual method of hand welding by means of screws and the "Johnny" hammer, an obtuse scarf is made which does not permit of the cinder being pressed out. Moreover, owing to an insufficient excess of metal left to compensate for waste in the fire, the heating is rarely continued sufficiently long for the interior to acquire a welding temperature; and, thirdly, the tightening up of the screws, generally to the extent of ¾in., tends rather to spread out the exterior sides of the scarf than to bring them together. Some years ago the Darlington Forge Company, on dealing with some large forgings welded up by screws, found the weld so unsatisfactory that they made a series of test welds upon large sections under a powerful steam hammer, and the results were so satisfactory that they decided to put down a special steam hammer capable of admitting the largest stern frame, and of striking a blow equal to 30 foot-tons. This hammer was illustrated in The Engineer of 5th September, 1884. The scarfs for the welds are made not only at a more acute angle and with "butts" never less than 4in. wide over the finished dimension, but also with the sides of the male portion rounded while those of the female are flat, so as to favour the escape of cinder. Lloyd's visiting committee, hearing of this method for forging stern frames, visited the Darlington Works and witnessed the process, and, under the direction of Mr. Cameron, Lloyd's inspector of forgings, a series of crucial tests were rigidly carried out on a large scale to ascertain how far the welds could be depended upon. In one case, after the parts were scarfed and welded together in his presence, Mr. Cameron had a short heat taken on the union, at which point the mass was bent to an angle of 30 deg. in both directions with respect to its axis without starting the weld, after which the joint was slotted through without revealing the slightest imperfection. One piece, 10in. by 7in., was broken cold under the hammer, requiring eleven blows from a 13-ton hammer, and a drop of 6ft. to 9ft., before it broke, without disclosing any imperfect weld. Another piece, 9in. by 5in., directly after being welded, and while still at a bright red heat, was bent backwards and forwards until it broke across without showing the slightest sign of opening.

REPAIRS OF SUBMARINE CABLES.

The cable of the Direct Spanish Telegraph Company between Kennack Cove, Cornwall, and Bilbao, Spain, which broke down on October 11th, was repaired by the Eastern Telegraph Company's cable steamer Electra on the 9th inst. These repairs were effected within three working days, although the depth of water was no less than 2300 fathoms, or more than two and a-half statute miles. Only three drags were made for the cable, it being caught and lifted in each case, but on the first haul the cable broke on the grapnel, the ship being a little too far from the broken end. The operations were under the direction of Captain G. Pattison, Commander of the Electra, assisted by Mr. A. E. Kennelly, electrician, and reflect the greatest credit on all those engaged in them, and there is we believe only one case of repairs being as promptly effected in such a depth of water. A few days ago another cable ship of the Eastern Telegraph Company, The Volta, succeeded in picking up and putting into working order the cable between Otranto and Corfu, which is one of the oldest deep sea cables, having been laid twenty-four years ago, and surface below water level, including a portable stay provided with zinc ferrules firmly secured on it and fixed in the centre of each nest of tubes for their protection, with which the two boilers in the Hindostan and a few others were fitted, but afterwards it was dispensed with on account principally of the expense and the difficulty of removing the scale, especialy in the cases where blowing off could not be put a stop to, and the old prejudices against high density could not be got over. However, prejudices of this kind, fortunately for the shipowners, are becoming things of the past, although there are a few superintendent engineers considered to be well informed and intelligent, maintain, or, I should say, profess even to this hour that it is neither on contact nor surface of the zinc protection from corrosion depends, although it is nothing new to hear of these very men, when they find themselves in a difficulty owing to corrosion commonly called pitting, to at once order a stud to be screwed into the affected part and firmly secure on it a slab of zinc. Such are the tactics of some of the non-believers in contact, nevertheless. However, be that as it may, I can vouch that when boilers are treated as I recommended as far back as 1877, that is, to fill them with fresh water, taking care to reduce the waste of steam and water from all sources to a minimum, and to see that the condensers are as perfect as they can be made—a proportion of something between $\frac{1}{100}$ to $\frac{1}{150}$ of zinc to that of the iron has been found after the first six months in new and old boilers, when fitted on my system, to answer well. And it is astonishing how small a percentage of sea water is needed to effect this.

As Mr. Rowe's paper appears to have been read at Sunderland, I may mention in conclusion that when I visited that place in 1878, after calling almost on all the superintendent engineers and steamshipowners in the district, as to the advisability of fitting and treating boilers according to my system, all that I succeeded in doing was to persuade three firms to fit, in all, five boilers between them; all of them, with two or three exceptions that I came in contact with—Newcastle-on-Tyne included—being unbelievers in contact, and I may say, zinc in any form in boilers, intimating, with a shrug of the shoulders, that they looked upon it from, in some cases, past experience, as a waste of money. Be this true or not, I can speak of having made a thorough convert of one in Sunderland who has written several letters to me acknowledging the great benefit his employers and himself have derived, and were deriving, from following my advice. In confirmation of what I have said in regard to zinc in and treatment of boilers, I beg to refer you to the articles and correspondence which appeared in your contemporary *Engineering*, in July and August, 1878.

For your information I enclose one of my printed instructions as to treating and preserving marine boilers, printed in 1877.

"To ensure perfect protection to the interior surfaces of boilers by the application of zinc, the following are the most important points to be observed; with also a few recommendations as to their treatment, &c.:—

"1.—To cast the zinc plates and ferrules, either vertically, or with the moulds considerably inclined, so as to insure them being as free from air cells as possible, and the zinc should be of the best quality procurable.

"2.—To see that the surfaces of both the iron and zinc, where in contact with each other, are fair and clean, and firmly held together, so as to prevent access of water between them, and consequently oxidation of the zinc at these points.

"3.—The zinc plates and ferrules need not fit tightly on the studs and stays, but great care should be observed, as pointed out in 2, with their collars and nuts, and also with the portion of the stays—round, square, or flat—where the iron fastenings grip them, or where they may be in contact with the zinc, as on these points continuity, and hence the protection of the boiler surfaces, will, in a great measure, depend.

"4.—For protecting the shells, furnaces. &c., the mode of attaching the zinc to studs screwed into the plates at points equally distanced, and of distributing it over the entire surface of the boiler—in the water—is much to be preferred to attaching it to the stays, unless the stays be specially fitted for insuring continuity, as in cases where the stays may be secured to L T or bars, or to the ends or sides of the boiler, as ordinarily fitted, continuity between the zinc and the parts to be protected will always be uncertain; but in parts of boilers already working, where it would be difficult, or inconvenient, to put in studs, such as the sides and backs of the combustion chambers, &c., the zinc may be attached to the screwed stays, which are admirably suited for insuring continuity, or to any of the stays, plates, bars, brackets, &c., which may be already in, or might be put in the boiler for the purpose of conveniently attaching the zinc; but the great points to be aimed at are, in all cases, to insure continuity between the two metals, and distributing the zinc as equally as possible over the surface of the boiler by any suitable and reliable means.

"5.—It is preferable to use many studs and small plates of zinc, especially in new boilers, to fewer and larger ones, in order to insure not only an even action on the entire surface, but for convenience of application, especially in narrow or confined places, and lessening the liability of the zinc plates cracking from expansion, &c., and falling to the bottom of the boiler, sometimes long before the metal is consumed. The proportion of zinc surface should be between 1-45th and 1-50th that of the iron exposed to the water: but its efficiency, as regards the protection it will afford, and time it will last, will very much depend, as already pointed out, on its quality.

"6.—The central parts of the zinc plates should be made thicker than at the edges—as shown on the sketch—because the oxidation of the metal will be found to be much greater where in close proximity to the collars, nuts, straps, &c., than at their extremities. The small plates have an exposed surface of ·75 of a square foot; but where it would be convenient to attach larger ones, especially when connected to stays, &c., between two surfaces, such as the back of the combustion chambers and the end of the boiler, &c., plates having double the surface might be used with advantage.

"7.—The length of the zinc ferrules for the tube plate stays, or rods, which may be made in two, three, or more pieces, is to be determined by the amount of tube and tube-plate surface which may be necessary for each of them to protect; and in order to make them as thick and durable as possible, the stays, or rods, on which they are to be placed, can be made as small in diameter as practicable, and the smallest factor of safety may be safely adopted in calculating their strength—if used as stays—because of the perfect protection which will be afforded to them against corrosion.

"8.—To ensure perfect metallic contact between the tubes and the tube-plates, it would be advisable to remove a portion of the scale or oxide from the ends of the tubes, by filing or otherwise, after they are annealed.

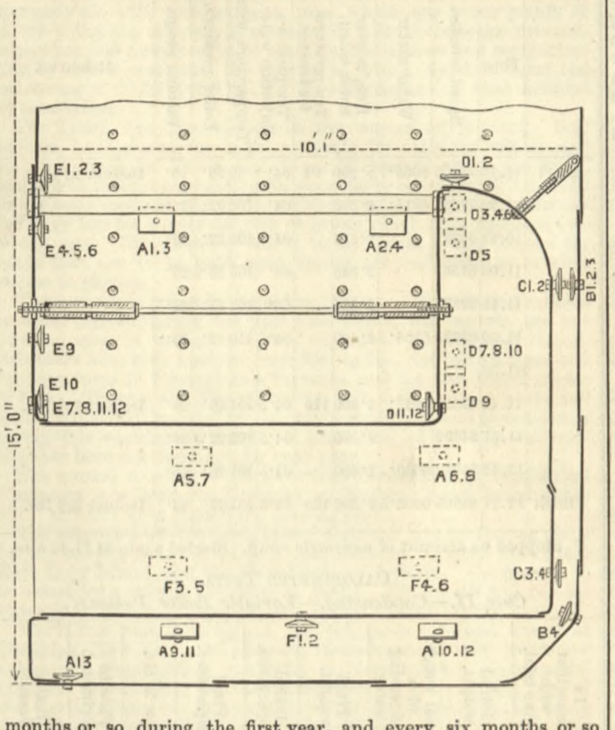
"9.—The thickness of the zinc plates and ferrules should be regulated by the time they will be required to last without changing, or renewing, or should be determined by the length of the voyages on which the vessel might be employed.

"10.—For attaching the stays, or rods, fitted with zinc ferrules, in the tube-plates, either of the plans shown on the lithograph drawing may be adopted; but where the rod is to take the place of a stay-tube, the mode shown in Fig. 3 is recommended, and for a boiler in course of construction that shown in Fig. 4 is no doubt the best; but for the front tube-plates, the coned plug may be preferable in all cases, especially for detaching the stays, for the renewal of the zinc ferrules. The ferrules are in short lengths, with a loose iron washer placed between them, so as to allow of the greater expansion due to the zinc over that of the iron, without crushing the ferrules.

"By these means, all that is needed to allow of the stay being taken out for renewing the zinc is confined, simply, to the taking off of the back nut, and to ensure continuity, and also tightness, at this end, the nut, which secures the zinc on the stay, should be brought up hard against the tube-plate, or plug, by screwing the outside nut up tightly. The cone, or front plug, should be adjusted to insure tightness only, care being taken not to use undue strain, and spring the tube-plates.

"11.—For the purpose of preserving the nuts on the back end of the stays, it might be advisable to protect them with specially made fire-clay caps or covers.

"12.—If the studs, stays, or straps, &c., be carefully made and proper care taken of them, the subsequent cost of protecting the boilers will be confined simply to the renewal of the zinc every four



months or so during the first year, and every six months or so during the second and subsequent years; but this will very much depend, not only on the quality of the zinc, but also on the manner of working the boilers and their treatment, especially when idle. In regard to the renewal of the zinc, the chief engineer should be guided by its condition, and especially by the condition of the boiler surfaces, on examination.

"13.—I would strongly recommend that the boilers, when idle, be kept, as far as may be practicable, full of water, and the water changed in them, when at work, as little and as seldom as possible, providing the density be not allowed to exceed $\frac{6}{32}$ or $\frac{7}{32}$; for which purpose, and also of preventing, as far as practicable, the deposition of scale on the heating surfaces, the waste from all sources should be reduced to a minimum. For the better preservation of the surfaces round the level of the water, the only parts likely to suffer internally from various causes, it might be advisable to either sheath them with thin plates, or carefully coat them with Portland cement, or some material of a still more impervious nature, each time they are opened. Good mineral oil should also be used for lubricating the interior working surfaces of the engines.

"14.—For a large boiler such as that shown on the lithograph drawing, which is 15ft. by 10ft. 7in. by 10ft. 1in., about 6 cwt. of zinc will be sufficient; ordinarily, less than half that amount."

I have to apologise for having gone so far as I have done, but the subject is one I could write—imperfectly, I confess—some pages more, were it not for my being conscious of having trespassed too much already on your valuable space, and being reluctant to indulge too freely in personalities as to the history of applying zinc in boilers and their treatment, in a few cases, in 1877-8, and since; in the institution and advancement of which I will not admit of having been quite asleep.

Chipping Sodbury, November 17th. DAVID PHILLIPS.

AID TO ENGINEERING SOLUTION.

SIR,—I shall be glad if you will kindly publish the parallel columns forwarded, which contain the quotations made from "Aid to Engineering Solution" in your paper, page 359, of 6th November, and the corresponding actual lines from the book itself.

As these eleven cases of misquotation all apply to the preface and first forty-six pages, and are made to serve as samples for the rest of the 400 pages, which do not contain preliminary principles of any sort, an erroneous impression has been conveyed of the real nature of the book. THE AUTHOR.

November 23rd.

On p. 359 of THE ENGINEER.	*In the book itself.*
1. The *new graphic methods* are dismissed as generally familiar, &c.	p. 35. The graphic reduction of joint stresses to bar stresses, either for process i. or ii. is generally familiar, &c.
2. The author states that *in all its ramifications* the graphic method is generally familiar.	p. 35. The graphic reduction of joint stresses to bar stresses, either for process i. or ii. is generally familiar, &c.
3. In his preface the author puts forward *no claim whatever to originality.*	Pref. The more strictly new portions are, &c. Pref. The remaining new portions are, &c.
4. In Chapter II., p. 13. Stress and load are used as synonymous or exchangeable terms.	p. 13. Nowhere is any such use made, or intended.
5. On p. 34. Stress and load are used as synonymous or exchangeable terms.	p. 34. Nowhere is any such use made or intended.
6. On p. 35. Stress and load are used as synonymous or exchangeable terms.	p. 35. Nowhere is any such use made or intended.
7. On p. 14 we fall on the expression, "segregation of stress solutions."	p. 14. May be treated generally as "stress solutions," without segregation.
8. This license is repeatedly assumed *throughout the book.*	p. 297. In the Section on Piers, pp. 279 to 348 this license is not repeatedly assumed, but is never assumed at all.
9. The entirely false statement *about a rigid arch.*	p. 38. The statement quoted occurs only on p. 38, about elastic curved ribs (lines 3 and 4). There is no such statement in the preliminary paragraph about the rigid arch p. 39 to 47, nor in the solutions of the rigid arch. Part II.
10. The treatment of the pressure curve in a *semicircular arch* on p. 44 is egregiously wrong. In the first place, the section of rupture lies not at 45 deg.	p. 44. The arch is *any arch* (line 10), not any special form, though it is inclusive of the form drawn. On p. 44 there is not any statement that the point of rupture is at 45 deg. (See line 7 "to determine the limiting points.")
11. Not about a point situate near the centre of the section.	p. 44. Nor is any point of rupture assumed. There is no statement that J is near the centre; though J is misplaced on the diagram unintentionally, this is not said anywhere.

[In the above extract it is Mr. Jackson's professed intention to compare my "quotation" with the "corresponding lines" in his book. Taking his items in their order, let us see how faithfully, and strictly to the letter, he carries out this purpose.

(1)—(2) With regard to these, the correct extract from the review runs thus:—The method of treatment throughout the book is entirely analytical, the new graphic methods being dismissed as "generally familiar, and exemplified in so many elementary books that further exemplification is needless." Then follows my criticism on this statement, as follows:—Now, if it be true, as the author says, that the graphic method, in all its ramifications, is "generally familiar." It is well, therefore, to point out to Mr. Jackson—who, by the way, is so supersensitive to misrepresentation—that, whilst pretending to compare my "quotation" with the actual text of his work, he really substitutes comment for extract, suppresses the introductory clause, "Now, if," &c., and retains of the whole quotation only the two words "generally familiar."

(3) Here Mr. Jackson fails to perceive that a thing may be perfectly new, and yet not in the least original. For example, let us suppcse that I take a new form of roof truss and apply the graphic methods to discover the stresses in its members; then I should be the author of a brand-new solution in graphics, about which there need be no originality. Well, then, in Mr. Jackson's preface there is no claim whatever to originality, but only to some "new solutions," and what he himself calls "new portions," concerning the newness of which I, of course, entirely reserve my opinion.

(4, 5, 6) With regard to these, I have only to state that the term "joint stresses" is frequently used where the context obliges us to interpret it, as intended, for loads. In support of this statement I need only refer to the first extract in the right column above, bearing in mind that at any joint of a roof or bridge truss we have only the stresses acting along the bars, and the externally-applied forces independent of the bars.

(7) Here I criticised the association of the term "segregation" with "stress-solution" as new-fangled, and therefore it is evident that my criticism was perfectly clear of the form of the phrase.

(8) Once more I must point out to Mr. Jackson that he has misquoted the review. No doubt he experienced some reluctance to reproduce the exact words, which run thus: "On the following page (18) the expression 'horizontal force' is substituted for 'bending moment'—a perfectly unwarrantable license repeatedly assumed throughout the work." Now as the author seems to call this statement into question, I will supply him with a few glaring instances. On page 20 we have the ordinary table of bending moments in girders headed as "General Expressions for Vertical Stress and Horizontal Stress." In this case the author not only uses the term "horizontal stress" for "bending moment," but also "vertical stress" for "shearing force." Again, on page 27, the terms are used conjointly and synonymously in taking "H_1 H_2" to represent "the horizontal forces or bending moments."

(9) On page 38 the author, although he may be ignorant of the fact, treats the arch as rigid, insomuch as he supposes the arch to be held by two bending moments at the abutments. He also illustrates the case by a figure on page 36, in which the end bending moments are shown as circles. The treatment of the arch problem on the page in question—38—is not only wrong, but highly ludicrous; for the author supplies us with six unknown quantities, namely, the two end vertical reactions, the two horizontal thrusts—which, of course, may or may not be equal—and the two end bending moments, to determine all of which he presents only four equations, one of the four being altogether irrelevant.

(10) I cannot help regarding this statement as disingenuous on the part of Mr. Jackson—that is, if he wrote the book out of the abundance of his own knowledge and not—as I opine—largely from extensive compilations. As a matter of fact, I find on page 44 the figure of a semi-circular arch, in which the section of rupture is shown as inclined at 45 deg. to the horizon, and in the text Mr. Jackson not only takes moments about this section to determine the horizontal thrust at the crown, but also expressly states that "the weight of arch affecting this thrust is the weight of it and its load down to a joint J inclined at 45 deg. to the horizon." Now, the maximum upper limit being approximately 30 deg. to the horizon, I felt perfectly justified in qualifying an error of not less than 50 per cent. as an egregious blunder.

With regard to Mr. Jackson's complaint that I have only dealt with the first forty-six pages of his book, I would only remark that apart from the fact that the quality of the hogshead can be tested by sipping but one cup, there is also a limit to the space which a technical journal can devote to literature.

YOUR REVIEWER.]

HUDDERSFIELD STATION ROOF.

SIR,—In reply to Mr. T. Graham Gribble's criticism upon my report, I beg to inform him 40 lb. per superficial foot is a standard figure used by eminent engineers of the present day for calculations of station and other large roofs, and includes weight of construction, resultant forces from wind, weight of snow—in fact every possible strain which would come upon a roof—and is not an ideal or very rough approximation, as he states. No doubt there are thousands of house roofs being built which are only safe at 15 lb. per superficial foot; but surely Mr. Gribble would not suggest that station roofs are constructed upon the same principle. The simile between a house and station roof to me appears unique. A house roof is generally constructed of timber, and I have often noticed, during the removal of buildings, after large portions of a roof are removed, how remarkably the remaining portions stand, to all appearances, perfectly firm. But not so with an iron roof; a displaced pin, or a faulty link, &c., may be the cause of total collapse.

I admit the "Queenpost" is a very simple and common roof, the style being chiefly used for timber roofs; but I do not believe there are many in England constructed in iron, as station roofs. As far as putting them in my "black books," I should most certainly do so, with all works I considered faulty.

Mr. Gribble's difficulty in understanding my diagrams rather disappoints me, as some trouble was taken to make them, as I thought, clear enough for anyone of ordinary intelligence. The scale of the elevation, he says, is stated to be 8ft., and measures 12ft. In my manuscript this was drawn to 8ft., but—I suppose for convenience of insertion in THE ENGINEER—was reduced to 12ft. scale. All the dimensions required can be taken off this elevation with a 12ft. to the inch scale. Fig. 10, he also states, is unintelligible. The struts as shown reversed is only a printer's mistake; but why, for this simple error, this figure should be unintelligible is hard to conceive. The letters A, B, C, &c., on Fig. 14, refer to the members between these letters—such as portion of rafter B G would mean the length between ties E F and G H, &c. This diagram appears to me to be explicit enough.

I did not say that portion B E of rafter is the same in compression as B C. My report states: "The compression in the part B E of the main rafter is 18 tons, and similar results for part B C. Therefore, the action of rafter required for B C would, of course, also refer to part B E." When I said similar results for the parts B C, I naturally concluded one would understand similar or proportional results would occur.

Mr. Gribble's request for my opinion as to the cause of failure, and my reasons for such opinion, not being in accordance with my report, I decline to give them.

Mr. Gribble entirely fails to comprehend that failure did actually arise from defective design, and says, by my own proving there was much less weight upon the rafters at the time of the fall than there would be when the boarding was completed. All the ironwork of the sixteen principals and supports was finished permanently, and staging removed, at the time of the accident.

As Mr. Gribble commenced his criticism in the interest of fairness, and immediately afterwards insinuates my report was for the purpose of attaching blame to the design, I feel justified in stating I wrote the report with perfect impartiality, and without the slightest prejudice to any party concerned. I have had no connection with the people concerned since the coroner's verdict, 2nd October, and the only motive for my report was a hope that the same would be of some little interest to those in the profession.

Sunderland, November 23rd. W. I. S. McCLEARY.

CYLINDER CONDENSATION IN STEAM ENGINES. AN EXPERIMENTAL INVESTIGATION.*

By CHAS. L. GATELY, M.E., and ALVIN P. KLETZSCH, M.E.

(*Continued from page* 402.)

16. *Case II.*—The next set of five tests with condenser was made with ratio of expansion and piston speed of engine constant, varying only the pressure of the boiler in the tests of this set. Starting with an average of 80 lb. in the first test, and concluding with a pressure of 22·3 lb. in the fifth. Table 2, lines 8 and 11, will show that the conditions of constancy of speed and ratio of expansion were maintained with a sufficient degree of accuracy, so that there can be no doubt but that any difference in the amount of condensation found to have occurred must be due to variation in the initial pressure. The logs and trials of this set are given below:—

Case II.—Condensing.—Variable Boiler Pressure.

Table No. 2.
Test No. 5.
Date of test, May 26, 1884 8.01 to 10.1 a.m.
Duration, 2 hours.
Conditions.—Variable pressure. Constant speed. Constant cut-off.

	Time	Speed counter.	Water meter.	Height over notch board.	Temperature feed-water.	Temperature injection-water.	Temperature weir.	Boiler pressure.	Vacuum gauge.	Remarks.
Start	8.01	43625	5848·7	3·740		66	101	75·	22·5	
	8.22	44695	5863·	4·020	61	66	110	82·	22·	Deduct 19½ lbs.
	8.37	45765		4·020		66	108	82·	22·5	
	8.52	46795	5883·	4·020	103	66	110	80·	22·5	
	9.01	47855		4·084		66	106	80·	22·5	Boiler foaming some, 9.15 a.m.
	9.22	48845		4·028	97	66	103	75·	22·5	Deduct 18¾ lbs.
	9.37	49887	5925·	3·640		66	110	83·	22·5	
	9.52	50945	5952·5	3·650		66	104	81·	22·5	
Finish	10.01	51907	5960·	3·620		66	111	82·	22·5	

Case II.—Condensing.—Variable Boiler Pressure.

Table No. 2.
Test No. 6.
Date of test. May 26, 1884, 10.38 a.m. to 12.23 p.m.
Duration, 1¾ hours.
Conditions.—Variable pressure. Constant speed. Constant cut-off.

	Time	Speed counter.	Water meter.	Height over notch board.	Temperature feed-water.	Temperature injection-water.	Temperature weir.	Boiler pressure.	Vacuum gauge.	Remarks.
Start	10.38	52610	5978·	4·120		66	111	65·	22·	
	10.53	53695		3·390	102	66	116	65·	22·25	
	11.08	54765	6000·	3·348	102	66	117	67·	22·	Deduct 12 lbs.
	11.23	55840		3·304		66	115	67·	23·	
	11.38	56865	6040·	3·375		66	108	69·	22·5	
	11.53	57895	6045·	3·392		66	130	66·	22·	
	12.08	58975	6057·5	3·324		66	118	69·	22·	
Finish	12.23	60036	6060·	3·360		66	136	67·	22·25	

Case II.—Condensing.—Variable Boiler Pressure.

Table No. 2.
Test No. 7.
Date of test, May 26, 1884, 2.54 to 4.54 p.m.
Duration, 2 hours.
Conditions.—Variable pressure. Constant speed. Constant cut-off.

	Time	Speed counter.	Water meter.	Height over notch board.	Temperature feed-water.	Temperature injection-water.	Temperature weir.	Boiler pressure.	Vacuum gauge.	Remarks.
Start	2.54	60090	6109·	3·500		68	101	52·	22·5	
	3.09	61100		3·632	118	68	104	52·	22·5	
	3.24	62125		3·516		68	108	54·	22·5	
	3.39	63230	6127·	3·432		68	110	52·	22·5	Deduct 20 lbs.
	3.54	64305		3·424		68	109	52·	22·	
	4.09	65405		3·280		68	112	52·	22·5	
	4.24	66510	6152·	3·320	110	68	118	52·	22·5	Deduct 9 lbs.
	4.39	67585	6169·	3·320		68	120	52·	22·5	
Finish	4.54	68698	6179·	3·315		68	122	53·	22·5	

Case II.—Condensing.—Variable Boiler Pressure.

Table No. 2.
Test No. 8.
Date of test, May 28, 1884, 7.36 to 9.36 a.m.
Duration, 2 hours.
Conditions.—Variable pressure. Constant speed. Constant cut-off.

	Time	Speed counter.	Water meter.	Height over notch board.	Temperature feed-water.	Temperature injection-water.	Temperature weir.	Boiler pressure.	Vacuum gauge.	Remarks.
Start	7.36	69053	6515·	3·300		65	102	37·	22·	
	7.51	70157	6526·	3·384		65	95	39·	22·5	
	8.06	71192		3·020		65	99	37·	22·5	
	8.21	72216	6540·	2·988		65	99	36·	22·5	
	8.36	73232		2·948		65	100	37·	22·75	
	8.51	74250	6545·	3·012	128	65	99	37·	23·	Deduct 20⅝ lbs.
	9.06	75274		3·010		64	102	36·	23·	
	9.21	76299	6565·	2·900	96	64	102	38·	23·	
Finish	9.36	77323	6569·	2·904		64	101	36·	23·	Deduct 7 lbs.

* Presented to the American Association for Advancemen of Science; Ann Arbor Meeting, 1885, with an Introduction by Professor R. H. Thurston.

Case II.—Condensing.—Variable Boiler Pressure.

Table No. 2.
Test No. 9.
Date of test, May 27, 1884, 10.15 a.m. to 12.27 p.m.
Duration, 2 hours.
Conditions.—Variable pressure. Constant speed. Constant cut-off.

	Time	Speed counter.	Water meter.	Height over notch board.	Temperature feed-water.	Temperature injection water.	Temperature weir.	Boiler pressure.	Vacuum gauge.	Remarks.
Start	10.15	78302	6608·7	3·200	94	64·	88	23·	23·	Deduct 22 lbs.
	10.30	79321	6614·	2·380		64·	102	22·	23·	
	10.45	80342		2·324		64·	103	22·	23·	
	11.00	81363		2·348		64·	103	22·5	23·	
	11.15	82379		2·404		64·	102	21·	23·	
	11.30	83391	6634·	2·400		64·5	110	22·	23·	
	11.36	*								
	11.42	83871	6642·	2·400	118	64·5	101	26·	23·	Deduct 15¾ lbs.
	11.57	84892		2·390		64·5	102	22·5	23·	
	12.12	85912	6650·	2·400		64·5	101	20·	23·	
Finish	12.27	86935	6652·5	2·396	106	64·5	104	22·	23·	Deduct 22¾ lbs.

* Stopped on account of excentric strap. Started again at 11.42 a.m.

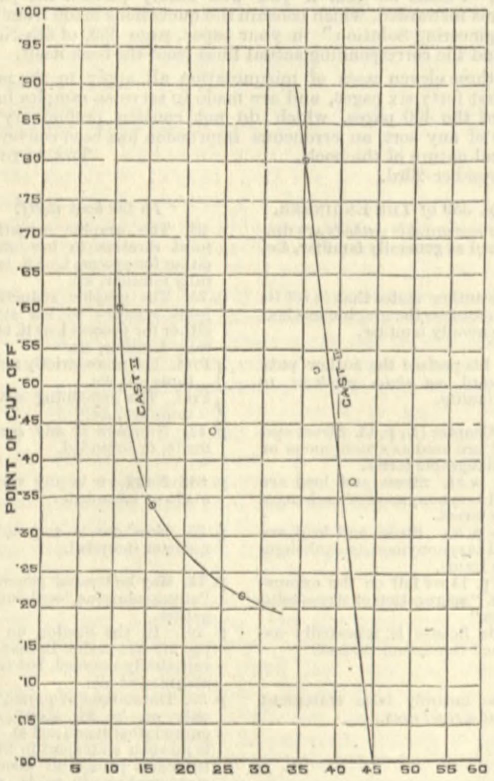
CALORIMETER TESTS.

Case II.—Condensing.—Variable Boiler Pressure.

In connection with engine trial.	Initial weight.	Initial weight plus condensing water.	Final weight.	Initial temperature.	Final temperature.	Flow in air.	Flow in calorimeter.	Boiler pressure.
				deg.	deg.	min.	min.	
No. 5.	69½	139½	145¼	67·5	152	1	2½	82·
No. 6.	70	140	146¼	69·	156	1	3	67·5
No. 7.	$70\frac{9}{16}$	$140\frac{9}{16}$	$145\frac{9}{16}$	70·	138	1	2	54·
No. 8.	70⅞	140⅞	146⅜	67·5	139	1	4	36·5
No. 9.	70⅞	140⅞	146¼	67·	140	1	6	22·5

17. *Case III.*—The third set of trials was made supplementary to the second, inasmuch as the conditions of constant ratio of expansion and speed of piston were the same, and the boiler pressure variable; the difference being that in the former the engine was worked under "low pressure," or condensing, while in the latter set the condenser was disconnected and the engine worked under "high pressure." The range in initial pressure worked under is not as great in this latter set, the boilers being unable to work higher without the aid of the condenser. In Test 2 the average pressure under which the test was made was 44·09, and the logs and indicator cards taken show that the proper conditions were rigidly observed. For some reason, in representing the result of this set graphically, the point corresponding with this second trial falls some distance to the right, so a curve passing through it and the remaining three points would be so irregular and would so widely differ from that curve representing the preceding set, that it is better disregarded. For it can be readily understood that the curve representing each should have the same general appearance, although a difference in the absolute amounts of condensation in the two cases would be expected and are seen to exist. Fig. 1: The logs and calorimeter tests made during this set are given below:—

Fig. 1.



Per cent. of Condensation.—Condensation with Varying Pressure.

Case III.—Non-condensing.—Variable Boiler Pressure.

Table No. 3.
Test No. 10.
Date of test, May 27, 1884, 1.50 to 4.50 p.m.
Duration, 3 hours.
Conditions.—Variable pressure. Constant speed. Constant cut-off.

Time.	Speed counter.	Water meter.	Boiler pressure.	Temperature feed-water.	Remarks.	Calorimeter test.
Start						
1.50	905	6688·3	20·	102		Initial weight.......71⅛
2.05	1915	6696·	22·	105		Initial w'ht + W. lbs.
2.20	2909	6705·5	22·	110		of cond. water....141⅛
2.35	3910		21·	112	Deduct $23\frac{3}{16}$ lbs.	Final weight after in-
2.50	4905		24·			troducing steam..146⅞

Case III.—Table No. 3, Test No. 10 (continued).

Time.	Speed counter.	Water meter.	Boiler pressure.	Temperature feed-water.	Remarks.	Calorimeter test.
3.05	5901		21·5			Initial temp.... 71° °F.
3.20	6899		22·	112		Final temp....152·5° F.
3.35	7891	6744·	23·25	111	Deduct $23\frac{3}{16}$ lbs.	Boiler pressure......22
3.50	8889	6750·5	20·			Flow of steam in air,
4.05	9886		20·5	96		1 min.
4.20	10884		23·25	94		Flow of steam in calori-
4.35	11881		21·5	95	Deduct $27\frac{4}{16}$ lbs.	meter..........6 min.
4.50	12878	6779·	22·			
Finish						

Case III.—Non-condensing.—Variable Boiler Pressure.

Table No. 3.
Test No. 11.
Date of test, May 28, 1884, 7.30 to 10.30 a.m.
Duration, 3 hours.
Conditions.—Variable pressure. Constant speed. Constant cut-off.

Time.	Speed counter.	Water meter.	Boiler pressure.	Temperature feed-water.	Remarks.	Calorimeter test.
Start						
7.30	12520	6854·	72·			Initial weight....71 lbs.
7.45	13537	6858·5	62·	158	Deduct 22½ lbs.	Initial w'ht + condens-
8.00	14562	6879·	55·	116		ing water......141 lbs.
8.15	15585	6905·	59·	106	Deduct 23½ lbs.	Final weight...146¼ lbs.
8.30	16615	6908·5	61·	116		Initial temp. ....68° F.
8.45	17624	6921·	62·			Final temp. ....146° F.
9.00	18656	6935·	51·	93		Boiler pressure......59
9.15	19680		62·			Steam flowed in air,
9.30	20685	6966·	59·5	104	Deduct 21¼ lbs.	1 min.
9.45	21701	6980·	60·	140		Steam flowed in calori-
10.00	22716	6991·	61·	98		meter.........3 min.
10.10	23738	7014·	56·5			
10.30	24757	7037·	61·	84	Deduct 23⅜ lbs.	
Finish						

Case III.—Non-condensing.—Variable Boiler Pressure.

Table No. 3.
Test No. 12.
Date of test, May 28, 1884, 11.08 a.m. to 1.38 p.m.
Duration, 2½ hours.
Conditions.—Variable pressure. Constant speed. Constant cut-off.

Time.	Speed counter.	Water meter.	Boiler pressure.	Temperature feed-water.	Remarks.	Calorimeter test.
Start						
11.08	25345	7078·2	44·			
11.23	26410	7086·	43·	94	Deduct 23⅛ lbs.	Initial weight..$71\frac{1}{16}$ lbs.
11.38	27417	7102·	45·	98		Initial weight + cond.
11.53	28448	7113·	43·	98		water. ......$141\frac{1}{16}$ lbs.
12.08	29510	7126·	44·	98		Final weight..$146\frac{1}{16}$ lbs.
12.23	30557	7142·	44·	98		Initial temp......65° F.
12.38	31583	7150·	43·	86		Final temp......137° F.
12.53	32586	7169·	45·	94		Boiler pressure.....43 5
1.08	33604	7178·	44·	100	Deduct 25½ lbs.	Flow in air......1 min.
1.23	34627	7193·	44·5	100		Flow in calorimeter,
1.38	35631	7215·	45·5	88	Deduct 16 lbs.	5 min.
Finish						

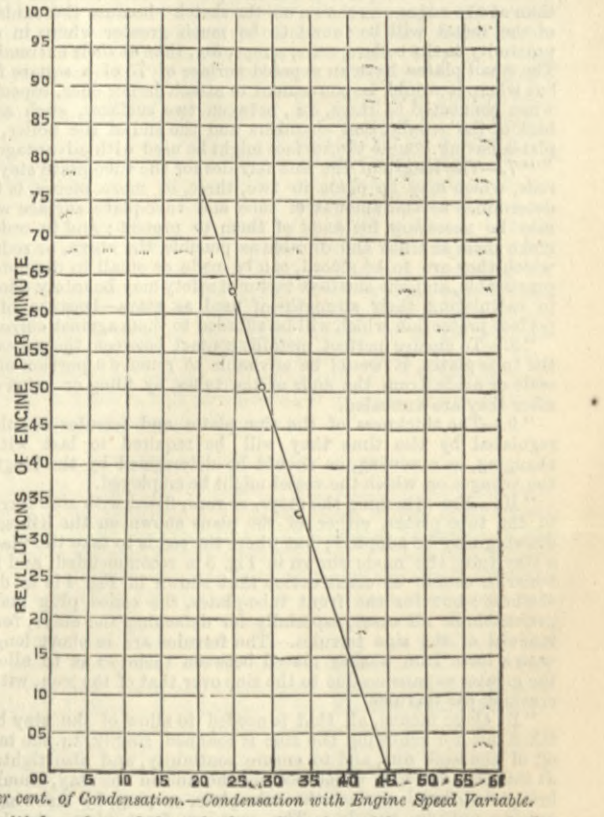
Case III.—Non-condensing.—Variable Boiler Pressure.

Table No. 3.
Test No. 13.
Date of t st, May 28, 1884, 2.19 to 5.19 p.m.
Duration, 3 hours.
Conditions.—Variable pressure. Constant speed. Constant cut-off.

Time.	Speed counter.	Water meter.	Boiler pressure.	Temperature feed-water.	Remarks.	Calorimeter test.
Start						1st. 2nd.
2.19	36204	7224·	32·			
2.34	37198	7233·	34·5	100		Initial w'ht..71¼ $71\frac{9}{16}$
2.49	38207	7242·	35·	106		Initial w'ht+
3.04	39225	7252·	34·5	110		con. water, 141¼ $141\frac{9}{16}$
3.19	40253	7265·	33·5	86	Deduct 18 lbs.	Final w'ht..148½ 148
3.34	41265	7270·	33·	88		In. temp, 60·5°F. 60·5°F.
3.49	42280	7292·	32·5	102		Final temp.
4.04	43294		34·			160·5°F. 150·5°F.
4.19	44300	7303·	32·	102	Deduct $20\frac{3}{16}$ lbs.	Boiler pres...33·5 33·
4.34	45311	7313·	32·5	105		Flow in air, 1 min. 1 min.
4.49	46325	7322·	34·	104		Flow in ca-
5.04	47325	7331·	34·5	90		lorime'r, 5½ min. 5 min.
5.19	48357	7343·5	33·5	95	Deduct 24⅜ lbs.	
Finish						

18. *Case IV.*—The fourth and last set made was to determine the effect caused by different speed of engine or time of exposure of

Fig. 2.



Per cent. of Condensation.—Condensation with Engine Speed Variable.

the initial surface of the cylinder. Starting with an average boiler pressure of 19·67 lb. and a cut-off of ·98 of the length of stroke and the engine running at an average of 33·74 revolutions per minute, three trials were made, concluding with an average speed of 62·977 revolutions per minute. The greatest variation in the point of cut-off being ·05 of the stroke, and in the pressure ·63 of a pound. Any difference in the condensative found to have occurred in the three trials can therefore be attributed strictly to the range of speed worked through. Difficulty was found in getting the engine to run smoothly lower than thirty-three revolutions per minute, and the opportunity was wanting to make a fourth test at a higher speed than sixty-three revolutions, the engine being needed on the regular work of the mill. But it will be seen by reference to Fig. 2 that the three points of the curve given by these three trials are so nearly in line that a fourth test is hardly necessary in order to find the law governing the variation. All the data taken during the three trials are given below in tabular form:—

Case IV.—Condensing.—Variable Revolutions.

Table No. 4.
Test No. 14.
Date of test, May 29, 1884, 7.57 to 9.42 a.m.
Duration, 1¾ hours.
Conditions. — Variable speed. Constant cut-off. Constant pressure.

	Time	Speed counter.	Water meter.	Height over notch board.	Temperature feed-water.	Temperature injection-water.	Temperature weir.	Boiler pressure.	Vacuum gauge.	Remarks.
Start	7.57	1182	7380·	1·900		53·	130	21·	20·	
	8.07	1497	7404·5	2·280	166	53·	135	21·	20·	
	8.17	1768		2·212		52·5	123	19·	20·	
	8.27	2121	7405·	2·282	110	53·	138	19·	20·	
	8.37	2478		2·280		53·	134	20·	20·	
	8.47	2819		2·288		53·	130	19·5	20·	
	8.57	3162		2·3		52·	137	19·	20·	
	9.07	3532		2·298	100	52·	137	20·	20·	23$\frac{7}{16}$ lbs. out.
	9.17	3880	7438·2	2·290		52·5	132	19·5	20·	
	9.27	4215		2·256		52·	131	19·	20·	
	9.37	4556		2·308	80	52·	134	20·	20·	
Finish	9.42	4725	7446·5	2·312		52·	128	19·	20·	Deduct 7 lbs.

Case IV.—Condensing.—Variable Revolutions.

Table No. 4.
Test No. 15.
Date of test, May 29, 1884, 9.47 to 11.47 a.m.
Duration, 2 hours.
Conditions. — Variable speed. Constant cut-off. Constant pressure.

	Time	Speed counter.	Water meter.	Height over notch board.	Temperature feed-water.	Temperature injection-water.	Temperature weir.	Boiler pressure.	Vacuum gauge.	Remarks.
Start	9.47	4949	7446·5	2·780		52·	129	18·5	21·5	
	9.57	5431	7452·	2·774	90	52·5	130	19·	22·	
	10.07	5927		2·712		52·5	135	18·5	21·5	
	10.17	6437	7466·	2·718		52·5	136	20·5	21·	
	10.27	6925		3·040	110	52·5	120	19·5	22·5	Deduct 18 lbs.
	10.37	7421	7470·	3·100		52·5	120	19·	22·5	
	10.47	7927		3·106		52·5	117	16·	23·	
	11.07	8975		3·036		53·	122	19·	22·5	
	11.17	9496	7507·	3·085	90	52·5	119	18·	22·5	
	11.27	9990	7514·	3·085		52·5	123	20·	22·5	
	11.37	10495	7520·	3·085		52·5	120	19·5	22·5	Deduct 17$\frac{13}{16}$ lbs.
Finish	11.47	10985	7543·	3·085	80	53·	123	21·	22·5	

Case IV.—Condensing.—Variable Revolutions.

Table No. 4.
Test No. 16.
Date of test, May 29, 1884, 3.00 to 4.30 p.m.
Duration, 1½ hours.
Conditions. — Variable speed. Constant cut-off. Constant pressure.

	Time	Speed counter.	Water meter.	Height over notch board.	Temperature feed-water.	Temperature injection-water.	Temperature weir.	Boiler pressure.	Vacuum gauge.	Remarks.
Start	3.00	18886	7655·5	4·154	98	55	105	24·	24·	
	3.10	19491	7668·	4·100		54	104	21·	23·5	
	3.20	20059	7672·	4·200	104	54	104	20·5	23·5	
	3.30	20639		4·140	100	54	103	20·	23·5	
	3.40	21248		4·040	86	54	107	17·5	23·5	Deduct 20¼ lbs.
	3.50	21925		4·200		54	107	18·	23·75	
	4.00	22597		4·168		54	102	17·5	23·5	
	4.10	23257		4·100	103	54	108	17·	23·75	
	4.20	23911		4·262		54	101	16·	23·5	
Finish	4.30	24554	7740·	4·080		54	112	19·	23·75	Deduct 5 lbs.

CONDENSING TESTS.

Case IV.—Calorimeter Trials.—Variable Revolutions.

In connection with engine trial.	Initial weight.	Initial weight plus condensing water.	Final weight.	Initial temperature.	Final temperature.	Flow in air.	Flow in calorimeter.	Boiler pressure.
				deg.	deg.	min.	min.	
No. 14.	71$\frac{7}{16}$	141$\frac{7}{16}$	148$\frac{1}{16}$	55·	145·5	1	7	20·
No. 15.	71⅝	141⅝	147$\frac{15}{16}$	55·5	142·5	1	7	20·5
No. 16.	71¾	141¾	145⅝	55·75	113·	1	5	145·

(*To be continued.*)

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, November 14th.

THE announcement by Gowen, the ex-president of the Reading Company, that he will be a candidate for re-election, is the surprise of the week in railroad circles. The reorganisation trustees of that company are still prosecuting a plan which has many points of interest, but the company is threatened with foreclosure proceedings, that just now seem to be more probable than any reorganisation by the ex-president, the success of which depends upon the borrowing of 20,000,000 dols., for the satisfaction of that amount of securitiies.

The Trunk line interests are in the way of adjustment. Rail brokers have closed for large contracts for rails for winter and spring delivery for Trunk and West Mississippi railway systems, and are at present negotiating for some large orders to be delivered to railways south of the Ohio. Makers refused orders yesterday for large lots for winter delivery at prices which were accepted two weeks ago. The tendency seems to be upward, and buyers for reads that are to be built next spring are undecided as to what course to pursue.

The iron trade generally is holding its own. Very little southern iron has arrived during the past two weeks, and agents are not pushing sales in eastern markets with their accustomed vigour. Advances have been made of from 25c. to 50c. per ton on forge and foundry irons in Pennsylvania furnaces making the better grades of iron. There is a falling off in the bar mills, but in plate and structural mills the usual run of orders continues, and prevents any perceptible weakness in prices. A great deal of railway construction has been decided upon for next year.

The annual meeting of the American Association of Mechanical Engineers was held on Thursday at Boston; total membership 621. Officers were elected for ensuing year.

The managers of the Long Island Railroad are perfecting plans for the establishment of a line of fast steamers between Fort Pond Bay, Long Island, and the West Coast of Ireland. Congress is to be asked for a subsidy for carrying mails. Six vessels will be constructed of 7000 tons capacity, at a cost of 1,500,000 dols. each.

Work has been resumed at the shipyards of John Roach at Brooklyn, New York, and Chester, Pennsylvania; 1000 hands are at work. Shipbuilding generally is very quiet. Commercial interests are agitating for the amendment of the shipping laws of the United States in Congress this winter, and resolutions are being drafted to be submitted to the various Chambers of Commerce in Atlantic coast cities, to be presented to Congress in January.

A good deal of interest is felt in the scheme for establishing a trans-continental railroad from Port Moody on the Pacific coast to Boston and Portland on the Atlantic coast. The new bridge under construction across the St. Lawrence at Lachine will be used, and twenty miles of road will be built to cover a gap. A combination will be made between New York and Halifax and St. Johns. The new line of steamships between Portland and Liverpool will begin to ply in a few days.

The manufacturing interests are somewhat concerned at the bold front taken by revenue reformers, and their apparent success in arousing the popular interest in their efforts at tariff reduction.

Several new railway enterprises in the South are attracting the attention of investors here. Connecting lines are projected which will give symmetry and completeness to three separate southern lines which have for months past been quarrelling over traffic. A new road, to cost 2,000,000 dols., will be built in Georgia, to tap a great cotton-producing district, and pass through the richest yellow pine district of that State heretofore unsupplied with railway facilities. English lumber interests will be benefitted by this construction. There is no perceptible diminution in industrial activity throughout the country, taking into account the usual dulness in several lines at this season.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

ELECTION matters engrossed so much attention at the ironmasters' meetings in Birmingham this—Thursday—afternoon and in Wolverhampton yesterday that business seemed almost a secondary consideration. Increased interest attached to the discussions since on Tuesday Mr. Alfred Hickman, chief proprietor of the Spring Vale blast furnaces, Bilston, and of the Staffordshire Steel and Ingot Iron Company, Bilston, was returned as the Conservative member for Wolverhampton West. Mr. Hickman has received warm congratulations upon all hands, and his return, it is hoped, will do something towards assisting the trade of the district. Mr. Hickman fought Wolverhampton in 1880, but was unsuccessful. He is the largest pig maker in Staffordshire, and it was by his influence that the railway companies were lately induced to lower the coke freights.

The enquiries which buyers are mostly making relate to deliveries in 1886. Certain pig buyers especially always regard November as a favourable time to purchase, and they are now willing to place contracts throughout the whole of next year if sellers will accept present prices. Some sellers there are who will consent, but by far the majority decline to tie their hands.

Specifications in the sheet and some other mills continue rather slack. Prices have now got down to the level which existed before the late rise. Merchant singles are £6 5s. to £6 10s. at works; galvanising doubles, £6 12s. 6d. to £6 15s. at works; and trebles, £7 15s.

The make of sheets will be increased early in the new year by the restart of the Eagle Ironworks, West Bromwich, formerly worked by the Eagle Iron Company, and latterly by Messrs. John Jones and Sons. They have now been purchased by Messrs. Parkes and Parkes, of the Atlas Ironworks, West Bromwich. Messrs. Parkes intend to convert the works into a sheet plant of about three mills.

Export requirements are not, as a rule, for heavy quantities of bar iron. Business in large sizes of rounds, squares, and flats registers a slight impetus in respect of home requirements. Marked bars keep at £7 10s. to £8 2s. 6d. for first qualities and £6 10s. for second qualities.

The first-class bars of Messrs. Noah Hingley and Sons are quoted:—Netherton Crown best, and Netherton Crown best horseshoe, £7 10s.; best rivet, £8; double best plating bars, £9; double best Crown bars, £8 10s.; and treble best ditto, £9 10s. These quotations apply to rounds and squares ½in. to 3in. and to flat bars 1in. to 6in. For angles up to 8 united inches an additional 10s. per ton extra is quoted, and for tees an additional 20s.

William Millington and Company quote bars £7 10s.; small rounds and squares, £8; $\frac{5}{16}$in. bars, £8 10s.; ¼in., £9; No. 5, £9 10s.; $\frac{3}{16}$in. £10; No. 7, £11; No. 8, £12; and No. 9, £13 10s. Best bars they quote £8 10s.; double best, £9 10s.; and treble best, £11 10s. Plating bars and cable iron, £8; and best ditto £9, with double best £10. Rivet iron, £8 10s.; best, £8 15s.; and double best, £10 5s. Angles, £8 10s. to £9, and on to £10, according to quality. Boiler-plates and sheets, £9; best, £9 10s.; double best, £10 10s.; and treble best boiler-plates, £12 10s.

The arbitration upon the notice of the ironmasters for a reconsideration of the wages question will, it is anticipated, take place pretty early next month. Until this arbitration is over finished iron buyers will not operate with freedom, since the opinion still holds that a decided reduction will be awarded.

Vendors of steel plating bars are just now meeting with unexpected and surprising competition. It comes from German steelmasters, from whom certain consumers of plating-bars in this district have lately made purchases at 5s. per ton under the English minimum, which is about £5 10s. delivered hereabouts. When the German steel arrives I am promised an inspection. Steel billets are this week offered at lower prices than ever. Some consumers assert that they are buying Welsh make at £4 10s. delivered.

Deliveries of pigs from outside districts have been slower during the past fortnight. Native makers, however, continue their regular output, and report that it is going steadily away. Foundry pigs are proportionately in better request than forge pigs. All-mines are 55s. to 57s. 6d.; part-mines, 40s. to 45s.; and cinder pigs, 32s. to 35s.; Midland pigs remain an average of 38s. to 40s. delivered.

Consumers of Welsh scrap—sheet shearings—offer 45s. per ton delivered. Sellers mostly ask more money, but unsuccessfully.

The trade in imported minerals is not very brisk. Derbyshire furnace cokes are quoted 14s. per ton; best Welsh furnace cokes, 16s.; and Welsh and Durham foundry sorts, 20s. to all delivered. Purple ore of the Widnes district for fettling is in slow demand at 12s. Northampton ore varies considerably according to the locality of delivery, the range being about 5s. 3d. to 6s. 3d.

The demand for coal is rather better, and prices are running up somewhat. Cannock Chase prices are about:—House coal, 6s. 6d. to 8s. 6d. at the pits, common forge and steam, 5s. 9d.; superior forge, 6s. 6d. to 7s.; and best picked steam, 6s. 6d. Fine slack is 2s. 6d., and best rough, 4s. 6d.

In the North Staffordshire coal-field certain of the pits companies have this week given notice for the 10 per cent. advance recommended by the general Conference.

Constructive and other engineers have made a good bid for the bridge work, railway carriage ironwork, and wrought iron tanks for which the India-office are now prepared to contract. Should our firms be successful, orders will be very welcome, although they are sure to be cut fine.

Certain of our manufacturers are going in strong for the tenders offered by some of the leading home railway companies for their twelvemonth's stores supply. A Wolverhampton firm has this week secured the Great Western tool contract.

Machinists and engineers in Birmingham continue to speak of the general dulness of trade, but the experience of local manufacturers in this branch is, at all events, no worse than that of their competitors in the north and south. In steam engines and gas engines a considerable demand is by some of the makers being filled for export, but the competition abroad of German machinists and engineers is still severe. Firms who manufacture specialities have most to do. Some of the younger ones report full employment, and several of them are extending their works. This applies more particularly to firms engaged in arsenal and dockyard work. Messrs. Jas. Archdale and Co., and Messrs. Geo. Bellis and Co. are both conspicuous in this connection. The former have recently increased their production about 50 per cent., and the latter have also considerably extended their works, consequent in part upon good Government orders for launch engines of great power, and compressed air reservoirs for torpedoes and other work.

The majority of the members of the Birmingham Chamber of Commerce express a good deal of surprise and dissatisfaction that in the recently issued report of the Royal Trade Commission it should appear as their recommendation that retaliatory duties should be adopted. Such suggestion was, it is true, specially forwarded by a small number of the Council, who took upon themselves to speak in the name of the Chamber, but their decision was afterwards reversed by the general body, and the Commissioners were informed of this change of opinion.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

LARGE purchases of Cleveland pig iron were made during last week for delivery over the first six months of next year, most of the transactions being direct with makers, and on the basis of 33s. per ton for No. 3 g.m.b.

At the market held at Middlesbrough on Tuesday, a quieter feeling prevailed. Few sales were made, and prices were somewhat weaker than last week. Sellers, however, managed to maintain their quotations for No. 3 g.m.b. at 32s. 3d. per ton for prompt delivery, and for delivery over the first half of 1886 at 33s. The demand for forge iron is relatively small, owing to continued slackness at the finished ironworks. Prices have, nevertheless, risen slightly in sympathy with No. 3. The minimum figure at which it can be had is 31s. 3d. per ton, and last week some sales were made at 31s. 6d.

Warrants are still firmly held, and the market value has moved up to 33s. 3d. per ton.

The stock of Cleveland pig iron in Messrs. Connal and Co.'s Middlesbrough store rose 2452 tons last week, the quantity held on Monday last being 118,975 tons. Six months ago their stock was only 50,000 tons.

November exports from the Tees reached a total of 56,554 tons on Monday last, being 2000 tons less than for the corresponding portion of October.

The eccentricities of steel plates are again exciting the apprehensions of shipowners and shipbuilders in the North. A certain steel ship is at present under construction at a north-east coast shipyard. The plates are supplied by a company which have every appliance for making them well, and, as a matter of fact, they are all subjected to Lloyd's survey before leaving maker's works. The garboard, or keel strake, was duly bent, punched, countersunk, and, last of all, annealed in the usual manner, and then rivetted to the ship frames. By the time the work was so far complete, however, three of the plates cracked in a mysterious manner, and became, of course, quite useless. After being cut out strips were taken from the cracked parts of the cracked plates, and were tested in every conceivable way. It was thought that brittleness or inferiority of some kind would be detected. Not so, however, for the test pieces behaved in every way as they should do, and afforded no clue whatever to the solution of the difficulty. The replacement of three plates out of a strake is not of itself a very serious matter; but the uncertainty which remains as to the condition of the remainder, and, indeed, as to the condition of similar plates, in similar ships, everywhere is naturally a source of trouble and anxiety. A keel strake plate cracking across, when a ship is at sea, might cause it to founder without any discovery of the reason why. If three plates of the highest attainable quality, and treated in the most skilful way, fail badly and suddenly after being secured in their places, and without any obvious strain upon them, why should not the same thing or worse occur when the unknown stresses occasioned by heavy seas try them perhaps to the utmost? There is obviously something yet to find out about steel plates. There appears to be an inherent uncertainty of behaviour consequent on homogeneity. The very quality that enables steel to beat its competitor iron so easily and so decidedly, in tensile strength, and in ductility, renders it also at certain times, and in certain conditions, as treacherous as glass. And those conditions, and how to provide gainst them, no one as yet seems fully to understand. If steel plates, like iron, would only show inferiority by obvious indications during manipulation, they could be submitted to the process of artificial selection. But like hypocritical individuals they always appear immaculate when undergoing observation, and alter their behaviour suddenly and completely just when they have established their character for reliability. It is understood that the further progress of the vessel in question has been delayed for the present pending certain inquiries and investigations. As a natural consequence there is a tendency for iron as a shipbuilding material again to come into favour with shipowners, and especially for sailing ships.

The finished iron trade is still in an extremely unsatisfactory condition. There are few inquiries and fewer orders in the market, and prices do not fluctuate much. Current quotations are as follows: Ship-plates, £4 12s. 6d. per ton; angles, £4 7s. 6d. to £4 10s.; and bars, £4 15s. to £4 17s. 6d. These prices are free in trucks at makers' works. Terms: Cash 10th, less 2½ per cent. discount. Work has been partially resumed at the West Marsh and Britannia Works, belonging to Messrs. Dorman, Long, and Co. Angles, bars, and rolled girders are being made in limited quantity, but no plate mills are, for the present, in operation at Middlesbrough.

Messrs. Raylton, Dixon, and Co., of Middlesbrough, have received an order for a steamer of 2000 tons burden for a Liverpool firm, and Messrs. Hawthorn, Leslie, and Co., of Newcastle and Hebburn, have secured an order for twelve torpedo boats from the Government.

At Stockton the shipbuilders have still a fair amount of work in hand, and Messrs. Pearse and Co., of the North Shore Shipyard, have just booked an order for a merchant vessel 385ft. long. This is the largest vessel hitherto ordered on the Tees.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—The past week has been so much given up to electioneering excitement that attention has been very largely diverted from business, and there has been little or no attempt at any transactions of importance beyond what have been absolutely necessary to cover urgent current requirements. No accurate estimate of the actual condition of trade is, of course, to be based upon the condition of the market in the present unsettled state of business, but apart from the disturbing excitement of the moment the general tone is one of extreme quietness. On the present low basis of prices, consumers have no hesitation in buying for actual requirements, but these are limited in most cases to very small quantities, and inquiries come forward only very slowly, with a gradual lessening weight of trade doing in natural sympathy with the decreasing activity in most of the large iron-using branches of industry. The advance in prices which sprang up last week in some of the outside brands of pig iron has again died away, and it has simply furnished an illustration of the occasional fluctuations to which the market, with the low prices now ruling, may be subject, whenever accidental combinations bring out temporarily an extra amount of buying, but in the face of decreasing rather than increasing trade; although there may be now and again spasmodic spurts, any permanent upward movement of the market can only follow upon an established real improvement in trade generally. Of this there is no present indication, so far as the home trade is concerned, and the prospects of a better American trade which have recently been put forward have not so far assumed a sufficiently definite basis to warrant as yet any very sanguine expectations in this direction, whilst as regards the Australian trade, the prospects for the immediate future are discouraging.

The Manchester iron market on Tuesday was fairly well attended, but there was comparatively little business doing. For Lancashire pig iron makers were quoting late rates—38s. 6d. for forge and 39s. for foundry, less 2½, delivered equal to Manchester, and for district brands prices remained at 38s. to 38s. 6d., less 2½, delivered here, as the minimum quoted by makers up to 39s. and 39s. 6d., less 2½, for some of the better class brands. There was, however, little or no business doing at these figures; a few offers were reported, but in most cases they were at prices lower than makers care to entertain. In outside brands sellers of Middlesbrough iron were still asking an advance of 3d. to 6d. per ton, but the higher prices which have only been got on a few exceptional sales have tended to check further buying, and generally there was a disposition to accept old rates to secure orders.

For hematites better prices are being got on order for shipment, but for the limited requirements of consumers in this district it is difficult to get buyers to pay any advance upon late rates, and so far as the local trade is concerned it cannot be said to show any very material improvement.

In the manufactured iron trade business continues extremely flat, and where orders are to be got, accompanied with actual specifications, makers are generally prepared to accept £5 2s. 6d. for bars delivered into the Manchester district, the quoted list price of £5 5s. being now only got in exceptional cases for some of the better class brands.

The general reports as to the condition of the engineering trades continue in the direction of a quieting down in most branches of industry. Even amongst special tool makers, machinists, and locomotive builders, where in some instances a fair amount of activity has been maintained, the orders which have been keeping works fairly employed are running out, with but a small weight of new work coming forward to take their place.

A new process of steel manufacture has recently been introduced into this district by Messrs. Bott and Hackney, who have opened works specially laid out for producing steel castings by what is termed a direct process, and which may briefly be described as a compromise between the Bessemer and the crucible processes. One of the chief advantages claimed for this process is, that baked moulds are dispensed with, the castings being made entirely in green sand, so that the many severe internal strains caused by hard moulds at the time of cooling are avoided. By their new process Messrs. Bott and Hackney are enabled to produce steel castings that are practically free from blow-holes and shrinkage, notwithstanding that metal out of one ladle can be poured indiscriminately into elevator bucket moulds less than ⅛in. thick, or into moulds for heavy crank shafts. I had an opportunity of inspecting a number of steel castings produced by this process, some of which, under any ordinary method, would probably have been considered practically impossible of production. Amongst these were mule sickles which had been twisted cold, then forged, and so hardened that they could be ground to a razor edge, whilst as a test of the intricate work the firm are prepared to undertake, they had successfully cast a pulsometer with all its internal parts complete, which is probably the first time that a complicated apparatus of this description has been produced in a steel casting. There were also pulsometer valves, which after turning were hardened, and complicated lever castings perfectly soft and ductile, which, after being machined, were perfectly free from any defects, and were afterwards hardened at the point where friction would require a wearing surface. The claim which Messrs. Bott and Hackney put forward that by their process they are able to produce malleable steel castings which are perfectly sound and reliable, and which can be easily forged or hardened as required, either in water or oil, was certainly borne out by the sample castings I had shown to me. The process has only quite recently been perfected as a practical system of steel casting, but already the inventors, Messrs. Bott and Hackney, have received a large amount of work, both from private firms and for Government requirements; and from the wide variety of castings they had in hand, from hammer heads to intricate machine parts, it is a process which is evidently adaptable for every class of light or heavy casting.

In connection with their works, Messrs. Bott and Hackney have put down a new gas furnace which has been built on a novel plan, requiring very little ironwork for outside stays or supports. The chief feature, however, is the roof, which is constructed of removable sections, by which means, in the event of any part burning away, it can be replaced without stopping the action of the furnace, and there is no thrust or strain on the walls of the furnace, owing to each section being at liberty to expand or contract freely. The heating is effected by small gas furnaces, by which the consumption of fuel has been very greatly reduced, whilst this system also secures a thorough combustion of the smoke, all the products from the fuel being burnt up in the furnaces, and no difficulty is experienced with tar or sooty deposits.

The coal trade remains practically the same as last reported. Prices are unchanged; house-fire coals move off moderately well, but all other sorts meet with a slow sale and are plentiful in the market.

The demand for shipment has fallen off rather, and it is exceptional where more than 7s. to 7s. 3d. is being got for steam coal delivered at Garston or Liverpool.

With regard to the wages' agitation, the South-West Lancashire coalowners are so determined not to entertain any questions of an advance that they have declined even to call a meeting to discuss the notices for a 10 per cent. that have been sent in by the men.

Barrow.—Business men have been largely engaged during the past few days in electioneering work, but nevertheless there has been a considerable business done in hematite qualities of pig iron. Very large sales have been made, and a good inquiry has sprung up from all quarters. The sales have mainly been directed to the reduction of the large stocks which have been held in the district for a considerable time past, and several consignments have been disposed of for delivery in the early part of the new year. The demand, however, is not so extensive as to render it necessary to increase the output of the furnaces, but the fact that not only makers of iron, but manufacturers of steel, have secured large orders, seems to point to the necessity at an early date for an increased production. At Barrow an order for 10,000 tons of steel rails for the American market has been booked, and others are likely to follow. Shipbuilders have not booked any new contracts, and very few orders are offering. Iron ore is in steady but quiet request. Coal and coke is in limited inquiry. Shipping very quiet.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE general elections have greatly unsettled business this week. Nothing has been talked of but politics, and work has been in a measure abandoned by extreme politicians for the pleasure of supporting their particular candidates. Another week and the pollings in the country divisions will end the turmoil, which will be a great comfort to all concerned.

During the week the arrangement made by Messrs. Charles Cammell and Co. with the Russian Government in regard to the production of armour-plates at Kolpino, near St. Petersburg, has excited unusual interest. Mr. Wilson, the chairman of the company, is a Conservative, and his action in the matter has been condemned by several speakers, notably Mr. Plimsoll, who, metaphorically speaking, of course, charges Mr. Wilson with "cutting the throats of working men." This strong language would have been shown to be undeserved had Mr. Wilson been able to fulfil his intention of speaking at Lord Talbot's meeting on Monday. He was well enough all that day, even up to 6.45, when he had a severe seizure as he was about to receive a party at the Cyclops Works. Medical assistance was promptly obtained, but Mr. Wilson remained unconscious until near midnight, when he was able to take a little nourishment. He was somewhat better next day, and hopes are now entertained of his recovery. The sudden prostration of our leading business man in the midst of his activities has caused a most painful sensation. It was his intention, I believe, to have given some information about the Kolpino undertaking. It is understood locally that the practical effect of that agreement is to bring work to Sheffield which would not otherwise come—one-half of the whole orders needed for Russia—and if this arrangement had not been made Russia would have adopted the French all-steel plates of Messrs. Schneider and Co., of Creusot.

Alderman Frederick Brittain, of the St. George's Works, Shoreham-street, Sheffield—steel, files, saws, tools, &c.—who is undoubtedly the best authority on trade and tariffs in this town, made his first appearance on a political platform during the present election. He is strong for federation and abandoning "one-sided free trade." He points out that owing to our being handicapped by foreign tariffs we are losing our trade in distant countries, while in England foreign manufactures are flooding our markets. In Sheffield, he says, German firms are now doing a flourishing business. A German manufacturer he met the other day told him that he had had a capital journey, only German competition in Sheffield was getting keen. When he started coming to Sheffield only two firms sent travellers; now, over a hundred German travellers regularly visited the town. Our goods cannot go into Germany because of the high tariffs. German and Belgian goods, produced by cheap female labour and long hours, flow into England duty free. Thus the English producer is doubly hampered.

The most convincing proof of the operation of tariffs I have seen is in the form of an extract from a letter written by Mr. W. Edgar Allen—Messrs. Edgar Allen and Co., Well Meadow Sheet Works. This firm is largely engaged as manufacturers and merchants of steel, files, saws, heavy hardware, engineers' tools, and as contractors to foreign Governments and railway companies. Mr. Allen, writing to Mr. J. E. Bingham, the ex-Master-Cutler, gives the following clear and interesting statement, which is being republished in part of a leaflet:—"In Spain the extra duties levied on English goods quite keep us out of the market in such articles as can be manufactured in Belgium, France, and Germany. I have this year passed some months travelling in Spain on business, and could have done as much as in former times, had it not been for the heavy extra duties which English goods pay beyond what the same goods pay from Germany and other countries. We have sold hundreds of tons of wrought iron gas and water tubing before the differential duties were put against English goods. The average price of these tubes in England is £9 per ton; the duty on them in Spain, if manufactured in Germany, is £3 8s. per ton; but English tubes pay £5 4s. per ton duty—a difference of £1 16s. per ton, say $52\frac{9}{10}$ per cent. extra duty on British make. We have sent out cargoes of steel rails to Spain, but now the duty on rails made in Belgium and Germany is 36s. per ton, whereas, for rails made in England, the duty is £3 4s. per ton—77¾ per cent. on English make. On iron the Belgian and German make pays £3 9s. per ton, while English make pays £5 4s. per ton—$50\frac{7}{10}$ per cent. extra. Bessemer rods, from Germany and Belgium, pay £3 9s. per ton duty, whereas from England they pay £5 4s. per ton—$50\frac{7}{10}$ per cent. extra—which differences keep us entirely out of the market."

A Sheffield manufacturer, whose firm finds wages for about 300 families all engaged in the staple trade of the town—cutlery—tells me that during his last London journey on calling on one of the oldest cutlers in Oxford-street he found the shop window chiefly filled with razors and cutlery of Swedish manufacture, and a large card calling special attention to them. This manufacturer adds—"They are admitted into this country duty free, and in consequence are enabled to be sold at prices to cut English-made goods out of the market, foreign labour being much cheaper. But is it fair or reasonable—he asks—that when a Swede or an American fancies a pair of razors, or a knife, a duty to the tune of 50 per cent. is imposed upon them before they can be sent into foreign markets."

The threatened strike in the coal trade will probably collapse. In Yorkshire and Derbyshire the demand was reduced to 10 per cent., but the men are generally showing a disinclination to send in their notices, and in some cases have torn them up and thrown them in the fire.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE great excitement that marked the pig iron market in the past week has now partially subsided, and as the elections are now engrossing much attention, business is likely to be quieter in the next few weeks. It appears that operators in the market are of opinion that the advance in warrants was somewhat greater than could be justified by the circumstances of the legitimate demand, and as a result there has been a good deal of selling this week, which has brought about a reaction in prices. Merchants report a rather better inquiry for the United States, but that the demand is mainly for hematite, and only to a small extent for ordinary pigs. The total pig iron shipments of the week have been fair for the season, amounting to 7951 tons, as compared with 7131 tons in the preceding week, and 6935 tons in the corresponding week of 1884. A considerable quantity of the common brands of pigs have been sold by makers for storing, and the additions to Messrs. Connal and Co.'s stocks have therefore been larger than usual—upwards of 5000 tons. An extra furnace has been put in blast since last report, and ninety-two are now blowing, against ninety-four twelve months ago.

Business was done in the warrant market on Friday at 43s. 6d. cash. Under the pressure of somewhat eager selling on Monday the quotations fell to 42s. 5d. On Tuesday forenoon business was done at 42s. 4½d. to 42s. 6d. cash, and in the afternoon the tone was a shade firmer at 42s. 6½d. to 42s. 7½d. each. Business took place on Wednesday at 42s. 11½d. to 42s. 5d. cash. To-day—Thursday—the market was quiet at 42s. 4½d. to 42s. 5d. cash, closing with buyers at a halfpenny less.

The current values of makers' pigs are as follows:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 46s.; No. 3, 43s. 6d.; Coltness, 50s. and 45s.; Langloan, 47s. 6d. and 45s.; Summerlee, 49s. and 44s.; Calder, 51s. 6d. and 44s.; Carnbroe, 45s. and 43s.; Clyde, 46s. and 42s.; Monkland, 43s. and 40s. 6d.; Quarter, 42s. 6d. and 40s.; Govan, at Broomielaw, 43s. and 40s. 6d.; Shotts, at Leith, 47s. and 46s. 6d.; Carron, at Grangemouth, 51s. and 47s.; Kinneil, at Bo'ness, 43s. 6d. and 43s.; Glengarnock, at Ardrossan, 45s. 6d. and 42s.; Eglinton, 42s. 6d. and 39s.; Dalmellington, 44s. 6d. and 41s.

The pig iron shipments for the year to date are 406,278 tons, against 492,888 last year.

Much satisfaction is felt on the Clyde, and especially by the people of Greenock, on account of a contract Messrs. Scott and Co. have secured for the building and engining of five steamers. The vessels are to be 2600 tons each, and they are for the China Steam Navigation Company, to be employed in the China and Calcutta trade. They are to be fitted with triple expansion engines, to attain a high rate of speed, and will be fitted up for a first-class passenger and mail service. It may be interesting to state that the managing owners, Messrs. John Swire and Sons, of London, have had upwards of twenty steamers built by Messrs. Scott and Co. in the course of the last ten years.

The past week's shipments of iron and steel goods from the Clyde included £29,835 worth of locomotive engines and tenders, of which £17,585 were for Bombay and £12,250 for Adelaide; £3725 machinery, £2366 sewing-machines, £3600 steel goods, and £25,000 general iron manufactures.

In consequence of the dispute with the miners about wages, the amount of business done in the coal trade has been restricted, the shipping and steam coal departments being particularly affected. At Glasgow the week's coal shipments aggregated 19,000 tons, which is much below the average; Greenock, 126; Irvine, 2222; Troon, 5632; Ayr, 5916; Leith, 2668; and Grangemouth, 7734 tons. A scarcity of coals led to an advance in some cases of 3d. per ton, but as the miners have since been working pretty regularly, the supplies have been more ample, and it is doubtful, therefore, whether the increase will be maintained. The weather has again been milder, and the recent increase in the quotations of household coals is nothing like general.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

IN the coal trade we have had a better week than last, and the hoped for improvement, which appears assured one week and receding the next, seems now almost in one's grasp. Not only is there a better tone in the coal trade, both house and steam, but a freer demand for rails is being made; exports are larger, and tin-plate shares in the activity to even a much greater extent than the other industries.

First let me note our coal exports: Cardiff sent away last week 146,675 tons; Newport, 32,314 tons foreign, and 24,870 coastwise; and Swansea, 29,828 tons. Thus each port shows well. Cardiff sustains its increase, except in the matter of a few tons, while Newport and Swansea both score a decided advance.

In the case of iron and steel, I have the pleasure of noting some creditable exports, showing that even with half-time a great amount of work is still being turned out, and that the activity visible is not all for stock. Cardiff, for instance, exported 2200 tons of iron and steel, and Newport 3928 tons. The Newport total was made up with 2800 tons rails for Buenos Ayres, 900 tons for Messina, 27 tons to Aruba, and 201 tons to Halifax. The outlook in the steel rail trade is yet unsatisfactory, for though inquiries have increased, business has not resulted in that vigorous manner one would wish to see. Yet there is a brightening up, and any day it may be my pleasant task to record distinct and unmistakeable improvement.

In steel sleepers more is being done, and as Dowlais and Tredegar have embarked in this at considerable outlay, and can hold their own against any competitors, home and foreign, I hope they will be reimbursed.

The question of malleable steel props instead of pitwood, which was noticed in these columns lately, has been freely discussed at Cardiff and elsewhere in the district, and the tendency to try the experiment in some parts of collieries is evident. Our suggestion is that even in places where a steel tube might be forced into the roof instead of propping it, a wooden "tag" at top and "shoe" at bottom would give the necessary prevention. If only a proportion of steel props were to be used the saving effected would be considerable. Pitwood quotations have been as low as 15s. 6d. Present week quotation is 17s. 6d.

A singular rebound occurred in tin-plate after the despatch of my last letter, and there was quite a rush of business, sending up prices from 3d. to 6d. for nearly all varieties.

The monthly totals for October contrast favourably with those for the corresponding month last year. In the case of America more than 2000 boxes extra were sent; Canada, &c., 182 more, and Australia 130 more.

Following October work we had depression, but now, since the rebound, there is very marked activity, and Newport as well as Swansea are sharers in it. From Swansea the shipments of tin-plates show a total of 2250 boxes to America, and various small cargoes to Portugal and Germany. In the dock offices the stocks now amount to 79,513, showing a reduction of 7888 boxes. This is hopeful, and there is every appearance that next week will show a still further decline in stock. Stock is the tin-makers' barometer, and buyers, too, note it with interest, timing their orders very much by its indications. Coke tins, now in free demand, have gone up from 13s. 9d. to 14s., to 14s. 9d., and even 15s. Coke wasters are sold readily for 13s. 6d. Siemens and Bessemers have gone up 6d. to 9d.

This improvement will tell also upon the steel works, as is shown by the fact that in Swansea alone last week orders for 20,000 tons of steel bars were placed at local works. At a meeting held in Swansea on Saturday it was decided that the slip week should be one week in every six.

A mining prosecution, for infringement of the Mines Act is to be instituted in the Merthyr district against one of the Plymouth colliers.

A fine and promising scheme has been brought forward by Mr. W. T. Lewis in connection with the Bute Docks, for improving the "roads" by giving ampler means of ingress and outgo, and for floating the docks by a company composed of the whole of the local railways and the Cardiff Corporation. The opposition to the Bill last Parliament for the Taff Vale Railway taking to the docks was successfully opposed on account of its giving too distinct a monopoly to the Taff over other lines. Now this opposition will have no ground to stand upon, and the application to Parliament will be as follows:—Incorporation of company; Transfer of Bute Docks and all rights therewith; Power to sell, with all levying powers; Powers to the Taff Vale, Rhymney, and Great Western Company, and to the Corporation of Cardiff, to subscribe to raise money and appoint directors, &c. &c. I give the heads as more fully explaining the scheme, which, it will be seen, foreshadows a Harbour Trust for Cardiff, and will be generally acceptable.

The masters have consented to meet the enginemen and stokers, and a compromise is likely.

NEW COMPANIES.

The following companies have just been registered:—

Fluid Fuel Company, Limited.

Upon terms of an agreement of the 28th ult., between Admiral J. H. Selwyn and W. Crichton Chalmers, this company proposes to purchase the Letters Patent, No. 730, A.D. 1883, No. 4108, A.D. 1883, and No. 2160, A.D. 1884, relating to an improved method or methods of an apparatus for applying liquid fuel for combustion in furnaces for the generation of steam, with improvements thereon relating to maritime purposes. It was registered on the 14th inst. with a capital of £500,000, in £5 shares. The subscribers are:—

	Shares.
C. Berry, 72, Harrogate-road, South Hackney, accountant	1
J. J. Fleming, 178, Elderfield-road, Clapton, clerk	1
P. B. Oppenheim, Gresham House, merchant	1
H. S. Dunkelsbuhler, 101, Leadenhall-street, merchant	1
C. West, 34, Old Broad-street, commission broker	1
D. W. Money, 10, Camberwell New-road, articled clerk	1
F. L. Jeyes, C.E., 9, Victoria-chambers, S.W.	1

The number and names of the first directors will be determined by the subscribers, who act *ad interim*. Remuneration, £10 per cent. of the realised net annual profits, after payment of £10 per cent. dividend.

Phœnix Metal Die and Engineering Company, Limited.

This company proposes to trade as engineers, die sinkers, type founders, printers, engravers, artists, &c., power being taken to acquire inventions relating to the manufacture of metal dies, or for machinery and apparatus connected therewith. It was registered on the 13th inst. with a capital of £10,000, in £10 shares, with the following as first subscribers:—

	Shares.
W. Rushton Adamson, Battle, Sussex	10
E. Ford Duncanson, 1, Whittington House, Leadenhall-street, merchant	10
Hugh Colin Smith, Hay's Wharf, Southwark, wharfinger	10
R. Stuart Erskine, 25, Woburn-square	10
J. M. Macdonald, 3, Lombard-street, merchant	1
Nicol Brown, 3, Lombard-street, clerk	10
H. R. Armstrong, 3, Lombard-street, clerk	1

Registered without special articles.

Francis Sumner and Company, Limited.

This is the conversion to a company of the cotton-spinning and manufacturing business formerly carried on by the late Mr. Francis James Sumner, at Glossop, Derby. The purchase includes premises, plant, stock-in-trade, and two mortgages under the seal of the Glossop Reservoir Commissioners for securing respectively £500 and £388 7s. 2d. with interest. The company was registered on the 16th inst. with a capital of £108,000, in 2160 shares of £50 each. The subscribers are:—

	Shares.
Francis John Sumner, Beckford, Glossop	1
William Sumner, Newcastle-under-Lyme, Stafford	1
J. Weetman, The Hanyards, near Tixall, Stafford	1
J. A. Weetman, Swinford, Leicester, farmer	1
H. C. Weetman, Newhouse Farm, Garway, Hereford, farmer	1
John Sumner, The Elms, Studley, Warwick	1
R. W. Latham, 6, Shakespeare-terrace, Coventry	1

The number of directors is not to be less than three nor more than nine; qualification, fifty shares; the first will be appointed by the subscribers; remuneration, £5 5s. to each director for every meeting attended.

Tarbutt's Liquid Fuel Company, Limited.

This company proposes to manufacture and trade in hydrocarbon and other fuels for the generation of heat, for raising steam, and other purposes, and to manufacture or acquire engines, plant, machinery, and appliances of every description, for generating and producing light and heat by the use of hydrocarbon or other fuel. It was registered on the 14th inst. with a capital of £50,000, in £1 shares. The subscribers are:—

	Shares.
G. G. L. Macpherson, 39, Lombard-street, merchant	1
J. Walker Mason, 23, Montgrove-road, N., clerk	1
A. W. Kerly, 47, Brownhill-road, Catford, solicitor	1
G. P. Armstrong, 18, Laurence Pountney-hill, merchant	1
J. F. C. Norman, 18, Laurence Pountney-hill, merchant	1
B. G. D. Cooke, Colomendy, Mold	1
C. S. Cornish Watkins, Carshalton, Surrey, chartered accountant	1

The number of directors is not to be less than three nor more than five; the subscribers are to appoint the first; qualification, 100 shares; remuneration, £50 per annum to each director.

Fischer Electro-Amalgamated Company, Limited.

This company proposes to purchase, on terms of an agreement of the 9th September, the invention of Ewald Fischer for improvements in extracting gold and other metals by amalgamation, and in apparatus therefor patented by him in the joint names of himself and Max William Weber. The Letters Patent are dated the 10th November, 1884, No. 5834. The company was registered on the 13th inst. with a capital of £25,000, in £5 shares. The purchase consideration is £15,000, one-half being payable in fully-paid shares. The subscribers are:—

	Shares.
Arthur John Rhodes, Oakdene, Beckenham	1
Captain G. P. Heine, Waltham-cross, Herts	1
Max W. Weber, 69, Darville-road, Stoke Newington, merchant	1
H. Julius, 36, The Avenue, Tottenham, warehouseman	1
L. J. Langmead, 2, Violet Villas, 117, Upland-road, Surrey, accountant	1
C. J. Perkins, 24, Horsford-road, Brixton-rise, accountant	1
S. Bodascher, 2, Trelawny-road, Brixton, commission agent	1

The subscribers are to appoint the first directors, and the company in general meeting will determine remuneration.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Applications for Letters Patent.

*** When patents have been "communicated" the name and address of the communicating party are printed in italics.

17th November, 1885.

13,998. Electrical Incubators, H. J. Allison.—(*C. Bassini and A. Heyden, United States.*)
13,999. Necktie Supporters, H. J. Allison.—(*B. B. Scully, United States.*)
14,000. Railway Car Axle-boxes, N. W. Cutter, London.
14,001. Lactates, A. G. Brookes.—(*T. S. Nowell, U.S.*)
14,002. Acid Bases for Aerated Beverages, A. G. Brookes.—(*T. S. Nowell, United States.*)
14,003. Laxative Compounds, A. G. Brookes.—(*T. S. Nowell, United States.*)
14,004. Patent Safety Revolving Brakes for Bicycles, &c., A. Hart, Wolverhampton.
14,005. Tamping Shot Holes for Blasting, W. Galloway, Cardiff.
14,006. Boots and Shoes, J. Blakey, Halifax.
14,007. Coupling, &c., Carriages on Railways, D. A. Smieton, Dundee.
14,008. Securing Lids of Metal Drums, W. H. Johnson and W. E. Williams, Manchester.
14,009. Shafts for Wire Healds in Weaving, H. B. and A. B. Barlow, Manchester.
14,010. Bicycles, &c., H. Pipe, London.
14,011. Spinning Yarns, J. W. Taylor, Oldham.
14,012. Brake for Perambulators, &c., G. and J. Whitehead, Aston.
14,013. Portable Couch for Surgical Operations, J. Kehoe, Dublin.
14,014. Coal Economisers, J. C. Pickard, Burnley.
14,015. Heald Regulating Machines, D. Crabtree and T. Fairburn, Bradford.
14,016. Holders for Suspending Plates, J. McGuire, Birmingham.
14,017. Tools for Chamfering Angle Iron, &c., B. Beard, Darlington.
14,018. Clips for Attaching Brace Ends, S. Taylor, Manchester.
14,019. Gymnastic Apparatus, A. W. Turner, London.
14,020. Raising Tubs in Doughing, &c., Machines, J. Melvin, Glasgow.
14,021. Locomotives, &c., T. R. Crampton, London.
14,022. Sight Feed Lubricators, J. T. Hailwood, Rochdale.
14,023. Attaching Door Knobs to Spindles, T. R. Paxton, Workington.
14,024. Velocipedes, T. R. Paxton, Worthington.
14,025. Revolving Tower System of Fortifications, T. R. Timby, United States.
14,026. Rail Fasteners for Railways, &c., G. H. Wells, London.
14,027. Soda, A. P. Laurie, London.
14,028. Means of Hanging Pictures, &c., E. T. Horsley, London.
14,029. Counterbalancing Window Sashes, J. Weber and W. F. Lennon, London.
14,030. Permanent Way of Railways, T. A. Davies, London.
14,031. Patent Policeman's, &c., Can, E. O. Eaton, London.
14,032. Lamps for Velocipedes, P. Hartzendorf, London.
14,033. Flues of Steam Boilers, J. Lee, Halifax.
14,034. Scouring, &c., R. H. Ainsworth and E. B. Manby, London.
14,035. Shedding Motions, J. Preston, London.
14,036. Friction Driving Gear for Centrifugal Pumps, T. Browett and H. Lindley, London.
14,037. Thermo-electric Batteries, A. Burjorji, London.
14,038. Soft-stitched Hats, &c., M. Schneiders, London.
14,039. Ornamenting Coffin Plates, &c., J. M. Shelley and S. May, London.
14,040. Capsules, C. L. Jensen, London.
14,041. Traps, W. L. Wise.—(*H. F. Serrin, France.*)
14,042. Planing Machines, W. W. Hulse, London.
14,043. Dobby Apparatus, E. Wilson, London.
14 044. Machines for the manufacture of Horseshoes, W. R. Lake.—(*F. Fuller, United States.*)
14,045. Preventing Incrustation in Steam Boilers, W. R. Lake.—(*J. H. Blessing, United States.*)
14,046. Driving Sewing Machines, W. R. Lake.—(*C. R. Sprengler, United States.*)
14,047. Machine Guns, &c., H. S. Maxim, London.
14,048. Brakes, G. Hopkins, London.
14,049. Racks for Hats, &c., G. F. Simonds, London.
14,050. Cocks or Taps, R. R. Vizer, London.
14,051. Torpedo Railway Signals, H. F. Clark, London.
14,052. Gunpowder, O. Bowen, London.
14,053. Disintegrating Rock by Heat, H. E. Newton.—(*A. Nobel, France.*)
14,054. Combined Water Pump and Air Compressor, H. E. Newton.—(*C. C. Worthington, United States.*)
14,055. Liquor Flasks, H. W. T. Jenner, Liverpool.
14,056. Packing Cases, &c., F. W. Blood, Liverpool
14,057. Journal Brasses, W. P. Thompson.—(*P. P Emory, S. A. Bemis, F. Harris, and C. E. Booth, United States.*)
14,058. Barrels, Casks, or Kegs, F. Myers, Liverpool.
14,059. Valve Gear, R. M. Baily, jun., London.
14,060. Water-closets, W. D. Cliff, London.
14,061. Driving Motion for Wringing, &c., Machines, J. Wilks, London.
14,062. Balanced Slide Valves, A. J. Boult.—(*D. A. Woodbury, United States.*)
14,063. Removing Hair from the Human Skin, S. R. Kennedy, London.
14,064. Cement and Lime, H. Mathey, London.
14,065. Mosaic Material for Building, &c., E. Robbins, London.
14,066. Backplates or Shanks of Buttons, R. J. S. Joyce, London.
14,067. Sawing and Cubing Loaf Sugar, J. Richmond and W. Whiting, London.
14,068. Coating Metal Plates with Tin, &c., D. Edwards and R. Lewis, London.
14,069. Bottles, H. Codd, London.
14,070. Speed Indicator for Engines, R. C. Parsons, London.
14,071. Fire-bars, H. Schärer-Hartmann, London.
14,072. Branding Boxes, &c., by Heat Stamp, J. Richmond and W. Whiting, London.
14,073. Umbrella Attachment, F. N. Cookson, London.
14,074. Convertible Tandem Velocipedes, T. R. Marriott and F. Cooper, London.
14,075. Packing for Engines, H. C. Heard and A. Gardner, London.
14,076. Incandescent Electric Lamp Holder, E. W. J. Hennah, London.
14,077. Boots and Shoes, G. T. Hawkins, London.
14,078. Electric Lighting, W. Emmott and W. Ackroyd, Bradford.
14,079. Shaft Couplings, W. R. R. Tillion, London.
14,080. Navigable Vessels, H. F. Swan, London.
14,081. Book Covers, H. K. Judd, sen., and H. K. Judd, jun., London.
14,082. Book Covers, H. K. Judd, sen., and H. K. Judd, jun., London.
14,083. Solitaires, &c., W. Parsons, Birmingham.

18th November, 1885.

14,084. Injectors, C. S. Madan, Manchester.
14,085. Spring-hinged Holders for Labels, &c., B. F. Cocker, London.
14,086. Gas-heated Laundry and similar Irons, T. Fletcher, London.
14,087. Machines for Thrashing Wheat, &c., W. Brierley.—(*H. Anders, Germany.*)
14,088. Plastic Picture Frames, &c., W. Brierley.—(*M. Wiesner, Germany.*)
14,089. Preparing Fibres, G. Little and T. C. Eastwood, Halifax.
14,090. Shirts, &c., D. W. Beard, Birmingham.
14,091. Detachable Wrists for Shirt Sleeves, W. G. Edwards, London.
14,092. Shaping Metals, A. Higginson, Liverpool.
14,093. Reeds for Looms, M. Leach, Bradford.
14,094. Retaining Neckties in Proper Position, W. J. Robertson, Belfast.
14,095. Automatically Varying the Length of Stroke of Cranks of Bicycles, &c., H. M. Death, Lincoln.
14,096. Trap Motions used in Twisting Yarns, J. Pease and G. A. White, near Leeds.
14,097. Trusses, W. and W. A. Whiting, Hove.
14,098. Sheep Wash, R. Morris and W. G. Little, Doncaster.
14,099. Advertising on Vehicles, &c., W. Shaw, Bradford.
14,100. Cowl for the Cure of Smoky Chimneys, E. H. R. D'Eye, Alderton.
14,101. Unfermented Beverage, W. Christie, Manchester.
14,102. Ironing Table, J. R. Winward, Bolton.
14,103. Metallic Packing for Piston-rod, &c., Boxes, W. Whyte, Newcastle-upon-Tyne, and J. Allan, South Shields.
14,104. Heating Apparatus, W. Randall, Wellingborough.
14,105. Photographic Cameras, W. Middlemiss, Bradford.
14,106. Stoppering Bottles, F. J. Beaumont, London.
14,107. Sporting or like Fire-arms, J. P. Pile, London.
14,108. Castors, J. Watkins, Birmingham.
14,109. Colliery Tubs, W. H. Wood, Birmingham.
14,110. Automatic Compressed Air Brake, A. Silcock, Sheffield.
14,111. Chain-links, J. L. Osborn.—(*F. Oakden, New Zealand.*)
14,112. Dredging Plant, W. Y. Fleming and P. Ferguson, Glasgow.
14,113. Ventilators, J. Honeyman, Glasgow.
14,114. Velocipedes, G. A. Wright and J. de L. Watson, London.
14,115. Pumps, G. A. Greeven, London.
14,116. Water-closets, W. T. F. Rowe, Plymouth.
14,117. Suspending Hub Lamps of Velocipedes, J. R. Henson, London.
14,118. Lamp Extinguisher, E. Phillips, London.
14,119. Miners' Safety Lamps, E. Thomas, London.
14,120. Separating Phosphorus from Basic Process Slags, W. Tomlinson and D. Crawford, London.
14,121. Locking Nuts on Screw Bolts, J. Barlow, London.
14,122. Economising Oil and Fuel, L. Murphy, Liverpool.
14,123. Lids for Caustic Drums, D. Maher, Liverpool.
14,124. Drying Paper Moulds for Stereotyping, G. Pearce and G. Pearce, jun., London.
14,125. Ferrules for Walking-sticks, &c., J. Ashdown, near Brighton.
14,126. Opening Metal Boxes or Cases, H. Ough, London.
14,127. Producing Window Glass, M. F. C. A. Oppermann, London.
14,128. Materials used in Making Paint, J. B. Spence, London.
14,129. Microphones for Telephonic Instruments, J. S. Sellon, London.
14,130. Tell-tale, F. C. Stanton, London.
14,131. Measuring Circles and Ovals, &c., L. Courlander, Croydon.
14,132. Enamelling Metal Articles, A. C. Henderson.—(*P. Zuloaga, France.*)
14,133. Bottle Stopper, G. F. Lütticke, London.
14,134. Soldering, Brazing, and Welding, W. Wood, London.
14,135. Floating Buoys, &c., H. Lane and M. Delmard, London.
14,136. Producing Malleable Castings, J. Lewthwaite, London.
14,137. Attaching Shanked Buttons to Boots, &c., S. M. Taylor, London.
14,138. Cuff Fasteners, J. R. Green and F. W. Plant, London.
14,139. Lamps, R. P. Williams, London.
14,140. Electrical Generating Apparatus, &c., O. E. Woodhouse and F. L. Rawson, London.
14,141. Flour Dressing Machines, J. W. Throop.—(*W. H. Williams, United States.*)
14,142. Lining Furnaces, F. Siemens, London.
14,143. Regenerative Gas Furnace, F. Siemens, London.
14,144. Spring Mattresses, W. Hollins, London.
14 145. Brown Charcoal for Gunpowder, H. R. Smith, London.
14,146. Supporting Lawn-tennis Posts, A. E. Heathcote, London.
14,147. Metallic Racquet Bat, J. A. Duthie, D. Sherrit, and J. Anderson, London.
14,148. Electric Bell and Pendulum Indicator, A. F. Lloyd, London.
14,149. Flexible Loop Handles for Tricycle Lamps, H. Salsbury, London.
14,150. Hansom Cabs, G. S. Betjemann, London.
14,151. Raising and Lowering Railway Carriage Windows, A. W. Child and G. B. Childs, London.
14,152. Saddles for Bicycles, &c., A. W. Child, London.
14,153. Steering Tricycles, A. W. Child and G. B. Childs, London.

19th November, 1885.

14,154. Vent Apparatus, F. N. Meixner, London.
14,155. Rotary Engines. R. Matthews, Manchester.
14,156. Generating or Inducing Electric Currents, J. Radcliffe, East Retford
14,157. Duple Speed, Power, and Safety Bicycle, W. C. Burton, Rochdale.
14,158. Stopper for Bottles, J. Stow, Manchester.
14,159. China Tiles, G. Johnston and J. Lockwood, Glasgow.
14,160. Propelling Vessels, R. Scott, Newcastle-on-Tyne.
14,161. Lubricators, D. A. Quiggin, Liverpool.
14,162. Preventing Fabrics from Shrinking, J. Leeming and O. Ingham, Halifax.
14,163. Velocipedes, J. and H. J. Brookes, and W. R. Kettle, Smethwick.
14,164. Enamelled Clay Goods, J. Howie, Glasgow.
14,165 Sewing Machines, A. Anderson.—(*The Singer Manufacturing Company, United States.*)
14,166. Shuttles for Sewing Machines, A. Anderson.—(*The Singer Manufacturing Company, United States.*)
14,167. Hat Finishing Machine, T. W. Clark, London.
14,168. Machinery for Washing Wool, J. and W. McNaught, jun., London.
14,169. Electro-magnets, A. M. Thompson, London.
14,170. Inserting Types in Stereotype Plates, W., J. M., W. M., and W. Richard, jun., London.
14,171. Sewing Machine Attachments, E. Tapscott, London.
14,172. Lifting the Trouser Bottoms, R. B. Colley, Jersey.
14,173. Appliances for Displaying Advertisements, J. O. Spong, London.
14,174. Electric Light Switch, A. P. Lundberg, London.
14,175. Sugar Cane Mills, J. G. Chapman, London.
14,176. Steering Mechanism for Bicycles, G. Ilston, London.
14,177. Cigar Cutter, H. Payton and E. Lucas, London.
14,178. Holders for Marking Material, W. F. B. Massey-Mainwaring, London.
14,179. Construction of Heels for Boots and Shoes, D. Gilson, London.
14,180. Furnaces for Marine Boilers, E. J. Curtin, London.
14,181. Substitutes for Pumice-stone, W. R. Lake.—(*H. X. Favre, France.*)
14,182. Chemical Compound for Rheumatism, S. Austin and S. Sellers, London.
14,183. Regulating the Outflow of Water from a Supplying Source, G. Broadhead, London.
14,184. Life-saving Apparatus, L. H. McMutrie.—(*W. G. Crockhart, India.*)
14 185. Securing Railway Keys in Rail Chairs, A. J. Wake, London.
14,186. Station Indicators for Railway Carriages, H. Crookes and H. W. Hake, London.
14,187. Automatically Acting Couplings for Railway Wagons, E. du Boulay, London.
14,188. Carriage Spring, S. Morrisson, London.
14,189. Capsules for Containing Medicinal Matter, P. Jensen.—(*G. G. Pohl, Prussia.*)
14,190. Chain Clips for Cloth Finishing Machines, W. Craig, Glasgow.
14,191. Condensing Exhaust Steam, J. Wright, London.
14,192. Torpedo Nets, W. M. Bullivant, London.
14,193. Aluminium, W. F. Richards, London.
14,194. Connecting the Steering Forks of Velocipedes with their Steering Wheels, J. Asbury, London.
14,195. Machinery for Winding Yarns, W. T. Stubbs and J. Corrigan, London.
14,196. Motors, G. Poore, C. Ingrey, and E. Latham, London.

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14,197. Files, S. Woodhead, Manchester.
14,198. Hollow Shell for Boots, &c., J. Boothroyd and F. W. Boothroyd, Leicester.
14,199. Preventing Overflow of Grease in Candles, G. White, Elgin.
14,200. Coat or other Buttons, S. Brown, Rotherham.
14,201. Polishing Lithographic Stones, W. Carter, Glasgow.
14,202. Application of Steam to Circular Motion, J. F. Russell, London.
14,203. Rails, &c., J. M. While and A. Butchart, Darlington.
14,204. Marine Steam Engines, E. Latham, Liverpool.
14,205. Portable Stands for Photographic Cameras, &c., J. Ashford, Birmingham.
14,206. Spinning and Twisting Machines, J. Reid, Ontario.
14,207. Footballs, S. E. Statham, Manchester.
14,208. Marine Masked Signal Lamps, J. J. Harwood, Liverpool.
14,209. Adjustable Pad to Collars, R. Auld, Whitletts-by-Ayr.
14,210. Steel Pens, M. Pollack, Birmingham.
14,211. Handle Bars of Bicycles, &c., W. Fisher, London.
14,212. Magnetometers, A. Millar, Glasgow.
14,213. Insulated Electric Conductors, A. Millar, Glasgow.
14,214. Insulated Electric Conductors, A. Millar, Glasgow.
14,215. Pumps, E. Buss and E. Müller, London.
14,216. Lighting Railway Carriages by Electricity, C. Smith, London.
14,217. Surfacing, &c., Metals, &c., A. Wilkinson, London.
14,218. Carburetting Atmospheric Air, &c., T. Charlton and C. S. Wright, Barnsley, and J. Wright, London.
14,219. Preventing Fractures in Troughs, &c., J. Duckett and A. Duckett, London.
14,220. Producing Motive Power, J. J. Royle, Manchester.
14,221. Couplers for Railway Vehicles, T. H. Heard, Sheffield.
14,222. Saw Spindles, J. Taylor, London.
14,223. Spring Back for Envelope Cutters, H. E. Platt, Hemel Hempsted.
14,224. Preventing Horses, &c., from Slipping, S. A. Johnson, London.
14,225. Ceramic Pastes, B. J. B. Mills.—(*P. A. Mignot, France.*)
14,226. Expansion Gear for Steam Motors, E. Friedrich and M. Jaffé, London.
14,227. Joints for Pipes, &c., P. Hoppe, London.
14,228. Skelhorn's Metal Mounts for Bracelets, &c., W. Skelhorn, London.
14,229. Turning Over the Leaves of Music, G. Brockelbank, Anerley.
14,230. Fire-arms, L. Armanni, London.
14,231. Automatic Nurse, R. Jackson, Birmingham.
14,232. Azo-dye-stuffs, E. Elsaesser, London.
14,233. Preservation of Fruit, J. E. Taylor.—(*W. Peacock, Australia.*)
14,234. Heating Cellular Buildings, J. Keith, Glasgow.
14,235. Circulating Water through Swimming Baths, &c., J. Keith, Glasgow.
14,236 Adjusting Door Knobs to their Spindles, W. G. Macvitie, London.
14,237. Knitted Trousers or Pants, J. H. Cooper and W. J. Ford, London.
14,238. Knitting Machines, J. H. Cooper and W. J. Ford, London.
14,239. Portable Dark Chambers for Photography, C. H. Stanbury, London.
14,240. Lamps, A. J. Boult.—(*W. H. Harvey, Canada.*)
14,241. Boots and Shoes, J. and A. Green and J. C. Swain, London.
14,242. Coating Metal Sheets, &c., E. Morewood, London.
14,243. Moulding Smoking Pipes, M. S. Calvert, London.
14,244. Composition for Making Billiard Balls, &c., C. H. Coiffier, London.
14,245. Mail Bags and Locks, D. P. Brophy, London.

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14,246. Hair Curlers, J. Gregory, Birmingham.
14,247. Bicycles and Tricycles, C. Cumber, London.
14,248. Hydraulic Engine, W. Robson, Newcastle-on-Tyne.
14,249. Footballs, W. Sykes, Wakefield.
14,250. Spreading India-rubber, &c., W. Coulter, Manchester.
14,251. Bottles and Stoppers, H. W. Robinson, C. J. Smith, and J. S. Howard, Northampton.
14,252. Trouser Stretchers, A. T. Saxelby, Birmingham.
14,253. Stench Traps for Drains, C. Garlick, Burton-on-Trent.
14,254. Cistern for Water-closets, &c., W. Towler, Leeds.
14,255. Attaching Straps to Pickers in Weaving, G. Howe, Manchester.
14,256. Shafts of Washing Machine Rollers, &c., Moore, Morton, and Varley, Keighley.
14,257. Treating Wheat for Bread, G. Whitley and J. Rowbottom, Halifax.
14,258. Safety Bicycles, P. T. Hill, London.
14,259. Velocipedes, F. W. Jones, London.
14,260. Footstools with Pianoforte Pedals, A. Barr, Glasgow.
14,261. Circular Knitting Machines, J. Cunningham, Glasgow.
14,262. Shuttles used in Looms, J. Ireland, Glasgow.
14,263. Drying Photographic Paper, A. Anderson, Elgin.
14,264. Pegged Board, &c., Puzzle, C. J. Clark, London.
14,265. Looms for Weaving Looped Fabrics, J. Clegg, Manchester.
14,266. Fasteners for Letters, &c., J. McN. Rimington and A. T. Turner.—(*C. T. Rimington, U.S.*)
14,267. Steel for Corsets, &c., W. L. Wise.—(*M. Seifert, Germany.*)
14,268. Magnifier for Thermometers, S. A. and A. J. Calderara, London.
14,269. Effecting Combustion of Liquid Fuel, P. Tarbutt, London.
14,270. Screw Ferrule for Handles of Brooms, J. N. Wordsworth, London.
14,271. Household Sinks, &c., W. H. and G. Barker, London.

14,272. Teaching the Piano, E. de Pass.—(*A. Thein, Germany.*)
14,273. Drying China Clay, &c., J. Rodgers, London.
14,274. Textile Fabrics, M. Gandy, London.
14,275. Presses for Rackets, &c., F. H. Ayres, London.
14,276. Casting Hollow Metallic Ingots, W. E. Everitt, London.
14,277. Sewing Machines, J. W. Post, London.
14,278. Punching and Gouging Machine, G. Atkins and G. Chamberlain, London.
14,279. Caustic Soda Drum Heads, G. H. Bolton and J. Leathwood, Liverpool.
14,280. Ladders of Fire-escape Landings, J. and J. Hall, London.
14,281. Moulding Jars, E. Johnson and R. A. Mathieson, London.
14,282. Metal Posts for Telegraph Wires, &c., E. Edwards.—(*G. Gesquière, Belgium.*)
14,283. Artificial Fuel, E. Edwards.—(*C. F. Sébille, and A. Colard, France.*)
14,284. Holding Sheep while being Dipped, J. Gordon, London.
14,285. Hydraulic Machines, R. C. Braithwaite and W. Kirk, Birmingham.
14,286. Raising Window Blinds, A. E. Harris and H. J. Luckock, London.
14,287. Covering of Bicycle, &c., E. T. Ratcliff and T. Kenrick, London.
14,288. Dynamo-electric Machines, J. A. Berly.—(*Zénobé Théophile Gramme, France.*)
14,289. Axles, &c., J. A. Berly.—(*N. Coulard, France.*)
14,290. Housings for Rolling, &c., Mills, J. Robertson, Glasgow.
14,291. Fencing Chain, F. W. Brampton Birmingham.
14,292. Suspension Railways, J. A. Enos, M. H. Robinson, and A. O. Foster, London.
14,293. Belt or Strap Fasteners, F. H. Keane and D. Wilson, London.
14,294. Screw Neck Bottles, D. W. Blaxter and S. G. Page, London.
14,295. Securing Tubes in the Tube Plates of Boilers, F. Hoppe, London.
14,296. Metallic Linings for Pits or Shafts, O. Terp, London.
14,297. Galvanic Batteries, C. Reiss and F. Hecht, London.
14,298. Textile Fabrics, H. J. M. Mellor, London.
14,299. Stop Cocks, J. A. and J. Hopkinson, London.
14,300. Electric Lamps, C. Heiss and F. Hecht, London.

23rd November, 1885.

14,301. Boots and Shoes, Caillet-Cashmere, London.
14,302. Adjustable Spanners, A. Kay and W. L. Young, Greenock.
14,303. Apparatus for Weaving Looped Fabrics, J. Lister, Bradford.
14,304. Automatic Steering in Tricycles, T. Robinson, Coventry.
14,305. Heat for the Preparation of Food, I. Engelson, Jersey.
14,306. Extinguishing Fire, A. Dougill, Leeds.
14,307. Regulating Injectors, H. Holden and R. G. Brooke, Salford.
14,308. Buttons, G. Twigg, Birmingham.
14,309. Igniting the Charges in Gas Motors, J. Söhnlein, London.
14,310. Letting-off Motions for Looms, C. Fox and P. Crossley, London.
14,311. Mowing Machines, W. Meffan and W. D. Brown, Glasgow.
14,312. Naval Carriage, A. C. Koerner, Paris.
14,313. Air Injector, R. Gregory and H. Harris, London.
14,314. Castors, J. S. Loynd, Halifax.
14,315. Smoking Toys, J. Sturrock and G. D. Macdougald, Dundee.
14,316. Lock and Key Puzzle Money Boxes, A. T. Smith, Liverpool.
14,317. Fire-lighters, J. Lott, Liverpool.
14,318. Cop Winding Machines, J. Cooper, Glasgow.
14,319. Holders for Presenting Twist Drills to Grinding Machines, R. C. W. Ross, Glasgow.
14,320. Cop Winding Machines, R. B. Thomson, Glasgow.
14,321. Glass Roofing, W. J. Hucklebridge, Exeter.
14,322. Filtering Water, J. B. Scammell, London.
14,323. Roughing Horses, A. Eke, London.
14,324. Actuating Tramway, &c., Brakes, W. H. Blakeney, Glasgow.
14,325. Aluminium, &c., R. Grätzel, London.
14,326. Regulating the Action of Dynamo-electric Machines and Motors, W. T. Goolden and A. P. Trotter, London.
14,327. Gauging for Fitting Set Jewels to Watches, &c., I. W. Whitney, London.
14,328. Wheel, W. H. Beck.—(*P. Maisonobe, France.*)
14,329. Combined Candlestick and Match-box, F. C. Trench, London.
14,330. Binders for Letters, &c., W. Burrows and G. Tucker, London.
14,331. Rocking Furnace-bars, L. Hopcraft, London.
14,332. Power Distribution, W. Lowrie, London.
14,333. Combined Sheep Racks and Troughs, F. K. Woodroffe, London.
14,334. Lip Preserver for Drinking Vessels, A. F. H. Purgstall, London.
14,335. Fire-extinguishing Apparatus, J. G. Lorrain, London.
14,336. Measuring, &c., the Flame of a Lamp, B. Redwood, London.
14,337. Posts for Electrical Conducting Wires, C. D. Abel.—(*La Compagnie de Five-Lilles, France.*)
14,338. Hulling Rice, &c., E. W. May.—(*S. Wilkes, Brazil.*)
14,339. Bottles, J. Edwards, London.
14,340. Gloves, J. F. O. Weston, London.
14,341. Steam Boilers, J. H. Fraser, London.
14,342. Engines, J. C. Peache, London.
14,343. Machine for Winding Thread, J. C. and F. A. Spach, London.
14,344. Tins for Containing Army Rations, J. Large, London.
14,345. Writing Slate Cleaners, A. J. Boult.—(*F. Schönbrunn, Germany.*)
14,346. Elastic Saddle Girths, J. G. Bareire, London.
14,347. Apparatus for Propping Purposes in Mines, C. Cordon, London.
14,348. Treatment of Cotton Materials, J. C. W. Stanley, London.
14,349. Handles for Lawn-tennis Bats, &c., J. Davidson, Glasgow.
14,350. Cylindrical Metal Bars, &c., J. Robertson, Glasgow.
14,351. Leather Compositions, S. F. Upington and W. J. Goulborne, London.
14,352. Syphonic Apparatus for Discharging Water from Tanks, P. Winn, London.
14,353. Stone Sawing Machines, J. Peckover, London.
14,354. Electric Lighting of Trains, A. M. Clark.—(*Wirth and Co., Germany.*)
14,355. Carbons for Electric Lighting, T. V. Hughes and C. R. Chambers, London.
14,356. Overshoe and Legging, H. Schwenk, H. Rudolph, and F. A. W. Day, London.
14,357. Attaching Gems to Lace, M. Romboults and H. W. Aberlin, London.
14,358. Mills for Crushing Stone, &c., W. S. Akerman, London.
14,359. Ploughs, A. M. Clark.—(*H. M. Horsford, Canada.*)
14,360. Finger Hole Frames of Scissors, R. J. S. Joyce.—(*G. Korn, United States.*)
14,361. Gas Burners, W. R. Lake.—(*A. Lambert, Belgium.*)

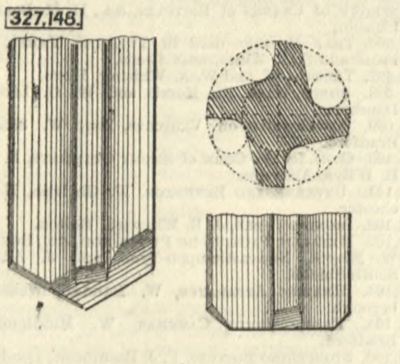
SELECTED AMERICAN PATENTS

(From the United States' Patent Office Official Gazette.)

327,148. Metal Boring Bit, *Luther R. Faught, Philadelphia, Pa.—Filed October, 22nd*, 1884.

Claim.—(1) A forged steel cutter having four or more cutting wings or ribs formed in one piece with and projecting from a central bar or body, each of said wings having a cutting edge upon one side of its outer face and the major portion of its thickness located upon the opposite side of a plane which is radial to the axis of the bar and substantially parallel to the front or leading side of the wing, substantially as set forth. (2) A forged steel cutter, having four cutting wings or ribs formed in one piece with and projecting from a

327,148.



central body each having an outer cutting edge and being disposed unequally on opposite sides of a plane radial to the axis of the body, said cutter having its end bevelled to form two drilling lips, each parallel to the other and to a segmental recess cut through one of the wings adjacent to its end, substantially as set forth.

327,206. Split Pulley, *H. Underwood and C. Schweizer, New York, N.Y.—Filed May 11th*, 1885.

Claim.—(1) In a split pulley, the combination, with two half sections, of a split band surrounding them, and secured to each section, substantially as herein shown and described. (2) In a split pulley, the combination, with two half-sections, of a split band surrounding the rims of the sections and secured to the same, angle pieces on the ends of the band, and bolts passed through the said angle pieces, substantially as herein shown and described. (3) A split pulley formed of two pulley sections secured to a split band serving

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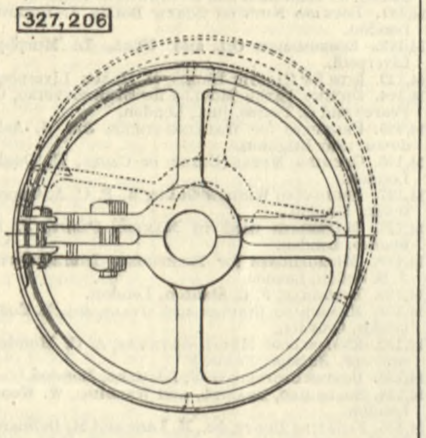

as a hinge, which permits of swinging the sections from each other, substantially as herein shown and described. (4) In a split pulley, the combination, with two half-sections having lugs or wings on the spokes, of bolts passed through the said lugs, a split band surrounding the pulley sections, angle pieces secured on the ends of the band, and bolts passed through the angle pieces, substantially as herein shown and described.

327,215. Pipe Coupling, *F. E. Youngs, Allegheny, Pa.—Filed June 1st*, 1885.

Claim.—(1) A screw socket or coupling provided with screw-threaded ends and an internal annular groove, the walls of which have sufficient elasticity to accommodate the expansion and contraction of a single length of pipe, and sufficient strength to withstand the twisting strain of screwing the ends of the pipes inside of it, substantially as shown. (2) In a line of

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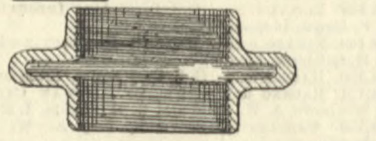

screw-threaded pipes, the combination, with each length of pipe, of an elastic screw-threaded socket or joint having sufficient elasticity to allow that length of pipe to contract and expand, substantially as described. (3) As a new article of manufacture, a single length of screw-threaded pipe provided with an elastic screw-threaded socket, substantially as and for the purpose specified.

327,251. Handle for Steam Valves, *John E. Gaitley, Troy, N.Y.—Filed December 31st*, 1884.

Claim.—(1) A handle or grasp for valve stems or other devices, consisting of a coil of wire, shells or discs which receive its ends, and a bolt which passes through said shells in the major axis of the coil and engages with a shank or broadened part of the stem placed between the central coils of the handle, substantially as described. (2) The combination of a spiral coil of wire having its diameter increased from each end toward the centre, shells or caps concaved on their adjacent faces, which engage the ends of the

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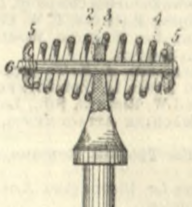

coil, a bolt passing through the shells and coil, and a stem having a broadened end placed between the coils and upon the bolt, substantially as described. (3) The combination, with the spiral coil 4, the shells 5, the bolt 6, headed at one end and having its other end secured in engagement with one of said shells by a nut or screw, and a stem 1, having its end between the central coils of the spring 4, and receiving the bolt 6, substantially as described.

327,275. Axe, *William C. Kelly, Louisville, Ky.—Filed April 3rd*, 1885.

Claim.—(1) As a new article of manufacture, an axe having the blade of a practically uniform thickness for so much of its extent as would be ordinarily consumed by wear and grinding, and tapered from a point at or near its centre towards the edges, the lines of taper diverging from said point toward the heel and toe of the cutting edge, substantially as and for the purposes hereinbefore set forth. (2) An axe having

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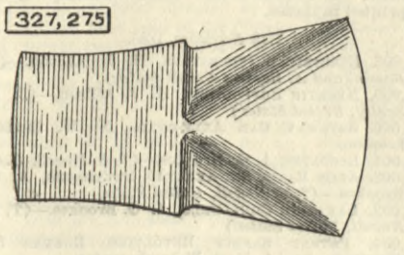
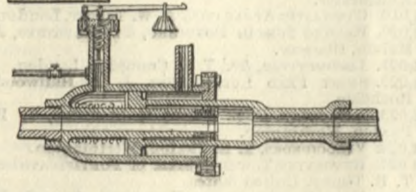


the back and front edges of its blade portion of practically uniform thickness from the point of juncture with the cutting edge to the shank or butt, substantially as and for the purpose set forth.

327,281. Expansion Joint, *L. Letzkus, Allegheny.—Filed March 5th*, 1885.

Claim.—(1) In an expansion joint, a shell having a passage therethrough for the conveyance of gas or other fluids, in combination with a piston fitting within said shell and provided with a hollow piston-rod, and a fluid pressure column, substantially as described, for forcing said shell and piston in opposite directions, said shell and piston-rod being provided with suitable means for connection with adjacent ends of a pipe line, as and for the purpose set forth. (2) In an expansion joint, a shell having a concentric tube enclosed therein, in combination with a piston located in said shell and fitting around the tube, and having a hollow piston-rod and a fluid pressure column, substantially as described, for forcing said

327,281



shell and piston in opposite directions, said shell and piston being provided with suitable means for connection with the adjacent ends of a pipe line, as and for the purpose set forth. (3) In an expansion joint, a shell, in combination with a tube located in said shell, an annular piston and rod surrounding said tube, and a cylinder, a fluid packing, and weighted piston connected to said shell, substantially as set forth. (4) In an expansion joint, a shell, in combination with a tube located in said shell, an annular piston and rod, a cylinder connected to the shell at one end thereof, a fluid packing, a weighted piston located in the cylinder, and a stand pipe connected to the opposite end of the cylinder, substantially as set forth.

327,312. Chisel Shoe, *William Reinhard, sen., and Charles Kalanquin, Eau Claire, Wis.—Filed June 18th*, 1885.

Claim.—In a shoe for attachment to a chisel blade, in combination with the sole-plate, the loop on the upper side thereof extending across the same, the plate extending through the loop, and means, substantially as described, for forcing and holding the plate down toward the sole-plate, substantially as and for the purpose described.

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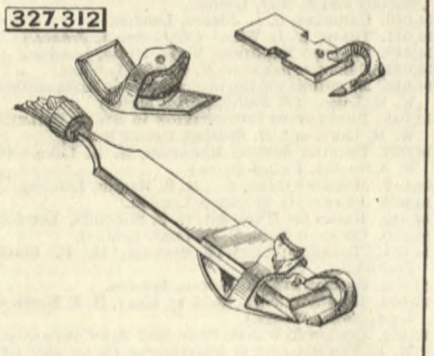
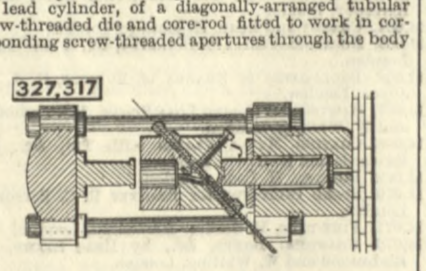


327,317. Hydraulic Lead Press, *John Robertson, Brooklyn, N.Y.—Filed October 8th*, 1884.

Claim.—(1) In a lead press, the combination, with the lead cylinder, of a tubular screw-threaded die and core-rod fitted to work in screw-threaded apertures made respectively diagonally through the body of said cylinder into its interior from opposite sides in line with each other and inclined at an angle to the axis of the said cylinder, as and for the purpose described. (2) In a hydraulic lead press, the combination, with the lead cylinder, of a diagonally-arranged tubular screw-threaded die and core-rod fitted to work in corresponding screw-threaded apertures through the body

327,317



of said cylinders, and the set-screw J, fitted to work in an aperture made through the body of the cylinder into its interior and to impinge against the side of the inner end of said core-bar, as and for the purpose described. (3) In a lead press the combination, with the lead cylinder provided with the chamber *e*, having the form described, of a die and core-bar located in and passing diagonally through said cylinder from side to side, with the line of their axes crossing at other than right angles the axis of said cylinder, as and for the purpose described.

327,381. Electric Railway, *Henry T. Clay, Philadelphia, Pa.—Filed February 7th*, 1885.

Claim.—(1) In a railway for the propulsion of a car provided with an electric motor, a rigid metallic conductor F, constructed, as described, with a flat upper internal surface, and supported between the rails, in combination with one or more adjustable contact spring brushes G^1 G^2, with means to support the same, and bring one or more of them, while moving in said conductor, against the upper internal surface thereof, whereby the electric current is supplied or led from said conductor to said motor, substantially as set forth. (2) The combination, with the rigid metallic conductor of an electric railway, of an adjustable contact device consisting of the insulated arm G and flat metallic spring G^2, with mechanism, substantially as described, to bring said spring brush G^2 into electrical contact with the interior surface of said conductor from time to time, as may be desired, as and for the purpose set forth. (3) In an electric railway provided with a rigid metallic conductor, the switch herein described, con-

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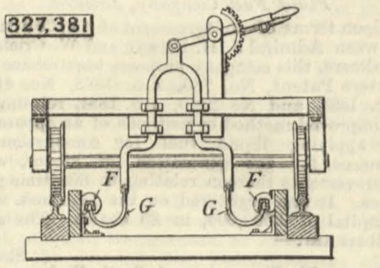
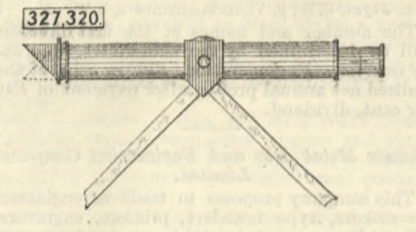


sisting of arms K K, joint N, lip *n*, and spring S, constructed and operating substantially as set forth.

327,320. Attachment for Engineers' Transits for Vertical Sighting, *George N. Saegmuller, Washington, D.C.—Filed March 28th*, 1885.

Claim.—As a new article of manufacture, an attachment for the object end of an engineers' transit, con-

327,320



sisting of an annulus, a collar or stop, a box having an opening, and a reflecting medium, placed at an angle of 45 deg. in said opening, substantially as described.

327,419. Process of Making Steel by the Pneumatic Operation, *James P. Witherow, Allegheny City, Pa.—Filed July 3rd*, 1885.

Claim.—As an improvement in the art of converting metal by the pneumatic process, the method herein described, which consists in first oxidising a portion

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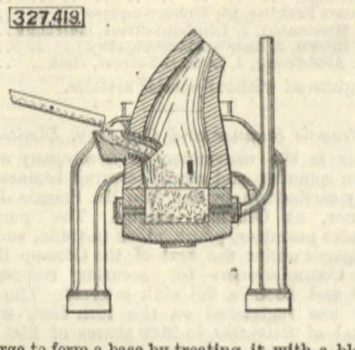

of a charge to form a base by treating it with a blast of air when in a divided state, and then blowing the charge in a converter to eliminate the impurities and effect the conversion of the same, substantially as and for the purposes described.

327,422. Converter, *James P. Witherow, Allegheny City, Pa.—Filed July 3rd*, 1885.

Claim.—(1) A converter composed of an upper and a lower section, the lower section constituting the crucible for containing the metal, and the upper section having a contraction or neck in its lower end and a charging hole above the neck, substantially as described. (2) A converter having a contraction or neck between the charging hole and the part which contains the charge, and grooves in the same, arranged directly over the tuyeres, substantially as and for the purposes described. (3) A converter having a charging

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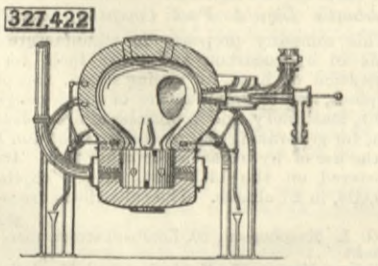

spout or hole, with a tuyere provided with concentric nozzles having separate connections blowing into or through said charging hole, substantially as and for the purposes described. (4) A converter having a charging spout or opening provided with a tuyere for blowing a jet of air into or through said charging spout, and water coils arranged in the side opposite thereto, substantially as and for the purposes described.

327,456. Stuffing-box Packing, *F. J. Roth, Cincinnati, Ohio.—Filed March 23rd*, 1885.

Claim.—(1) In combination with the stuffing-box A and gland C, the rings *a c*, cup *b*, spring *d*, and the contained elastic packing, substantially as set forth. (2) In stuffing-box packing, in combination with

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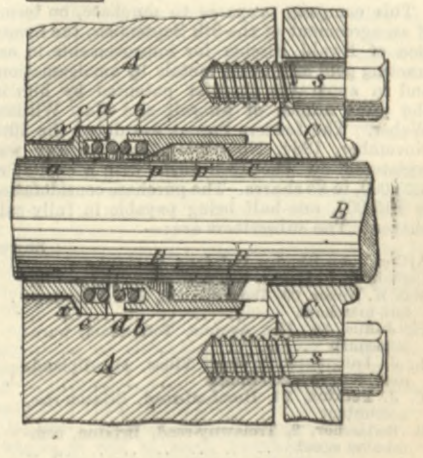

the ring *c* and spring-impelled cup *b*, the compound packing consisting of a body portion p^1, of felt or other elastic material, and an edging *p*, of asbestos or other heat-resisting material, substantially as set forth.