ACCIDENT TO NECAXA DAM NO. 2.

No. I.

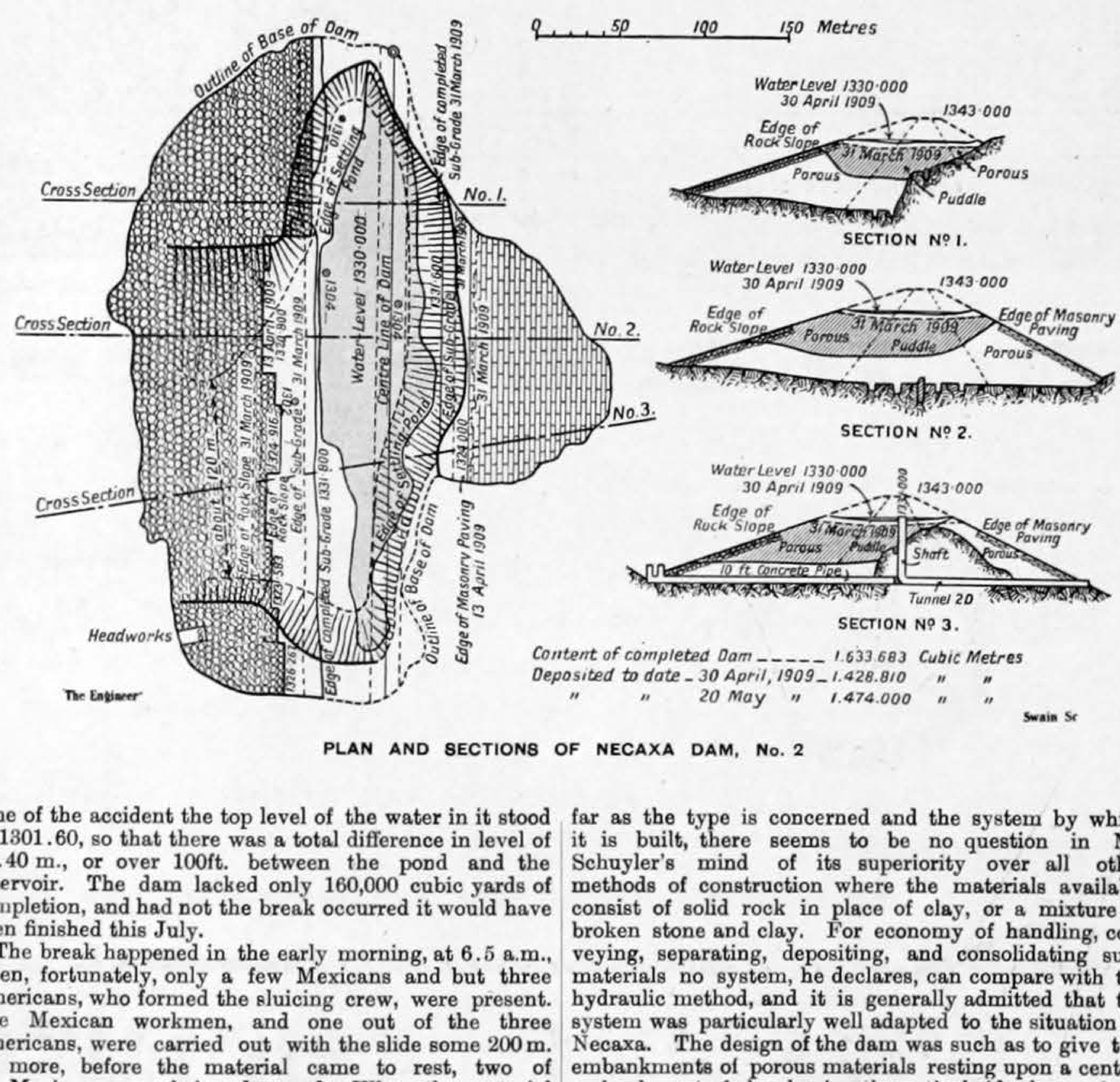
WE have already drawn attention to the accident which took place at Necaxa, in the State of Puébla, Mexico, towards the end of May last, when a break occurred in one of three large dams under construction, and a huge volume of material, amounting to some 555,000 cubic metres, was displaced and slid into the reservoir. A complete technical description of the Necaxa installation was given in THE ENGINEER of November 8th and 29th, 1907, when it was pointed out that the Mexican Light and Power Company, to which the works belong, could claim to have the largest transmission from its generating station to its customers of any in the world. It will not therefore be necessary to refer to these again, and all that it is proposed to do in the present article is to describe the accident to dam No. 2, showing the various causes which contributed thereto, and the steps which are proposed for reconstruction and restoration.

When the accident occurred, the volume of material in the dam was 1,474,000 cubic metres, and the average elevation of its crest may be put at 1380 m. It was, it will be remembered, being constructed on the hydraulic principle, and the water level in the pond was at 1332, 11 m. below the top of the dam as planned. Side embankments about half a metre higher than the water level in the pond retained the water in the latter. This was from 1 m. to 2 m. deep, from 10 m. to 60 m. wide and 340 m. long, and covered a surface area of about 10,000 square metres. The construction was proceeding both rapidly and normally, the material pumped into the pond having raised its level 2 m. in the previous two weeks, and 9.3 m. in the preceding ten weeks. The level of the water in the reservoir was considerably lower than this, the depth not having exceeded 9.26 m. since October 1st, 1908. At the time of the accident the top level of the water in it stood at 1301.60, so that there was a total difference in level of 31.40 m., or over 100ft. between the pond and the reservoir. The dam lacked only 160,000 cubic yards of completion, and had not the break occurred it would have been finished this July.

The break happened in the early morning, at 6.5 a.m., when, fortunately, only a few Mexicans and but three Americans, who formed the sluicing crew, were present. The Mexican workmen, and one out of the three Americans, were carried out with the slide some 200 m. or more, before the material came to rest, two of the Mexican peons being drowned. When the material commenced to move, it first pushed out from the upper toe of the dam at about the level of the water in the reservoir, and directly in the line of a 10ft. conduit, which had been built as a temporary passage for flood waters. It was at first supposed that an earthquake had occurred, as the flume vibrated and immediately began to settle. All the material composing the middle or puddle third slid out, to fall with much of the semi-porous and porous parts from the slopes. The break through the up-stream slope, all the way down to about elevation 1303, extended to about 120 m. The lower toe stood all the way across at about elevation 1326, some 2 m. above the paved slope as it had been finished. After the slip the slope of the material from elevation 1326 on the reservoir side varied from almost vertical to about one to one. This was found to be true also with what remained of the shell of the up-stream toe. The whole of the puddled centre of the entire dam from end to end went through the 120 m. break of the upper toe.

Immediately after the break occurred a survey was made by the resident engineer, and the engraving shows the sections and the outlines of the top and bottom of the cavity formed by the slide of earth. The three sections show the depth of this cavity at various points. The complete outline in the drawing shows how the dam stood at the 30th April, about a month before the accident took place, while the shaded part of the section represents the portion which slid out. As already indicated, the volume of material which was displaced and slid into the reservoir was estimated at 555,000 cubic metres. Soundings were made at intervals through mud to hard bottom across the break in the up-stream toe and in the puddle core area. It was found that in the whole width of the break the movement has extended practically to the original hard bottom, averaging about 6 m. deep, and the material thus carried away has been replaced by soft clay, the volume of which was computed at about 34,000 cubic metres. The greater portion of this material will have to be removed in order to get a new toe embankment of rock down to the hard bottom, and the total loss may be fairly estimated at about 600,000 cubic metres, or about 40 per cent of the entire quantity that had been placed. Henceforth the greatest caution will have to be employed and in effecting the repair, and it is estimated that it will take at least six months to refill the dam and bring it up to elevation 1333. At this height it is proposed to suspend construction for a year, so as to give absolutely perfect settlement, or at least to proceed very slowly thenceforward.

Having seen what occurred, it may be interesting to trace its cause, more especially as the accident came as a complete surprise to all the experienced engineers who were connected and familiar with the construction, and who had seen it built up from the bottom with what appeared to be perfect solidity. Everyone who had witnessed the construction and then heard of the accident declare that they would have believed it impossible that such an event could have occurred, more especially as it is quite unprecedented in the building of such dams. Being without precedent, the lesson it conveys is perhaps all the more profound and impressive. The celebrated American consulting hydraulic engineer, Mr. James D. Schuyler, the designer of this dam, is a firm believer in this type of construction, and the accident has in no way shaken his faith. It was Mr. Schuyler who planned its dimensions and method of construction, and he had supervised it from time to time since it began. As far as the type is concerned and the system by which it is built, there seems to be no question in Mr. Schuyler's mind of its superiority over all other methods of construction where the materials available consist of solid rock in place of clay, or a mixture of broken stone and clay. For economy of handling, conveying, separating, depositing, and consolidating such materials no system, he declares, can compare with the hydraulic method, and it is generally admitted that the system was particularly well adapted to the situation at Necaxa. The design of the dam was such as to give two embankments of porous materials resting upon a central embankment of clay, having theoretical side slopes of one to one. The base width of embankments of materials composed of rock, or rock and sand, was about 350ft. on the upper stream side and 250ft. on the down side, while the central core has a base width of about 365ft. The theory upon which this design was based was that as the rock embankments advanced in height, and rested upon the clay, they would aid in forcing the water out of the clay by the superimposed weight, so that the portion of the clay underlying the overhanging part of the rock-fill at least would become particularly hard, while in the centre the water would be forced to rise as the weight of clay increased, and that section would also finally become hard a little later. It was always recognised that there was a considerable excess of thickness of clay in the centre core, but as the materials in the pits where broken stone and clay were mingled were found in about equal proportions, it was not regarded as detrimental to have a layer of clay of extraordinary thickness. It was not desirable to waste the excess clay, and so it was employed, but it was not foreseen that this particular clay was extraordinarily slow in drying or parting with its water when in a mass, remaining semi-liquid far longer than most other clays, such as those, for instance, resulting from decomposition of granite. The curious nature of the clay employed, totally unlike that used by the engineers in any other dams constructed by them, is held to be largely responsible for the lack of stability in the design adopted. It would have required longer time to put in rock in the place of any considerable portion of the clay core, and as the clay would have been wasted the cost would have been much greater. It was therefore with some regard to economy that so much clay was used in the construction of this dam; and that the engineers were justified by previous experience in using clay may be inferred from the following examples of clay used in other dams:—



PLAN AND SECTIONS OF NECAXA DAM, No. 2

The Lake Frances dam in California, built wholly by sluicing, was composed almost entirely of clay, and while it hardened quite slowly, it solidified by its own gravity and natural side-drainage, and became hard, solid, and stable. The water in the reservoir was usually kept within 10ft. or 15ft. of the top during construction. The rate at which the pond on the dam was raised was, however, less rapid than the rate of the past eight or nine months at Necaxa, and possibly the clay had rather longer time to settle.

At the Santo Amaro dam, in Brazil, the materials used in sluicing were disintegrated granite containing a reddish clay. This contained also a good deal of mica, which is usually a strong lubricant. The puddle core of this material became firm under water immediately after being deposited, and was really more stable and would stand up more firmly than the sand and gravel separated from it. A washout occurred, which demonstrated the remarkable stability of this clay. In a shallow section of the dam—which is a mile in length altogether—the side levees had been built up by hauling in sand with cars. This material could not be so well settled as the sluiced material, and a break in one side occurred, washing out about 50ft. of the levee, as well as its base down vertically to the original ground surface, the summit pond being quickly emptied the entire length of the dam. Although the water fell vertically over the clay a height of some 8 m., the freshly deposited puddle stood up, resisting erosion almost like stone. This was quite remarkable, as the oldest of the clay had not been deposited more than three months.

The fine surface soils of the plains of Idaho, U.S.A., which geologists say are wind-borne, resemble clay in appearance; but the dams built of this material drained out so quickly that a person could safely walk over the pond of the hydraulic fill a few hours after the water had been drained off the top.

It will be readily seen from the above examples that the respective engineers had abundant justification in employing the clay as a fill at Necaxa. It also seems that they took all the necessary precautions in finding out what the clay in the dam was doing. Soundings were made to ascertain its condition, and upon every occasion it was reported as becoming firm at a depth of below 45 m. from the top. As recently as January of this year a device was introduced for bringing up samples at any depth desired, while tests were frequently made over the puddle core to determine its nature. These samples showed a softer condition than was anticipated, and it was found to be possible to force the 1in. pipe down practically to the bottom with four men. Nevertheless the clay brought up was stiff, and contained very little more moisture than the ordinary clay soils in a bank of that material. To all appearances it seemed firm enough to resist transmission of hydrostatic pressure laterally for at least half its depth from the bottom up.

THE MANAGEMENT AND EQUIPMENT OF AN EXPERIMENTAL TANK.

No. III.*

Filing records.—Not the least important part of tank routine is the systematic filing of all the records in such a way that any required data can be readily obtained. It will be seen that a vast amount of information falls to be dealt with in the course of time, and a regular method must be formulated and adopted. All models, whether of ships or propellers, are numbered, and the particulars of each placed on record in a "history" book. A sample page from such a book is reproduced on page 104. The drawings from which the models are made are similarly numbered and stored in sequence, or by index. The record of weighing, measuring, and ballasting of each ship model is kept in what is called a "trim book." All experiments, of whatever kind, are numbered, and each one as it is taken is entered in a "day book" with all essential notes and particulars of test.

An example reproduced from an actual resistance diagram record is shown in Fig. 1. Results of resistance diagrams analysis are plotted upon section paper, the abscissæ being speed in feet per minute of the model, with a corresponding scale of knots for the ship. The ordinates are resistance in pounds for the model, with a scale of tons for the ship if thought necessary. On each of these sheets are plotted curves of surface friction of the model, and curves of surface friction corrections necessary to be made in passing from the model to a full-sized ship. These latter curves are calculated from the classical experiments made by the late Dr. Froude. It is found convenient to make nearly all ordinary ship models of a constant length, for by this means the correction curves can be systematised and plotted for passing from this constant length to varying lengths of ship, at various speeds, whereas if both lengths were variable the calculations would have to be made in each case *ab initio*. This saves a great deal of work, the correction being proportional to the wetted surfaces of the models. A sample sheet of Curves of Resistance, with surface friction, and surface friction correction, is given in Fig. 4, page 104.

The resistance sheets, when complete, are filed in boxes, where they hang in such a way that any one may be removed without disturbing the others. Each sheet has a numbered tag, and the boxes are all indexed to correspond.

Displacement, skin, and midship area of ship and model; prismatic, block, water line, and midship area

* No. II. appeared July 23rd.

coefficients are all calculated, and plotted on sheets in terms of moulded draught. These sheets are filed in indexed boxes also.

Propeller results are plotted in the way which has been described, on a base of revolution or slip ratio, as the case may be, and similarly filed. In this case the propeller history book forms a convenient index for the sheets, the propellers being arranged numerically, and also indexed in terms of diameter and pitch. An example exactly reproduced from an actual record is shown in Fig. 2.

The next step is to get the resistance into an easily handled form for estimating the power of proposed new vessels. It is convenient to calculate the E.H.P. from all models for ships of constant length, say, 100ft., and the final results may be kept in a constant form, as Dr. Froude did, or simply as E.H.P. for 100ft. ships. If the E.H.P. be divided by a function of the wetted surface, say, in such a form as $\frac{\text{E.H P.} \times 200}{\text{Wetted surface}}$, the curves approach a constant value for all draughts, and may be completely plotted in terms of speed in knots, for a ship 100ft. long. Here, again, the surface friction correction for passing from a constant length of 100ft. to other lengths may be easily systematised, and the correction plotted in the same terms as that adopted for the E.H.P., on a base of speeds for ships 100ft. long. It is then immediately applicable to the "rate" or "constant" curves. A specimen of a rate curve sheet as filed for reference is given in Fig. 3, page 104.

Sheets of these "rate" curves are plotted, having upon them a small scale drawing of the form which enables the estimator to recognise any outstanding feature of the design he is estimating from.

The sheets have numbered tags, and are filed in boxes. The index in this case may be made upon any desired basis, say, breadth, or block coefficient; but in any case, breadth, range of speeds and draught, and block coefficients should appear on the index for facility in selecting suitable forms.

After making the necessary surface friction and other corrections, the E.H.P. from the rate sheet is multiplied by (length of proposed ship ÷ 100)$^{\frac{7}{2}}$. A table of figures raised to this power is prepared and kept, so that it is readily available for use.

When wave profiles of paddle steamers and transverse sections in the region of the paddle wheels are made, these are drawn to scale, filed, and indexed similarly to the plotted sheets of results.

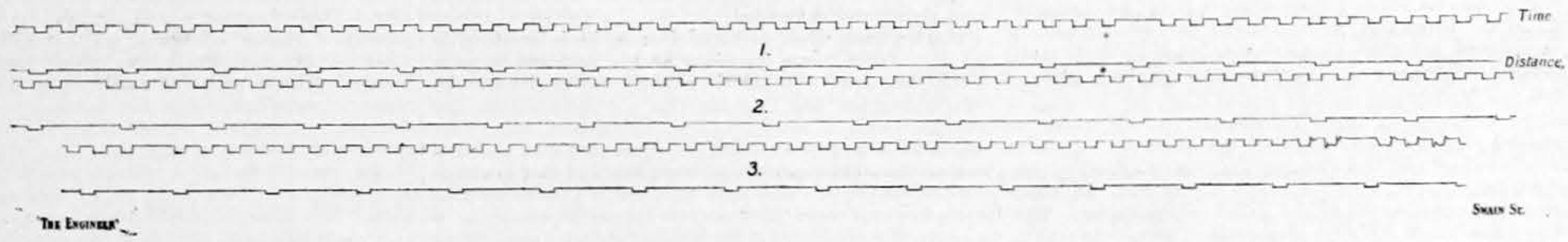
The final form in which the E.H.P. is plotted is as a basis of comparison with the indicated horse-power or shaft horse-power of the actual ships on their measured mile trials. These sheets are termed "efficiency" sheets, and are a complete analysis and comparison of all the data observed and recorded on the trial trip. These sheets are plotted on a base of speed. The E.H.P. with and without excrescences is calculated from the model trials, and these curves plotted first. Indicated horse-power and shaft horse-power spots are then plotted, and from the efficiency curves thus obtained, curves of indicated horse-power and shaft horse-power are passed through their respective spots. All the other usual engine-room information is plotted in the same way, keeping hold of the E.H.P. as a groundwork for building up the rest. The completion of these sheets forms a fitting conclusion to the previous work done during the design and building of the vessel.

Fixing of design and estimating power and speed.—This, the third of the broad groups into which the normal work of a tank may be conveniently divided, is not the least important, because it may be made sufficiently reliable to dispense with the need of actual experiment altogether in many cases. It is the natural fruit of accumulated data and a wide experience of the combined model and ship results under all kinds of conditions.

It is rarely that the problem is an entirely unfettered one. The exigencies of service for which the vessel is intended generally make some of its factors fixed and unalterable—such, perhaps, as draught of water at a harbour wharf, breadth of a dock entrance, maximum length available for canting in a basin, and so on. These fix draught, beam, or length respectively. The problem is then stated in terms of the other variables in order to discover the most suitable combination to attain the highest efficiency of service. Then, again, much depends on what is actually the factor upon which most stress is to be laid. If a vessel for purely high-speed passenger service be under consideration, then endeavour is usually made to attain the highest possible speed with a given expenditure of power. If, however, on the contrary, the problem be that of a slow, or moderate, speed cargo-carrying steamer, then it often happens that speed is of small consequence relatively in comparison with increase of deadweight carrying capacity. The form of the estimate depends upon these things, but the goal aimed at is in every case the same—viz., what is the best form of vessel for the desired conditions?

Now we may consider "form" from two points of view:—(1) The actual mathematical proportions which subsist between the coefficients. These are the relation between block coefficient and prismatic coefficient, and its consequent bearing on midship area coefficient, and the relation between prismatic coefficient and water-line coefficient, which involves the vertical distribution of the displacement and the shape of the cross sections.

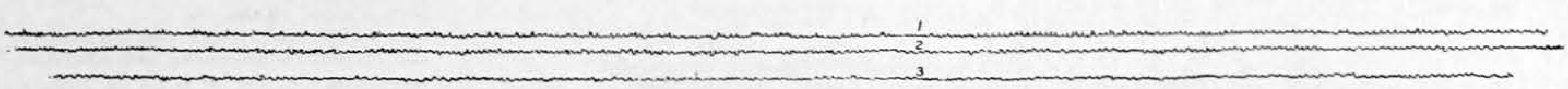
The other aspect of form, namely, the actual contour of the midship section and of the water lines, is not by any means so important, and yet there are conditions where it assumes value which must be seriously reckoned with. We have not yet forgotten the controversy which raged round the question of comparative values of hollow or straight water lines for the 24-knot cruisers. In all these considerations, which are mutually interdependent,



Scale of Spring 13' 498 to 15 lbs.

	Speed in feet per min.	Resistance in lbs.
1	387·64	3·956
2	374·57	3·645
3	350·03	3·072

Swain Sc.



STROPHOMETER DIAGRAM

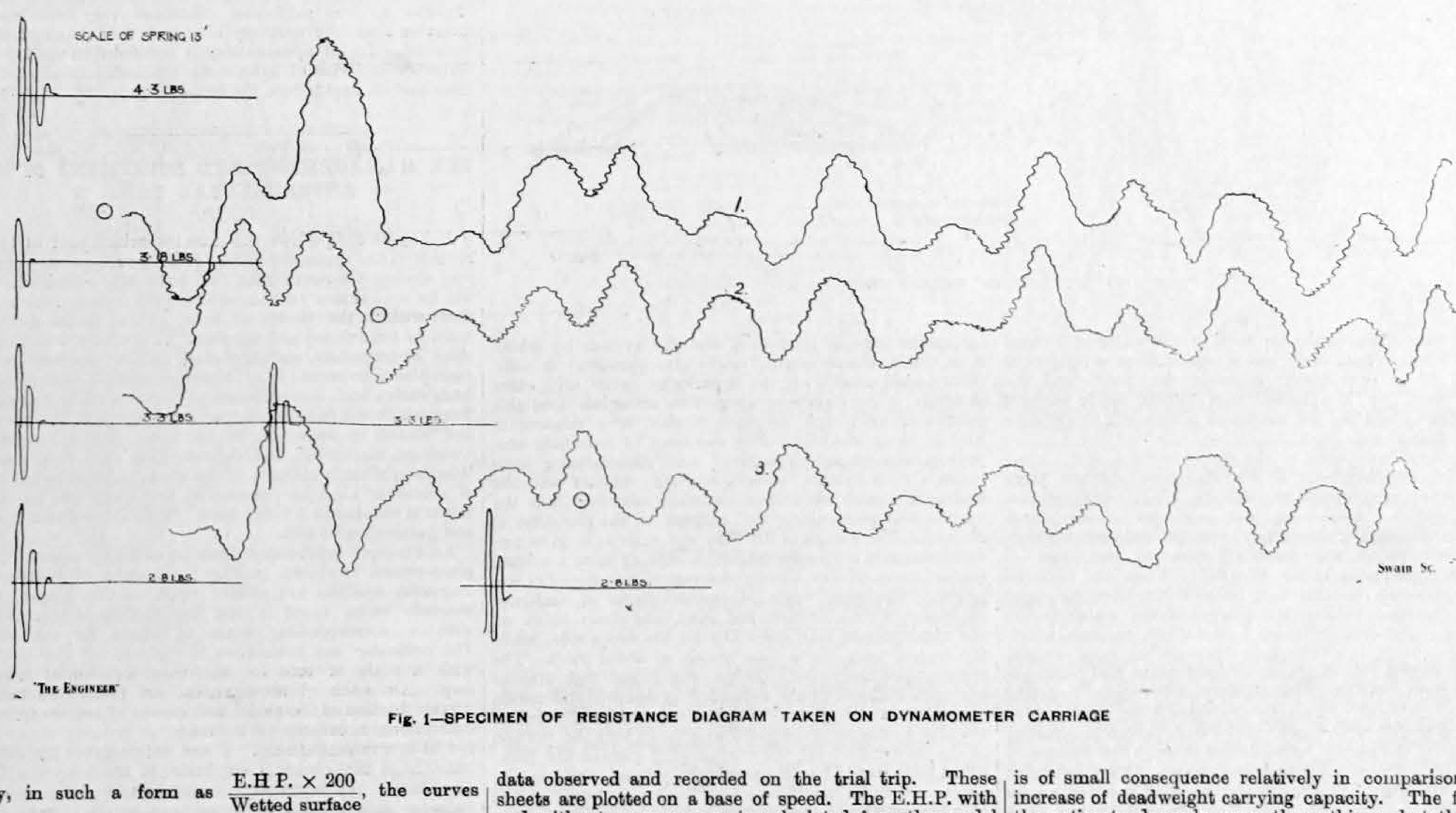


Fig. 1—SPECIMEN OF RESISTANCE DIAGRAM TAKEN ON DYNAMOMETER CARRIAGE

a clear line of argument must be maintained so that confusion of different variables is not allowed to creep in.

The first thing to be done then is to set down the fixed and unalterable factors. To take a simple case of a moderate speed steamer to carry cargo and some passengers:—Suppose length, breadth, and draught are fixed, and a trial speed desired has been also fixed, the problem then is purely to settle what is the best form to carry the maximum displacement. The variables are block and prismatic coefficient, and form of line, to satisfy accommodation requirements, give good stability, and good deep sea efficiency. The dimensions are reduced to a standard of 100ft. length. E.H.P. for many possible forms is calculated from the rate or constant curves above mentioned, and these are all plotted on a basis of block coefficients. A curve of displacement for the various degrees of fullness is plotted on the same base. An inspection of the plotted spots of E.H.P. shows at once the kind of form most suitable for the speed, and a curve of E.H.P. can be put in through those selected as apparently suitable. From this information a curve of weights may be deduced, and plotted on the same base of block coefficients. Obviously the intersection of the curve of length? What will be the increase of speed if a certain percentage be added to or taken from the power? What will be the effect of increasing breadth or draught on the same, or a proportionately increased displacement? &c. &c.

Each of these must be stated as a problem by itself.

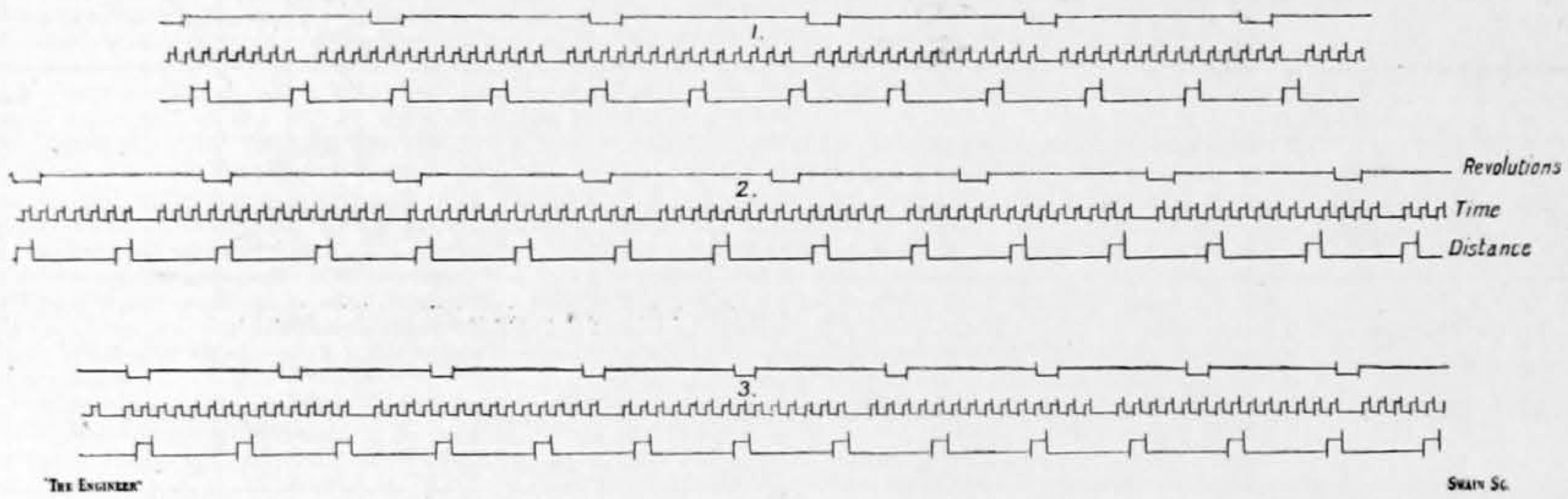
Suppose, for example, we take the first, what will be the effect of increasing length, keeping power constant? We must make separate calculations for lengths which shall include the proposed alteration and plot the results similarly to the other on a basis of block coefficient. From these curves a cross curve may be constructed and plotted in terms of the new variable, *i.e.*, length, which will give the desired information, and so on for the others.

It is at this point that tank data often save a considerable amount of labour, for if the proposed modifications are moderate in amount, empirical formulæ may be applied with a sufficient degree of accuracy for estimating purposes.

The operations sketched out are of constant occurrence in a tank attached to a shipbuilding establishment. Copies of all estimates sent out are kept and docketed for future reference. The information given is sufficiently accurate the staff, and the necessary work can be finished before the experiments for the day are begun.

Each department attends to a particular portion. The mechanics see that the carriages are in good working order, pen batteries charged, propeller frame put into position on the water after having been lifted out, dried, and oiled at the conclusion of the previous day's experimenting, rails cleaned with naphtha or oil, and the mechanical apparatus generally ready for work.

An electrician from the yard staff connects the motor generator with the yard circuit, and charges the main driving batteries, having them at full voltage in time for the operator to start. Every alternate day the ship model under test must be scrubbed or sponged, as the case may demand, to remove a slime which gradually gathers on the surface of the model, and adds considerably to its resistance. The water surface has to be skimmed at intervals to remove floating dirt. This is done by the joiners' labourers. A siphon is fitted at one end of the tank, with a vertical pipe having at the top an open funnel, with a removable plug in its throat. The rim of this funnel is at about the intended normal level of the water surface. When the tank is skimmed, water is run



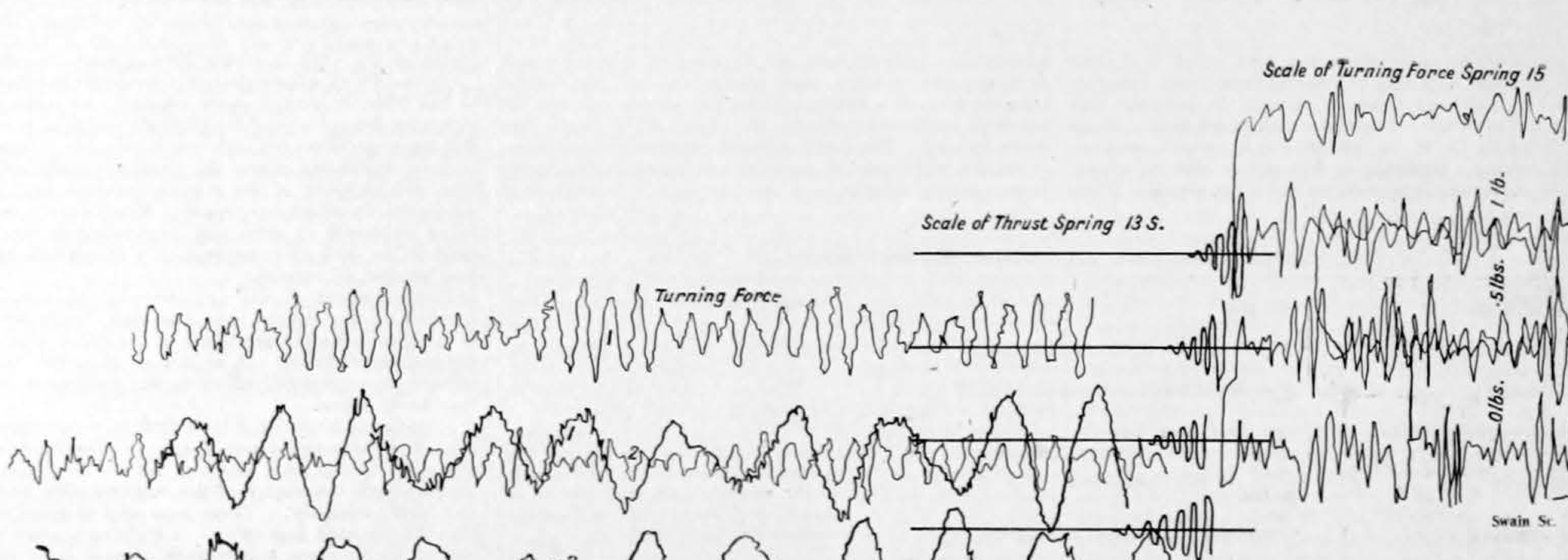


Fig. 2—SPECIMEN OF DIAGRAMS AS ACTUALLY TAKEN ON PROPELLER CARRIAGE

weights, and the curve of displacement, determines the maximum fullness which may be used, and the E.H.P. may be read from its curve. Having got this, and made sure that the kind of form selected is suitable from all considerations of service, recourse is had to the efficiency sheets of similar vessels as nearly as may be attained from the records of the trial trips of actual vessels. The relations of E.H.P. to indicated horse-power are carefully considered, and here experience is largely laid under toll, to settle what is a correct probable proportion to assume. This done, the probable indicated horse-power on trial is known.

This last factor is necessarily dependent in a large measure on propeller design. It may be found that on the draught available it will not be possible to carry propellers of adequate size to get maximum efficiency, and we enter on the consideration of one, two, or three propellers, if that is not already fixed by the conditions laid down in the problem. Usually the specification supplied by prospective owners has settled this beforehand. In such a case it is necessary to modify the relation of E.H.P. to indicated horse-power, which is to be assumed accordingly.

The problem may now assume varying degrees of complexity, such as, what will be the value of increasing in most cases for a tender to be made, and as soon as the variable factors have been tentatively settled upon a model is put in hand and run through in the least possible time. Usually three days serve to confirm the estimate of E.H.P., and a few more, if circumstances demand it, suffice to make and test propellers.

The analytical method of dealing with marine engineering problems, as sketched out, is of great value in differentiating the various factors which go to make up the case under investigation and in putting quantitative values upon them. It also enables an intelligent synthetical treatment of new proposals to be made, and prevents the adoption of schemes which are based on fundamental error. Needless to say, all kinds of inventions and ideas, wise and otherwise, are likely to be submitted for opinion or trial from time to time. It is often possible to point out at once where misconception, or actual want of knowledge, either of fact or of correct proportion, has led to false conclusions, though not always easy to convince the promoter of the inaccuracy.

General maintenance of plant.—There is a daily routine to be followed which, while not absorbing a great amount of time, has to be regularly done in order to maintain the plant in an efficient working condition. The workmen's hours usually begin earlier than those of in until the surface is just above the funnel rim. A skimmer is then drawn from the end of the tank furthest from the siphon, towards the funnel outlet, down which all the scum passes to the sewer.

The youngest member of the office staff is responsible for the periodic timing and rating of the clocks and stop watches. The watches are rated once a day, and the clocks on the carriages three times. The level of the water is observed and recorded three times a day, note being taken each time water is either run in or out at the siphon. An abnormal leakage is at once detected, and the cause ascertained.

Storing and classification of models.—Where paraffin is the material adopted for manufacture of ship models, no great accumulation is allowed, those which are tested being broken up and returned to the paraffin store. The exigencies of work generally prevent a straightforward disposal of this kind however, and models lie awaiting completion for a considerable time. In this case they are filled with water and float at the surface of the tank, where they are moored out of the way. They retain their shape under these conditions remarkably well, and can be lifted, scrubbed, polished, or fine scraped if necessary, when occasion allows of completing their tests. After a considerable lapse of time the surface under the slime becomes pitted and the model is apt to become distorted. It is better then to re-cast and re-cut the model, a simple thing to do when drawings and moulding sections are already prepared.

Some operators have preferred to use wood as the normal material of the models. Wood models, when carefully made, are quite suitable for the purpose of experiment, but the time necessary to make them, the cost, which is at least trebled, and the difficulty of keeping them from changing weight by absorbing water, is enough to indicate that paraffin is the better material for a shipyard tank. Some little difficulty is to be looked for in warm weather, paraffin having a tendency to flow and so alter its shape, but with moderate temperatures this is not serious. When wooden models are adopted, provision must be made for storing and classifying the accumulated stock.

With the propeller models the case is different. These are small and permanent, so each propeller or set of propellers as it is made goes into stock. They are all typed with their registered number, and, as has been mentioned, the propeller history book is so indexed that propellers of suitable diameter and pitch may at any time be selected.

Direction of probable improvements.—No one who has studied the work of the late Dr. Froude can fail to be struck with the marvellous insight exhibited in dealing with an entirely new problem, as the experimental tank was when he instituted it. His mechanical methods of dealing with the problem as he found it were entirely admirable. Indeed, were one disposed to criticise recent developments in some tank plants, the criticism might take the form of a statement that the innovations had not followed sufficiently closely the lines which were laid down by him. The much debated question of the wisdom of using a wide span of carriage and thereby introducing large moving weights is a case in point. It will not be surprising to find a reversion to some modifications of Dr. Froude's original narrow carriage in future tanks, and it is curious to note that the old battle of wide and narrow gauge, which Froude's friend Brunel fought unsuccessfully on the railway, is by way of repeating itself on a small scale here, with, we think, the odds in favour of narrow gauge.

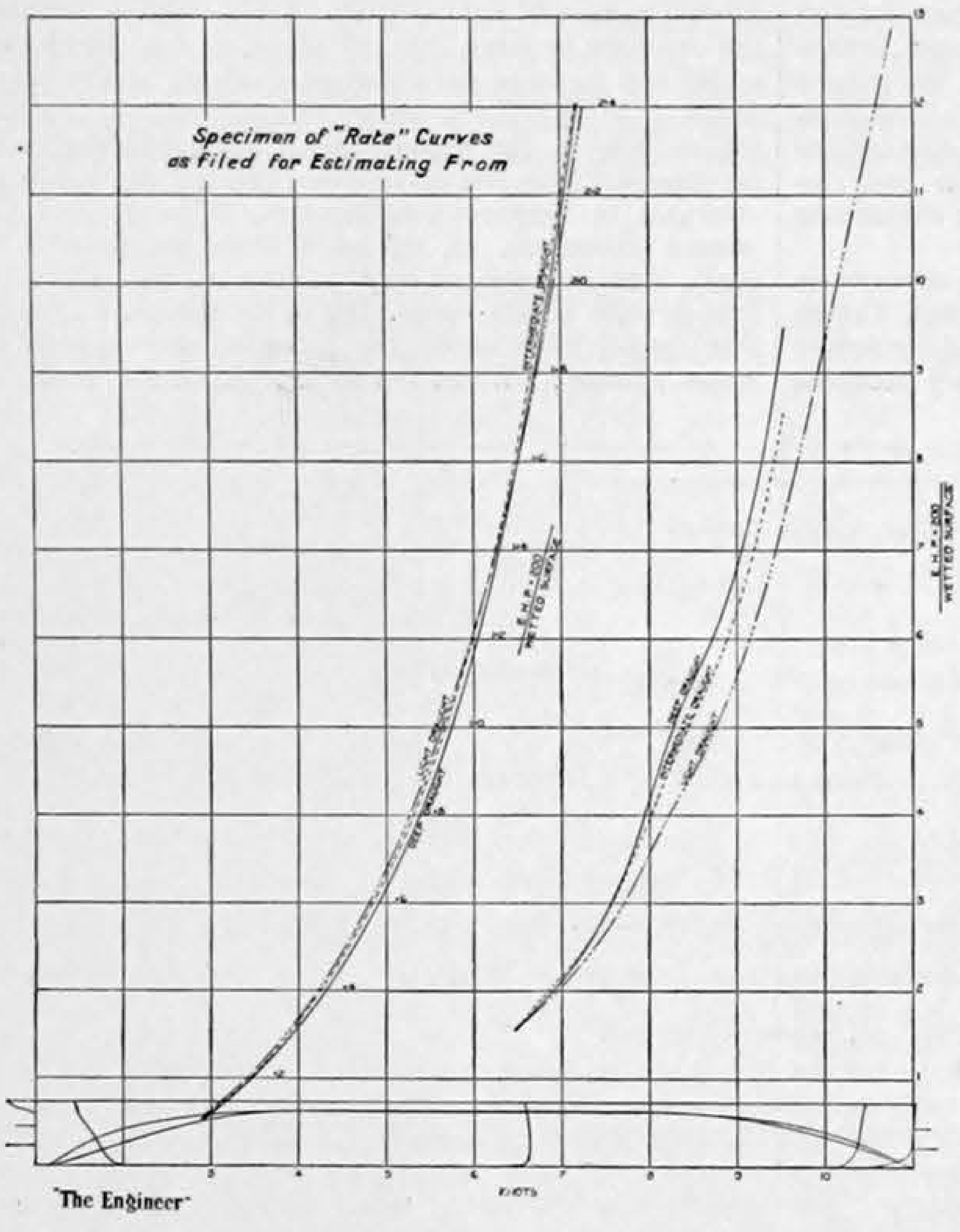


Fig. 3—SPECIMEN OF RATE CURVES

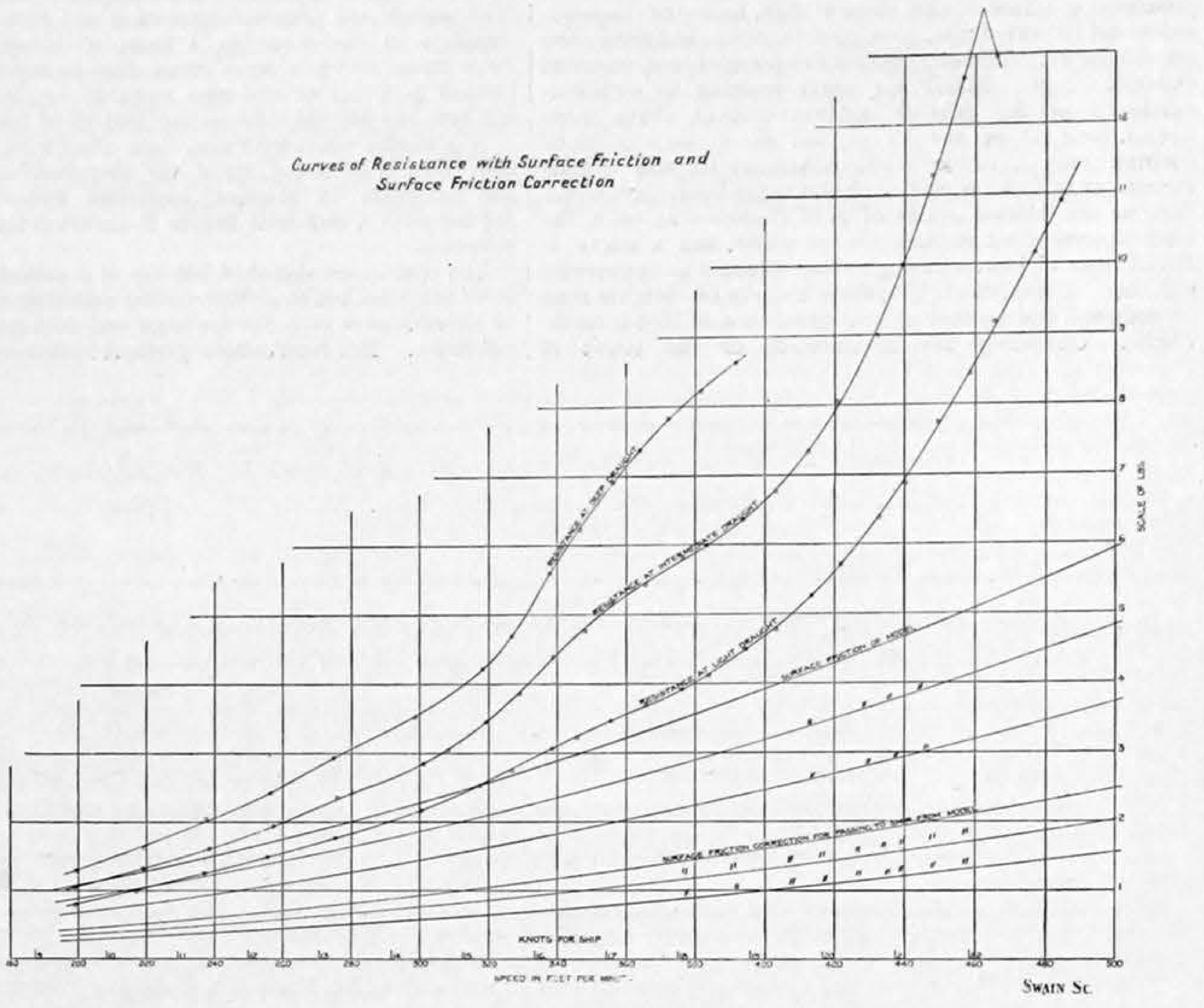


Fig. 4—CURVES OF RESISTANCE AND SURFACE FRICTION CORRECTION

Sample Page from the Model History Book.

		Notes.
Number of model	*No.* 500	
Dimensions of ship	*T.S.S.* 440*ft.* × 60*ft.* × 22*ft. moulded draught*	
Model drawing	*New model drawing prepared* 10/12/07	
Length and depth of model ...	12*ft. long*, 15*in. deep*	
Scale of model	$\frac{1}{36.666}$ *of ship dimensions*	*The form was deduced from model* 485, *prismatic coefficient being kept the same, but the midship area coefficient is increased, and the block coefficient is increased correspondingly.*
Needle trimming	*Confirmed displacement calculation*	
Displacement, wetted surface and coefficient curves	*All calculated and plotted for a range of draughts*	
Duplicate ditto	*Made and filed in record-office*	*Shaft bosses fitted at* 30 *deg. and* 40 *deg. to the horizontal, these models numbered* 500A *and* 500B.
Resistance and surface friction curves	*Resistances taken at four draughts in terms of speed. Resistance spots all plotted, surface friction curves all plotted on the resistance sheet.* *Shaft bosses and bilge keels have been fitted to the model. Resistances plotted on resistance sheet*	*Model with shaft bosses at* 40 *deg., and bilge keels numbered* 500C.
Duplicate ditto	*Made and filed in record-office*	*Model* 500D *was a recut of model* 500 *to the actual lines as lifted from the moulding loft floor, being as the ship was built.*
Wave sections and profile	*None done for this model*	
Duplicate ditto	*None*	*A new model drawing was made.*
Rate curves	*All calculated, plotted, and filed*	
Duplicate ditto	*Made and filed in record-office*	*E.H.P. for the efficiency sheet was made at the trial draught from model* 500D.
Duplicates for sending out	*Made and forwarded*	
Efficiency sheets	*Trial results all worked up, and comparison sheet plotted and filed*	*Rolling extinction diagrams were taken with models* 500 *and* 500C.
Duplicate ditto	*All made and forwarded*	
Propeller experiments	*Tests made with two new sets of model propellers made specially, and three sets from stock, Nos.* 250, 251, 86, 192, 210 *respectively. The results all plotted and filed*	*Model broken up* 5/3/08.

An entirely different system of tank work has been proposed and put into material shape by Herr Wellenkamp, at Kiel. The arrangements are ingenious and well worked out. Here, again, Herr Wellenkamp is traversing ground already covered by Dr. Froude at the inception of his idea, and rejected by him as being unreliable, which it certainly is, and by no means so simple to construct as the form in which Froude cast his apparatus.

On the whole, substantial improvements in future tanks, as has been suggested above, seem to be more probable along the line of enlargement of the original plan to suit the more onerous demands made on it. Innovations become inevitable when the demands made are greater than the capacity of the original scheme, and must be welcomed, by whomsover made. Minor details are always being improved as time and experience dictate, but in essence the tank plan, as originally conceived, holds the field against all comers.

In conclusion, it will be conceded by most serious thinkers on the subject, that the tank has justified itself as a valuable tool in the hands of the naval architect and the marine engineer. It is not so apparent that shipowners are as generally alive to the enormous benefit it may be to them.

A saving of 30 per cent. of power is a common experience, and cases are extant of actual ships where a saving of nearly double this amount might have been made had adequate knowledge of the requirements been available to the designer. There is no need to labour the point that the lessened first cost is a trifle compared with the cost of the needless expenditure of coal involved during the whole life of the ship. This is a point which may never clearly emerge on a trial trip, for a good efficiency of screw propellers may be associated with an E.H.P. of hull much larger than necessary to carry the displacement and deadweight.

The tank as a "shipyard tool" has been the burden of the song, but there are sometimes intermittent periods when research work may be indulged in from an academic point of view for a short time. From these much invaluable information can be built up, and empirical formulæ evolved which enable estimating to be done from varying types of ship with much greater accuracy than is ordinarily possible.

The wonder is that more large shipbuilding concerns have not equipped themselves with the plant. Probably the increased, and, as one cannot help thinking, unnecessarily increased, expenditure indulged in by some recent tank designers has a great deal to do with this. Of its usefulness there can be little doubt; of its value to those who have scope and insight to use it to its full capacity there will be less doubt in the minds of those most competent to judge.

Sell's Dictionary of the World's Press.—The 1909 edition of this useful dictionary contains nearly thirty thousand entries and separate newspaper announcements. There are also interesting articles pertaining to the Imperial Press Conference, flight, anecdotal history of journalism, newspaper happenings, &c. A special feature of the present edition is a novel map of the world which has some noteworthy advantages. An article on page 587 of the book fully describes the map and its special features. Among other things of note, mention should be made of the continuation of the World's Press Survey. It represents more particularly the Anglo-Saxon world which lies beyond the British Isles, and deals with the developments and maintenance of all newspapers printed in our language. It is interesting to note that out of the thirty thousand newspaper entries mentioned above, the number of papers published in the British Isles is approximately 2712, London being responsible for 695 of these. In addition there are some 1400 magazines and miscellaneous publications. The publishers state that all the lists of newspapers and other publications have been carefully checked and brought up to date.

INSTITUTION OF MECHANICAL ENGINEERS.

THE summer meeting of this Institution opened on Tuesday last, at the Central Technical School, Byron-street, Liverpool, under the presidency of Mr. J. A. F. Aspinall. There was a very large attendance, the number of members and associate members present at the meeting being the largest for some years past, if indeed it does not constitute a record for the summer meetings of the Institution. This is no doubt partly due to the convenience of Liverpool as a place of meeting, the city being within easy reach of the great centres of mechanical industry. Mr. Aspinall was supported at the opening ceremony by four past-presidents of the Institution in Mr. Edward P. Martin, Mr. William H. Maw, Mr. T. Hurry Riches, and Mr. Hartley Wicksteed, and the vice-presidents were represented by Mr. E. B. Ellington, Mr. H. Graham Harris, and Mr. A. T. Tannett-Walker. The members of Council attending the meeting are Messrs. W. H. Allen, Michael Longridge, Thomas P. Reay, John F. Robinson, Mark H. Robinson, and Mr. Wilson Worsdell. The programme of papers and the comprehensive list of visits arranged has already been published in THE ENGINEER, and it is sufficient to say here that the papers deal with an admirable variety of subjects, including locomotive engineering, marine engineering, reinforced concrete, gas engine problems, and the electrical operation of textile factories.

The proceedings opened with a formal welcome to the Institution on behalf of the city by the Lord Mayor of Liverpool (Councillor H. Chaloner Dowdall, M.A.), who said that were it not for the pleasure it gave him to do so, it would be quite unnecessary to formulate any welcome of the Institution to Liverpool. The city owed so much to the mechanical engineer, that the Institution was inevitably welcome, particularly in view of the President's long and honourable association with Liverpool. Other towns might have much of interest to show, but nowhere would the Institution meet with a more hearty welcome than in Liverpool.

The President briefly thanked the Lord Mayor for his words of welcome, and bore testimony to the part played by various public bodies in Liverpool to make the meeting a success.

The minutes of the last meeting having been confirmed, the reading and discussion of papers was then proceeded with.

The first paper taken was that by Mr. George Hughes dealing with "Locomotives Designed and Built at Horwich, with some Results." We commence reprinting this paper on page 119. A vote of thanks to the author having been passed on the motion of the President, the discussion, which was participated in by many members, and occupied practically the whole of the session on Tuesday, was opened by Mr. Joseph Adamson.

Mr. Adamson said that his interest was in the boiler with the corrugated flue. It would appear that some trouble had been experienced with bulging or collapsing between the bridge and the fire-box, an experience which was not uncommon in marine engineering. The remedy, as far as collapsing and corrosion were concerned, was to take care to get rapid circulation around that part of the boiler. In all types of boilers in which water was allowed to become stagnant, if pains were taken to make the water circulate a much better result would be obtained both in evaporative duty and in general economy of working. Experiments had been carried out at his own works, of which more he hoped would be heard in the future.

Mr. George Cawley said he had been experimenting for some years past with regard to the circulation in locomotive boilers. The experiments were carried out on models, and the results arrived at went to confirm the contention of Mr. Adamson that all boilers would give an improved service if the circulation received more attention. In his experiments it was found possible to get in full operation a circulation of ¼ ton of water per minute round the fire-box sides automatically. This suggested what could be done with great advantage to the economy of the boiler and the life of fire-boxes generally. In his experiments there was a special arrangement of the pipes from the smoke-box end of the boiler to the space round the fire-box. He had also made experiments on Lancashire and vertical boilers with satisfactory results in the way of efficient circulation. At the same time the question of water circulation was still open to further consideration.

Mr. T. P. Reay, speaking as a builder and not as a user, said that want of circulation was at the bottom of the boiler difficulty. He would call attention to the fact that the Broton boiler had been introduced into Austria with apparently satisfactory results, and they were giving the boiler a trial in Messrs. Kitson's works. Referring to what the author said on four-cylinder engines, it was clear that they must give better results than any two-cylinder arrangement which could be devised. He would like to know if Mr. Hughes had tried any blast pipe top with an annulus, as they had done so with marked success in some cases. Mr. Hughes appeared to give a fair mileage for his cylinders, the life extending from eight to fourteen years, but he would like to ask if they were not on the soft side.

Mr. T. Hurry Riches said the author had produced a very complete and useful paper which ought to meet with the appreciation of the younger members of the Institution. The paper detailed a large amount of practical experience which it was impossible for the majority of the members to acquire. The information given in the paper was of vital importance to the mechanical engineer. With regard to the corrosion of boilers, he agreed with those who had preceded him in the discussion; but there was one subject which did not appear to have been mentioned, and that was the necessity of taking as far as possible all the impurities out of the water before it went into the boiler. Another important point related to the necessity of having large spaces between the internal and external fire-box, and it was also essential that the tubes should be kept spaced as far apart as possible. He had tried the experiment of using the same number of tubes but of smaller diameter, and spacing them ¼in. further apart, and by that device they had overcome a great many of the difficulties to which they had formerly been subjected on the Taff Vale. The trouble in respect to priming disappeared, and corrosion was enormously decreased. He was afraid that locomotive engineers, owing to the pressure of circumstances, often allowed boilers to get into a very dirty state, and he would emphasise the importance of giving the boiler proper rest and cleansing. The blast pipe was a far more important adjunct than most people imagined. The important point was to allow the gases from the smoke-box to escape freely, and he had been very much struck by the difference occasioned by a slight variation in the area of the blast pipe compared with the chimney. The need of ascertaining the correct positions and proportions of blast pipe and chimney was dealt with in the paper, and it was not necessary to go into further detail as to the factors governing that matter. Mr. Hughes had given a good deal of information as to built-up cranks, and much useful knowledge on that subject could be gained from the experience of the marine engineer. In marine work it was the fashion to build up all large cranks, and sound information could be gained from marine experience which would enable the locomotive engineer to do better. The built-up crank lent itself very readily to the balancing of the engine. He hoped that the papers which Mr. Hughes was to read at a later date would lead to a full discussion of the important points involved.

Mr. Henry Fowler said the paper was important partly because the author had done what few people did, and that was, give the Institution the experience of his failures as well as his successes. Mr. Hughes referred to the solid cranks formerly in service having a tensile breaking load of 28 to 32 tons, and he would like to ask if something harder than this had been tried for the journal portion of built-up cranks? They had had no trouble with regard to oval wear on the Midland Railway. He would like to refer to the question of heat treatment in relation to locomotive cranks, and perhaps Mr. Hughes would say if he gave the material of which the cranks were built up any special heat treatment. With straight axles there was always some difficulty in ascertaining the character of the flaw. The flaw tended to creep round the whole circumference of the axle when a flaw occurred, and he would be glad to know what had been the Lancashire and Yorkshire Company's experience. The life of tires was to a large extent bound up with the wear of the flange, and Mr. Hughes had not mentioned if he had experimented with tires of higher tensile strength than that mentioned in the paper, 46 tons with 20 per cent. elongation in 3in. Steel with a tensile strength of 65 tons to the square inch, with an elongation of 8 per cent. in 2in., had been tried by some locomotive engineers. The shrinkage mentioned in the paper, 1 in 750, seemed to be high, the more usual figure being 1 in 1100 or 1 in 1200. An interesting point not dealt with was where the water was put into the boiler, because that was where the largest amount of pitting would take place. He was surprised to see in the diagram in the paper that pitting and grooving occurred round the bottom of the copper tube plate. The information given with regard to priming was of considerable interest. Mr. Hughes showed that when the soluble salts exceeded 230 to 250 grains per gallon bad priming took place. The experience of locomotive superintendents using Belpaire fire-boxes was of interest in this connection.

Mr. E. R. Dolby, referring to the corrosion troubles mentioned in the paper, asked if the feed-water had been artificially softened, and if so, what was the hardness of the artificially softened water. He had recently been installing some stationary boilers, and dealing with water which had an original hardness of 18.5, had artificially softened it down to 3 deg. There had been considerable trouble with corrosion, and it had been decided to make the minimum 4 deg. An examination of the inside of the boiler revealed a considerable amount of rust, and the inside had been painted with graphite paint, which, it was hoped, would prove a remedy. He would like to elicit opinions as to the lowest limit to which feed-water should be artificially softened with advantage.

Mr. J. F. L. Crosland said that reference was made by the author to trials which were being carried out with the Ross-Hotchkiss scum collector and circulator. He could speak of experience with the apparatus as far as the removal of deposit was concerned, and he knew it had some merit as a circulator. He was intensely interested in the trials being carried out on the Lancashire and Yorkshire Railway, and he hoped the results would be communicated at a later date. Mr. Hughes apparently softened his feed-water, the effects upon lead being referred to in the paper, and he also dealt to some extent with the cycle of chemical reactions in connection with pitting. It had always been difficult to understand how it was that plates pitted in parts.

Mr. J. D. Twinberrow discussed the question of water spaced stays. He noted that by increasing the water space Mr. Hughes appeared to have got over the difficulty of stay breakage with the Belpaire fire-box. He knew something of the experience of a foreign railway company in connection with stay breakage. In July, 1907, that company put into service two Pacific type engines, having 48 square feet of grate area and 2800 square feet of heating surface. These engines were supplemented by 68 additional engines of the same type in 1908, and down to the beginning of the present year, when the original engines had a mileage to their credit of 70,000, and the later engines a proportionate mileage, there had been no single case of stay breakage. Objection might be taken to the Belpaire type of fire-box on account of its greater weight and cost and the obstruction which it offered to the look-out from the engine cab. It also suffered from the disadvantage that where the flat plates of the outer shell and the sides merged into the cylindrical shape of the barrel there was necessarily an appreciable amount of flat area which had no counterpart in the shape of the inner box, and consequently the stays at this part exercised a resultant pull upon the flanges of the tube plate. The circular shape was naturally in equilibrium under the internal pressure, which produced a circumferential tension in the plates, and when the load on the box roof was transferred thereto by means of direct stays a load of about 300 tons was imposed over a length of about 8ft. of plates, of about ⅝in. thickness. This counterbalanced the vertical components of the radial pressures, but the horizontal components had to arrive at equilibrium by exercising bending moments of considerable intensity upon the individual stays. Fig. 1 illustrated a

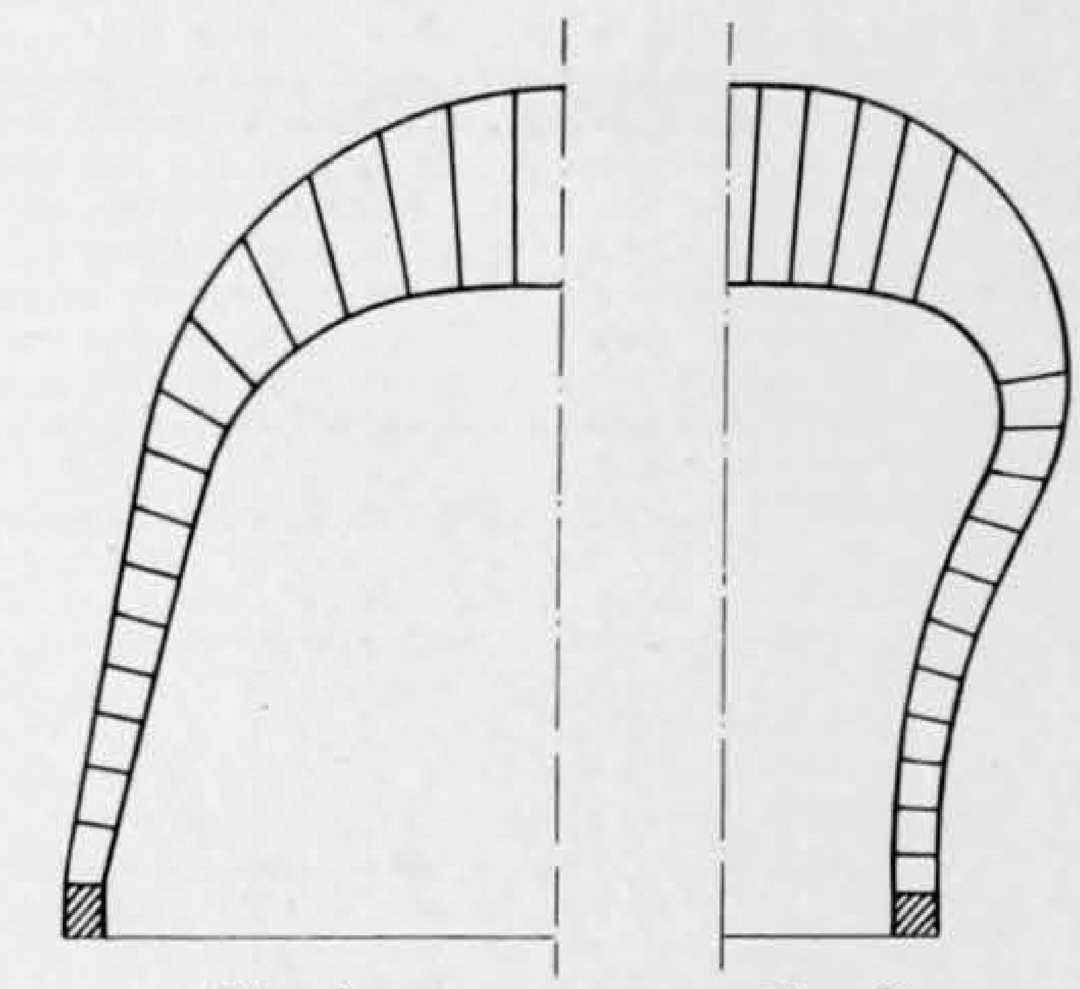


Fig. 1. Half Cross Sec. Wide Firebox with Radial Stays.

Fig. 2. Half Cross Sec. Narrow Firebox with Direct Stays.

style of construction common in the United States which had given rise to a large amount of stay breakage in modern boilers of large size. Fig. 2 was a half cross section, showing somewhat similar construction, in which the shoulders were entirely unsupported, and therefore exerted their full normal tension in the tangential direction at the landings of the outer rows of roof stays, and the upper rows of water spaced stays; the obvious cure lay in adopting the form of construction used on the Harriman lines in America, or that adopted by the Prussian State and other railways on the Continent, which employed the round top fire-box instead of the Belpaire form.

On the subject of rapid acceleration, he would point out that the compound accelerated much better at higher speeds than the simple engine. This was borne out by the speed of 96 miles per hour recorded on the Bavarian State Railway, and by a performance on the Baden line of a thirty mile run, start to stop, on a rising gradient averaging 1 in 600, at a speed equal to 75 miles per hour, a performance never equalled by any non-compound engine.

Mr. Graham Harris referred to the statement in the paper that cracks in crank axles developed from a corner, which bore out the contention made by Sir Frederick Bramwell many years ago, that if you had a sharp corner where rapid and varying stresses were experienced failure would commence at that point. In that connection he thought that locomotive engineers might learn something from the automobile industry. In automobile building eight cylinders and eight cranks were not uncommon, and the greatest possible precautions were taken in smoothing over any change of shape. Motor-car engines were subjected to much more rapid changes of direction than a railway engine, and the service was generally more severe than that of a locomotive on a railway track.

Mr. J. W. Smith said he had experience of the problems arising in road locomotion, and having used the locomotive boiler with corrugated fire-box, would like to ask Mr. Hughes whether such fire-boxes with two or three corrugations on the top would not be suitable for the rail locomotive. He was able to quote many years' experience to the effect that there had never been a failure. Tested under hydraulic pressure of 300 lb. to the square inch, the defection measured on the inside of the box was about ⅛in., and the plate always returned to within a few thousandths of its original form. With regard to cranks, it would be of great assistance if a rule could be formulated of the size of radius to diameter.

Mr. Michael Longridge said it was noteworthy that with the higher steam pressures of recent years feed-water, which formerly produced no corrosion, now had a corrosive action. It was possible, under modern high pressures and temperatures, that there was an interchange between the salt and the carbonate which resulted in the formation of chloride of magnesia, the most corrosive thing which could possibly be put into any boiler. The matter was worth experiment, but there were great difficulties, which hampered research. The blast pipe, although very useful, was a most wasteful contrivance, and he believed that by subdivision much better results could be obtained. He had recently come across a very disquieting fact in relation to forged crank shafts in making tests of a broken shaft. Three pieces had been cut from the crank web parallel to the arm of the crank and three pieces parallel to the axis of the crank pin. These were subjected to tensile and impact tests in the Izod machine, and to fatigue tests in Captain Sankey's machine. The pieces cut parallel to the crank arm broke with a fourth or less of the number of foot-pounds which were required for the pieces cut parallel to the crank pin.

Mr. C. E. Stromeyer said that engineers were more and more coming to the conclusion that boilers might be harmed by using water which had been over-softened, or had been subjected to a particular form of softening. If hard water were taken and soda put in to remove the lime and to get rid of the scale, electrolytic action was set up. Pitting was always due to some extent to galvanic action. What the engineer wanted was a method of getting rid of the scale-forming salts without introducing other salts. It would appear that aluminate of barium was produced sometimes with very unsatisfactory results.

Mr. Aspinall, in winding up the discussion, said he was pleased to notice that the boiler had been the main point discussed, as that was the only thing which caused the locomotive engineer any real trouble. On the tire question members would be interested to hear that over twenty years ago the Lancashire and Yorkshire Company had decided to use rails with the flattest possible top, and to make the curvature at the side of the rail head exactly the same as the tires. When those rails were taken up after ten or twelve years' service, sections were cut and found to exactly fit tires then coming out of the shops. Mr. Aspinall gave the details of an engine built at Wolverton in 1849, to show that even as long since as that date what would now be considered a heavy locomotive had been built.

Mr. Hughes, in replying on the discussion, said that the Joy valve gear was the standard on the Lancashire and Yorkshire, although they had recently built a few engines fitted with Walschaert gear. With regard to the blast pipe problem, they had carried a division up to the orifice of the pipe in the case of four-cylinder engines, but it was found that the plain blast pipe gave the best results. Their experience of water softening was that where good corporation water could be obtained cheaply, at 4d. to 6d., there was not much in water softening. With regard to blast pipes and chimneys, it was all a question of experiment as to the proper position and the proper pipe. Mr. Fowler had asked about heat treatment of steel of which the cranks were built up. Careful attention was paid to annealing at Horwich, the temperature of the furnaces being carefully regulated by pyrometrical methods. With regard to high tensile steel for tires, it was a compromise between the point of view of the locomotive department and the permanent way staff, and a compromise had to be made. It was true that the greatest amount of pitting took place where the water was put in. As to the artificial softening of water, Mr. Riches told him that he never softened below 6 deg. A typical water would contain carbonate of lime, 1.6; carbonate of magnesia, a trace; sulphate of lime, 1.2; sulphate of magnesia, 1.6; sodium chloride, 2.1; maximum scale-forming matter, 4.4; total dissolved solids, 9. With reference to broken stays, as a result of the introduction of wider water spaces and longer stays breakages had been reduced, and the mileage life was increased from 28,000 to 38,000, this longer life being accompanied by a considerable reduction in the wages paid for maintenance of fire-boxes. The four-cylinder compound was only adopted partially by reason of the superior acceleration. With regard to the behaviour of the compound at high speeds, his experience was that at anything over 30 miles per hour the back pressure on the high-pressure piston, by reason of cutting off at such high pressures, was the creation of a negative H.P. in the high-pressure cylinders. He would reply more fully in writing.

Mr. Arthur C. Auden then partly read his paper on "Reinforced Concrete," the discussion on the paper being adjourned until Wednesday.

The members of the Institution were entertained to luncheon on Tuesday at the Exchange Station Hotel, on the invitation of the Tramways and Electricity Power and Lighting Committee.

In view of the more popular excursions which were arranged for the afternoon, and to which we draw attention later on, the number of members who decided on accepting the opportunity of visiting the power stations at Lister Drive was fairly satisfactory. There are two stations, the engine room of each of which is 247ft. long, 52ft. wide by 37ft. high to the eaves of the roof. In No. 1 station the engines are twelve in number. They are of the Willans vertical triple-expansion type, running at 230 revolutions per minute, and giving a continuous output of 1200 horse power, but are capable of giving 1500 indicated horse-power for short periods. Automatic expansion gear and high speed sensitive governors, with speed regulating adjustment, are provided. The dynamos are Siemens multipolar machines, mounted on a bed-plate rigidly connected to the engine bed-plate, the armature shaft being carried at one end by a flanged connection to the crank shaft, and at the other end revolves in a massive bearing attached to the bed-plate. The machines are shunt wound and self-excited, and give an output of 1420 ampères at 550 volts. On either side of the engine room is a boiler house, the same length as the former, and in the centre of each boiler house is a chimney 220ft. high resting on a bed of concrete 35ft. square and 8ft. thick. These chimneys vary from 13ft. to 15ft. diameter. Each boiler house is divided into two sections by the chimney and pump room, and each contains seven Lancashire boilers and a Green's economiser. The boilers are 30ft. long and 8ft. diameter, and are fitted with Hodgkinson's mechanical stokers. Sidings from the London and North-Western Railway run alongside each boiler house, and the fuel is delivered from the trucks to the storage hoppers. The condensing water is pumped up into cooling towers as it leaves the condensers, and the ashes are raised from the stokeholds by elevators on to a storage platform, from which they are discharged into railway wagons. The switch room extends across the whole width of the building at the front end, and the flat roof of the room affords a space for the main water tanks. The switchboards are fitted with the usual measuring instruments and automatic pressure recorders. The lighting feeding mains are protected by fuses, and the tramway feeding mains by automatic magnetic circuit breakers. The switchboards are also fitted with the instruments required by the Board of Trade for indicating leakage and the fall of pressure in the tramway rails which form the return conductors. The bus bars for each service are divided into two parts, and connecting plugs for each dynamo and feeder enable the work of the station to be grouped into four divisions. The plant is divided into four independent sections, and each section is connected to a common switchboard. This switchboard is subdivided into two sections, one for the tramways and one for the lighting service, so that it is possible to work any set of plant on either service, and so regulate the work of the station that each unit may be given an equal share of the work.

The No. 2 station has been built to deal with the outlying districts, which cannot be economically served by direct current. It is generally similar in design to No. 1 station, but its output is three-phase current at a pressure of 6000 volts, which is supplied to sub-stations, where it is transformed into low-pressure direct current. The station is not yet complete, three sections only being in working order. The fourth is in course of erection. When complete the generating plant will comprise four 2000-kilowatt Westinghouse horizontal, three 2000-kilowatt and three 2500-kilowatt Curtis British-Thomson Houston vertical turbo alternators. The boiler-house equipment comprises sixteen Babcock boilers, each capable of evaporating 25,000 lb. of water per hour under ordinary conditions, and having each a total heating surface of 6182 square feet. The boiler pressure is 200 lb. per square inch, and the boilers have chain grate stokers and superheaters. Each group of four boilers is connected to a Green's economiser. In connection with the Westinghouse turbines, four Wheeler "Admiralty" pattern surface condensers are used, together with electrically-operated air and circulating pumps and a battery of cooling towers containing ten sections, each fitted with a motor-driven fan. The Curtis machines are mounted on surface condensers, each having a cooling surface of 6600 square feet, and the circulating water is cooled in towers supplied by Richardson, Westgarth and Co., Ltd. Each of these is said to be capable of dealing with 360,000 gallons of water per hour. Each station is provided with a 30-ton overhead electric travelling crane, by J. Booth and Sons, Rodley. Triple concentric distributing mains are run in duplicate to transforming stations. It may be mentioned that the quantity of energy sold last year by all the corporation's stations amounted altogether to 35,387,731 B.T.U.'s.

Three other alternative visits were also arranged. The first was a steamboat excursion on the Mersey; the next a visit to the Cunard Steamship Company's s.s. Carmania; and the third to the Diamond match factory of Bryant and May, Limited. We may say that the Carmania was described in our issue of 24th November, 1905, and that we described and fully illustrated the Diamond match factory in July, 1899.

The Institution dinner was held at the Exchange Station Hotel on Tuesday evening, Mr. Aspinall presiding over a large and distinguished gathering. The toasts, in addition to that of "The Institution," included "The City, Port, and Trade of Liverpool," and "The Engineering Interests of Liverpool."

SUBMARINES AND LIFE-SAVING DEVICES.

The loss of the Submarine C 11 on the night of Wednesday, July 14th, has served to direct attention to the fact that the boat was unprovided with appliances for saving life in the event of disaster resulting in sinking with members of the crew on board. Replying to a question in the House of Commons immediately after the news of the accident became public, the First Lord of the Admiralty informed Mr. Lee that he "assumed Submarine C 11 was provided with the safety appliances" which have been devised for use in case of disaster; but a few days later Mr. McKenna admitted that neither C 11 nor the sister boat C 17, which was in collision at the time of the disaster, had been fitted with the safety air traps, and supplied with helmets for the use of the crew. The delivery of the helmets ordered will not be completed until November next. Mr. McKenna was unable to state when the order for the helmets was placed, and it is understood that a question to elicit this information will be placed on the paper.

In view of this statement there certainly appears to be some ground for inquiry into the cause of the delay in equipping all British submarines with the simple life-saving appliances which have been available for at least two years. Nearly two years ago we had an opportunity of witnessing tests of the safety helmets at the works of the makers, at which time the appliances had been adopted for use by the Admiralty. The apparatus is so simple, and can be constructed so rapidly, that there does not seem any valid reason why an ample supply could not have been obtained to equip every submarine on commissioning. As regards the air traps, which must be constructed within the hold of the boat for use in conjunction with the safety helmets, the fitment of the screens can be effected without any delay or difficulty in the case of boats under construction, and is only a matter of the detention of the older submarines in dockyard hands for a few days or weeks.

The helmet appliance consists of a short tunic of waterproof material, to which is united a helmet containing cartridges of a certain chemical substance, which, in the presence of water vapour of the breath, gives off pure oxygen, and takes up the carbon dioxide of the expired air. In this respect the apparatus is similar to certain forms of self-contained smoke helmets for use in mines. As adapted for submarines the helmet and jacket complete weighs only 16 lb. For use in conjunction with the helmet a submarine is fitted with a pair of steel curtains or screens, one on either side of the hull, pendant from the shell plating of the main compartment. These screens are closed at either end, and extend to within about 3ft. 6in. of the deck of the boat, thus forming air traps in the event of the hull becoming flooded with water. Within these traps, which are open at the bottom, are suspended helmets for each one of the crew; each helmet is arranged with the dress tucked up inside it, and, if by any mishap the hold is flooded with members of the crew below, or the air becomes charged with chlorine gas, those in danger can quickly get under the steel screens and stand up with their heads and shoulders in the air trap and out of reach of the water. The putting on of the helmet and jacket is a matter of a few moments, the appliance being dropped over the head and the arms inserted. The tap admitting air to the oxygen-producing cartridge is then opened, and a supply of oxygen sufficient for half an hour or more is ensured.

The next step to gain safety no doubt contains some elements of excitement and danger, but any risks are preferable to the almost certainty of a horrible death which awaits those unfortunate enough to be in the hold of a submarine at the time of a serious disaster. If the accident has resulted in the formation of poisonous fumes of chlorine gas, the apparatus enables the wearers to escape through the conning towers with safety, or, perhaps, to rectify defects in the machinery. On the other hand, if, as possibly may have been the case of C 11, a collision results in the sinking of the boat with the conning tower open, the unfortunate man below rushes to the temporary shelter of the trap, and, having donned the helmet, gets under the screen, and finds his way as best he can to the open hatchway, and quickly floats to the surface. In comparatively shallow water, as, for instance, up to 20 fathoms, the ascent to the surface, when once the man is clear of the boat, presents no difficulties, and the dress itself acts as a lifebuoy which will enable the wearer to float without difficulty so long as the supply of oxygen holds out. In deep water the physiological dangers attending a too rapid ascent have to be faced. Even when the conning tower's hatch happens to be closed, it can be opened from within the sunken boat as soon as the hold is flooded to a sufficient degree to equalise the hydrostatic pressure within and without. There is another set of conditions in which the helmet may be used with good prospects of success. In the case of a boat becoming disabled when submerged and refusing to rise to the surface, the crew are able to don their helmets, and then deliberately to flood the compartment, when the hatchway can be opened, and the way of escape to the surface provided.

The trials to which these safety appliances have been subjected have undoubtedly shown that they at least offer a fair chance of safety to the men who risk their lives in the most dangerous form of warship in common use. It is stated that on one occasion when a submarine was accidentally sunk in a basin two men escaped by means of the air trap, without any helmet, but this was in shallow water, and the fore-hatch was open. The conditions which, so far as our knowledge goes, attended the regrettable accident off Haisborough are just those under which the appliances we have described would have had a fair opportunity of being utilised with success, and had the boat been equipped some, if not all, of the lives lost might have been saved.

BOOM-BREAKING EXPERIMENT.

Early on Wednesday morning experiments were carried out at Portsmouth with a view to testing the efficacy of the ordinary boom for harbour defence purposes. The destroyer Ferret, one of the older type of vessels, with engines of 4400 indicated horse-power, was dry docked recently and specially prepared for the test. Strengthening plates were fixed to either side of her bows, and these were brought to a sharp edge to facilitate the cutting of the boom. Some alterations and additions to her were also made internally, but great secrecy has been maintained with regard to these.

The boom consisted of heavy logs of timber of about 9ft. in length, the logs being bound together by strong wire rope. On the outer side long steel spikes were fixed, while both above and below the boom were stretched additional wire ropes, intended to foul the funnels, &c., and propellers respectively.

The Ferret, with a volunteer crew on board, approached the boom with a speed of about 15 knots. When quite close steam was shut off. Steering direct for the centre of the boom, she easily cut her way through it, and it is stated that it appeared to offer no resistance to her progress. The vessel herself apparently sustained but little damage. No casualties or injuries of any kind are reported from among her crew.

Specification for Standard Cast Iron Pipes.—The Engineering Standards Committee have just issued the British standard specification for cast iron pipes for hydraulic power. The committee engaged in drafting the specification met for the first time in June, 1904, and information as to current practice was sought from the principal users and manufacturers of hydraulic pipes, resulting in a mass of valuable information being placed at the disposal of the committee. It was found that cast iron pipes for hydraulic power as generally used fell naturally into two divisions, the greater number being for pressures from 700 lb. to 900 lb. per square inch, while in recent years higher pressures from 900 lb. to 1200 lb. per square inch have been extensively used. Two standard series have, therefore, been drawn up to suit these respective ranges of pressure. The committee regard 900 lb. per square inch as the maximum permissible pressure for Class A, and recommend that Class B be used when a working pressure of 900 lb. per square inch and upwards is the normal working pressure. As regards the leading dimensions, the committee have endeavoured, as far as possible, to fall in with the general practice in existing work as indicated by the replies received. In every case except that referred to below, it has been practicable to adopt dimensions which will allow pipes made to the Standard Specification to be connected to existing pipes without alteration. The only exception is in the case of the diameter of the spigot of the 6in. pipe, Class A. Two dimensions, 6⅞in. and 7in., appeared from the replies to be in equally general use, and it was eventually decided to make the diameter of the spigot of the 6in. pipe 7in., as the extra material could readily be turned off if it were required to connect the Standard pipe to one having a socket of 6⅞in. diameter,

TRAIN FERRY SERVICE BETWEEN SASSNITZ AND TRELLEBORG

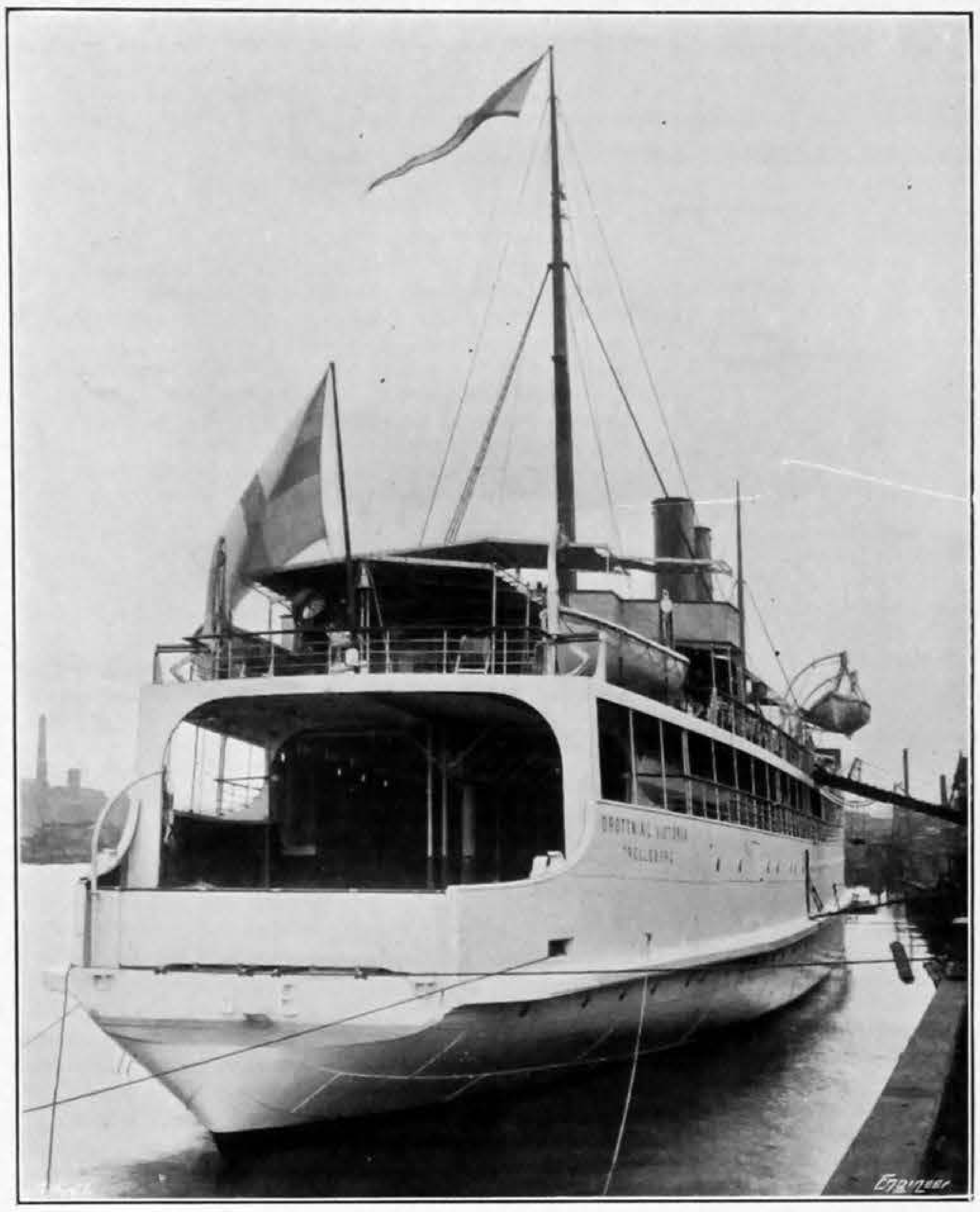


Fig. 4—THE DROTTNING VICTORIA

Fig. 5—VIEW OF TRAIN FERRY FROM LANDING BRIDGE

A NEW RAILWAY TRAIN FERRY SERVICE.

No. II.*

The steamships which have been specially built for the new joint railway train ferry service of the German and Swedish Governments, which was started on July 7th between Sassnitz and Trelleborg, are of outstanding interest, and no other railway car ferries in Europe or America are comparable to them in point of size, speed, accommodation and the provision of safety precautions. The most important American train ferry lines—those of the Père Marquette Steamship Company, the Ann Arbor Railroad Company, and the Grand Trunk Company—are over the waters of Lake Michigan, whilst, with the single exception of the 26 miles journey between Gjedser and Warnemünde, the other seven railway car ferry routes of the Danish Government are chiefly over comparatively short stretches of inland water; but separating Sassnitz and Trelleborg is a distance of no less than 65 miles of Baltic, and where at times heavy seas are to be encountered. Whilst the two train ferries built for the German Government differ in some respects from those of the Swedish Government, yet all four vessels will be of precisely the same overall dimensions and general outline, and, by the courtesy of the builders, we are now enabled to present in a two-page Supplement detailed drawings and a series of engravings reproduced from photographs and other drawings illustrative of the Drottning Victoria, the train ferry steamer which has recently been delivered to the Swedish Government by Swan, Hunter and Wigham Richardson, Limited, of the Neptune Shipyard, Walker-on-Tyne.

The Drottning Victoria is not the first railway train ferry which has been built at the Neptune Shipyard, for it was there that so long ago as 1864 the well-known firm of Wigham Richardson and Co. built a ferry to transport railway vehicles over the Rhine, prior to the erection of a railway bridge. Seven years later the same firm constructed, to the order of the Danish Government, the train ferry Lillebelt. This vessel was the first railway car ferry of a system now so complete, and it continues in regular service on the Sallingsund route. Fig. 6 gives some idea of the design and dimensions of the Lillebelt, the engines of which were supplied by the old Tyneside firm of Thompson, Boyd and Co. The cylinders are 36in. diameter and 45in. stroke. The two boilers work at 25 lb. pressure, and the total heating surface amounts to 1750 square feet. The following table of dimensions will doubtless be perused with interest:—

Lillebelt.		Drottning Victoria.
390	Displacement, tons	4270
85	Nominal horse-power	440
9	Maximum speed in knots	16½ (on service)
140ft.	Length, overall	370ft.
26ft.	Width, overall	53ft. 6in.
7ft.	Draught, loaded	16ft. 6in.
80 tons	Deadweight capacity	600 tons

In the consideration of the dimensions and proportions of the Drottning Victoria the necessity for having a very steady vessel at sea was of prime importance, and a special feature of the form of the ship is the provision of deep bilge keels in order to minimise any rolling tendencies. Briefly described, the Drottning Victoria is 370ft. long and 51ft. in the beam, and she is fitted with triple-expansion engines of sufficient power to enable her to cover the 65 miles between Sassnitz and Trelleborg within four hours. The trains enter the after end of the ship from a specially constructed quay and landing stage made exactly to suit the form of the vessel, and thus ensure perfectly smooth running and safety in embarking and disembarking. A complete train of eight bogie vehicles may be accommodated on board on two parallel lines laid to a gauge of 1.435 metres, and each having an effective length of 295ft. During shipment complete steadiness is secured by a system of trimming tanks. The landing berths consist of stone piers lined with wooden piles and connected thereto by a series of iron spring buffers. Upon reaching the basin the ship strikes against the wooden piles on one side. These yield, owing to the spring buffers, and ricochet her gently to the piles on the other side until the vessel is gradually brought to rest, firmly embedded in the structure of the wooden piles—see the two upper figures on page 108. The connecting link between the land railway and the rails of the ship consists of a bridge of steel construction—see the bottom figure on page 108 and Fig. 5—ordinary open girder work 160ft. in length, and consisting of two portals hinged at one end, with another hinge in the middle, so that the outer hinge only is used under ordinary conditions. At the seaside the bridge is provided with a large steel bolt which fits into a hole in the stern of the ferry boat, and thus rigidly maintains strict alignment between the land rails and ship rails.

Upon arrival on the car deck, the vehicles are secured to the deck by means of specially designed screws, spaced at intervals of 8ft. 8in. on the outside, and at intervals of 4ft. 4in. in the centre of the track. These are attached to gun-metal shackle plates, and then screw jacks are placed under the cars to relieve the car springs. As a special precaution during heavy seas, there is provision made for an additional screw attachment, extending from the top of the cars to the fore and aft girders of the structure of the vessel—Fig. 7. The car deck is built so as to accommodate vehicles having a height of 15ft. 3in., and a width of 11ft. 2in.—the maximum loading limits of the Prussian and Swedish State railways.

The track consists of heavy standard Swedish rails, laid in channels, and secured by cast steel chocks, and not riveted through the deck, so obviating a possibility of any leakage into the cabins below the car deck, and also constituting a portable track, and facilitating the work of renewal and repairs. Heavy girders are placed under the track to take the stresses due to the train load.

The propelling machinery of the Drottning Victoria,

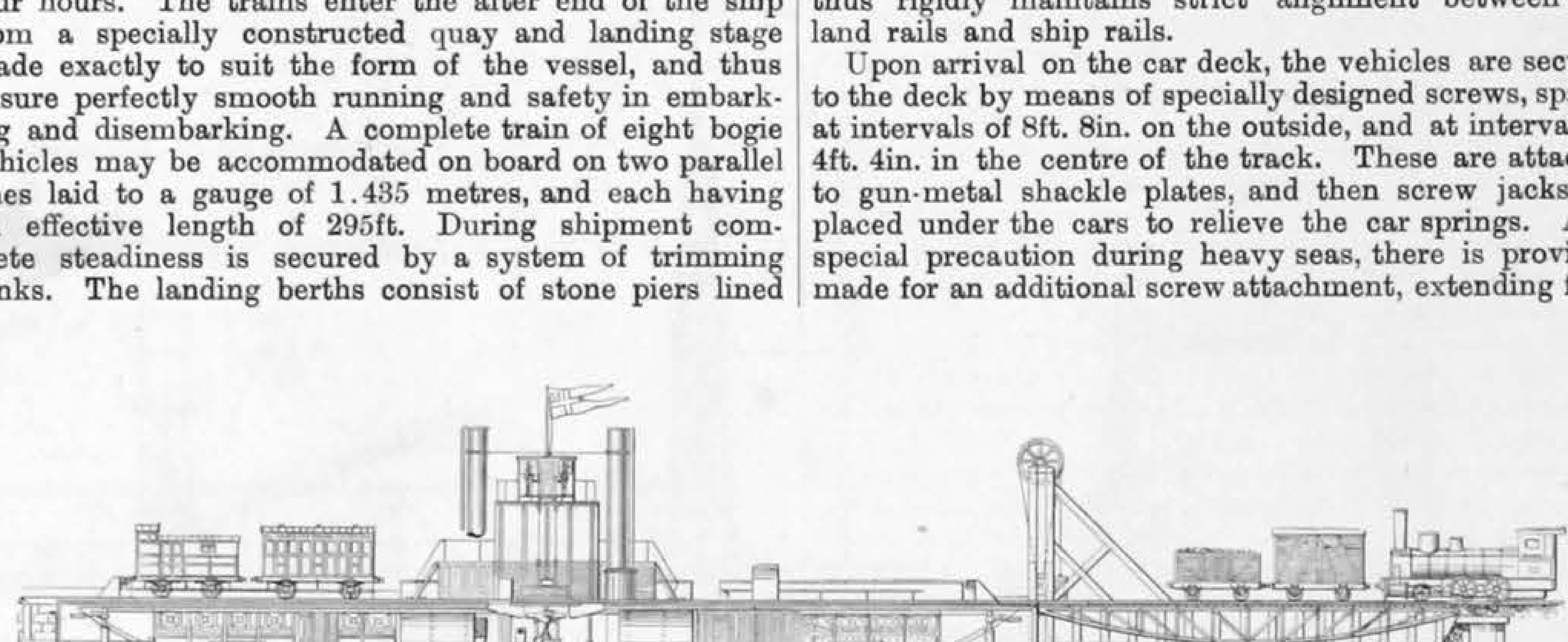
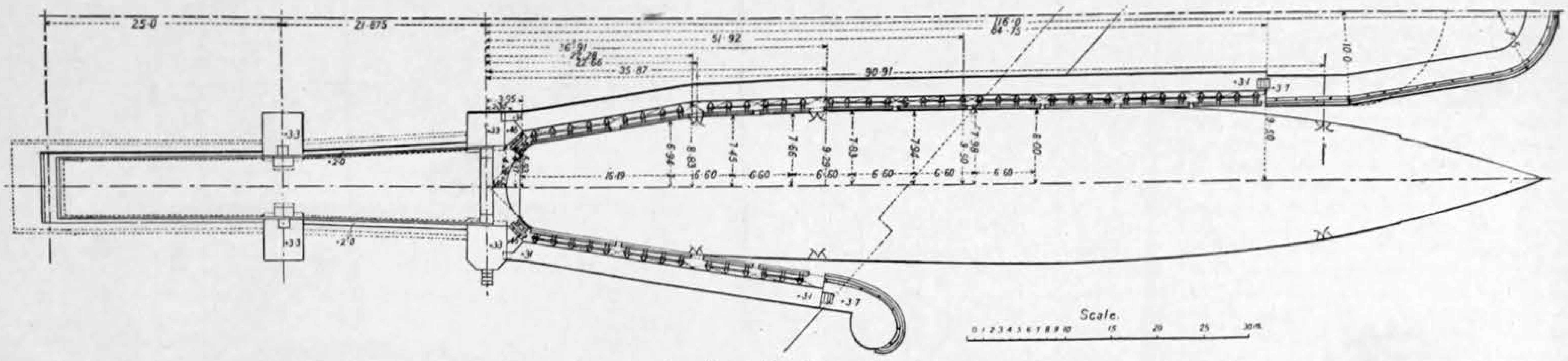


Fig. 6—THE TRAIN FERRY STEAMER LILLEBELT

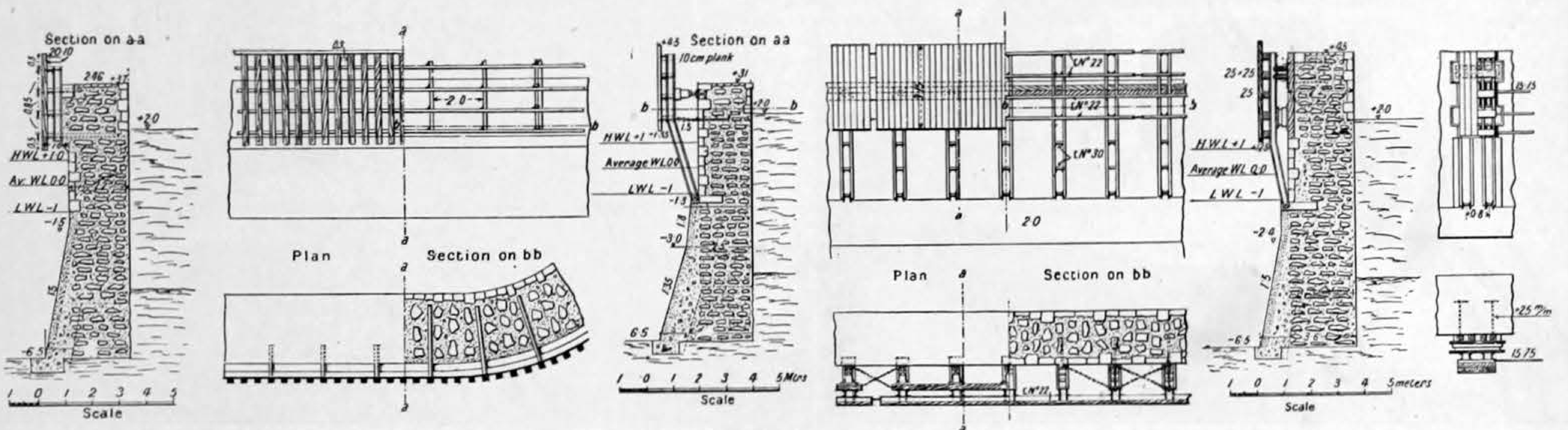
* appeared July 16th.

TRAIN FERRY SERVICE BETWEEN SASSNITZ AND TRELLEBORG

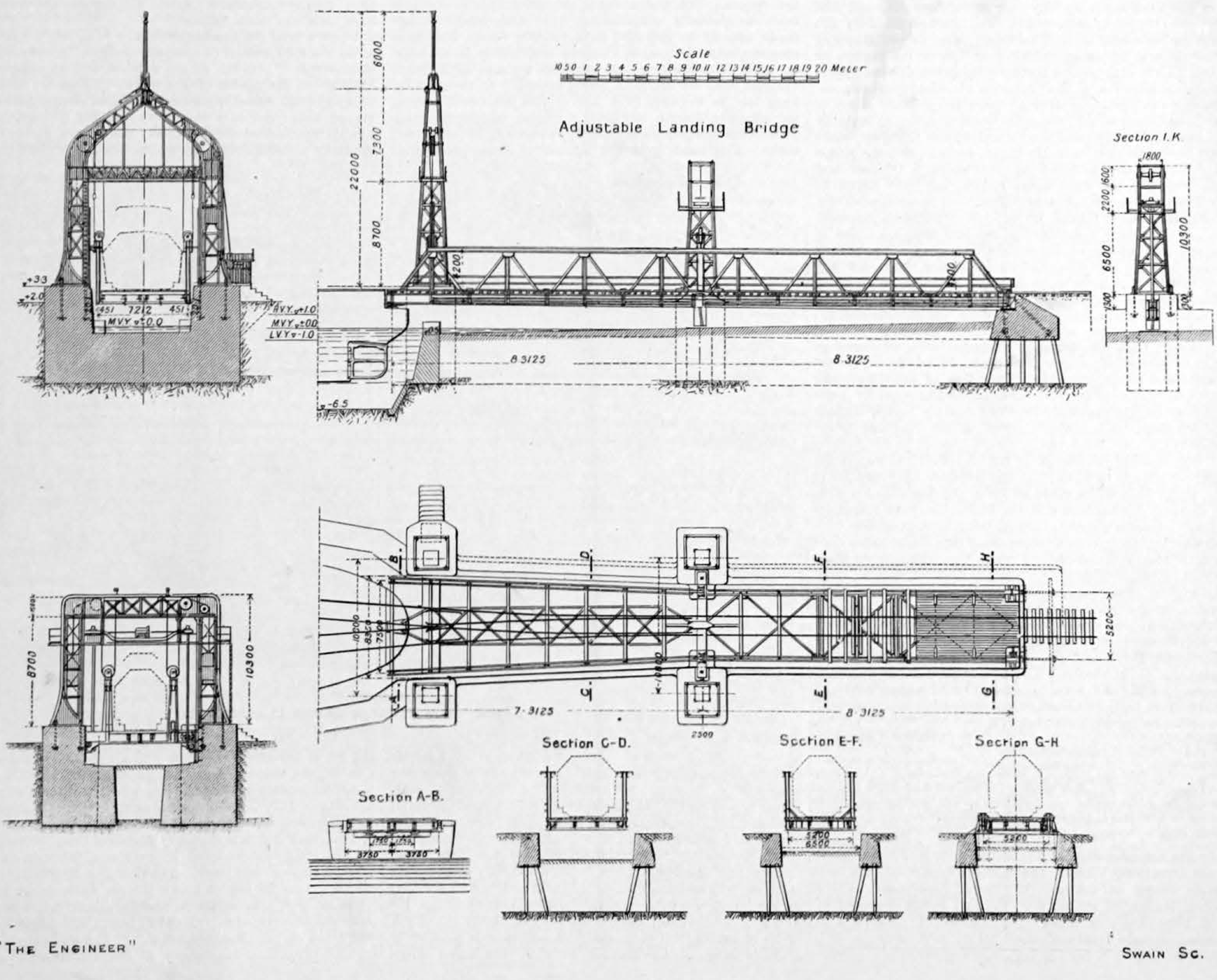
(For description see page 107)



Landing Berth.



Types of Buffers



Adjustable Landing Bridge

which was built at the Neptune Works of Swan, Hunter and Wigham Richardson, Limited, consists of twin-screw triple-expansion engines, with four boilers working under Howden's forced draught, 16ft. 4in. diameter and 12ft. long. Air is supplied to the boilers by a fan 102in. in diameter. The steam pipes of the main engines are of steel passing through separators. The main engines are of the following diameters :—23½in., 38¼in., 63in. and 36in. stroke, working at a pressure of 185 lb. per square inch. The condensers are independent and are of circular form, carried upon the back column, each being served by a large pump fitted with double engines of Drysdale's manufacture. Worked from the main engines is an Edwards air pump and bilge and sanitary pumps. The feed pumps are independent of the main engine, and are of Clarke, Chapman and Co.'s (Woodeson's) automatic type, discharging through a feed heater made at the Neptune Works. The discharge from each air pump is led into large hotwell tanks, arranged to filter the water previous to reaching the feed pump. A Sees ash ejector is fitted in each stokehold for the discharge of ashes. The engines are fitted with Aspinall's governors, and amongst other auxiliary machinery are two large evaporators and feed and ballast donkeys. The trimming tanks, one being fitted on each side of the vessel abreast of the boilers, have each a maximum capacity of 90 tons, and there is provided in connection with these a 15in. centrifugal pump—Drysdale's manufacture—which quickly empties and fills the tanks, so as to counteract the load on one of the lines of the car deck.

Apart from the system of shipping the vehicles on a separate deck, the design of the Drottning Victoria is of special interest, inasmuch as besides being a car ferry, she is provided with passenger accommodation but rarely equalled in cross-Channel steamers, and is in every respect a first-class passenger steamship having dining-room,

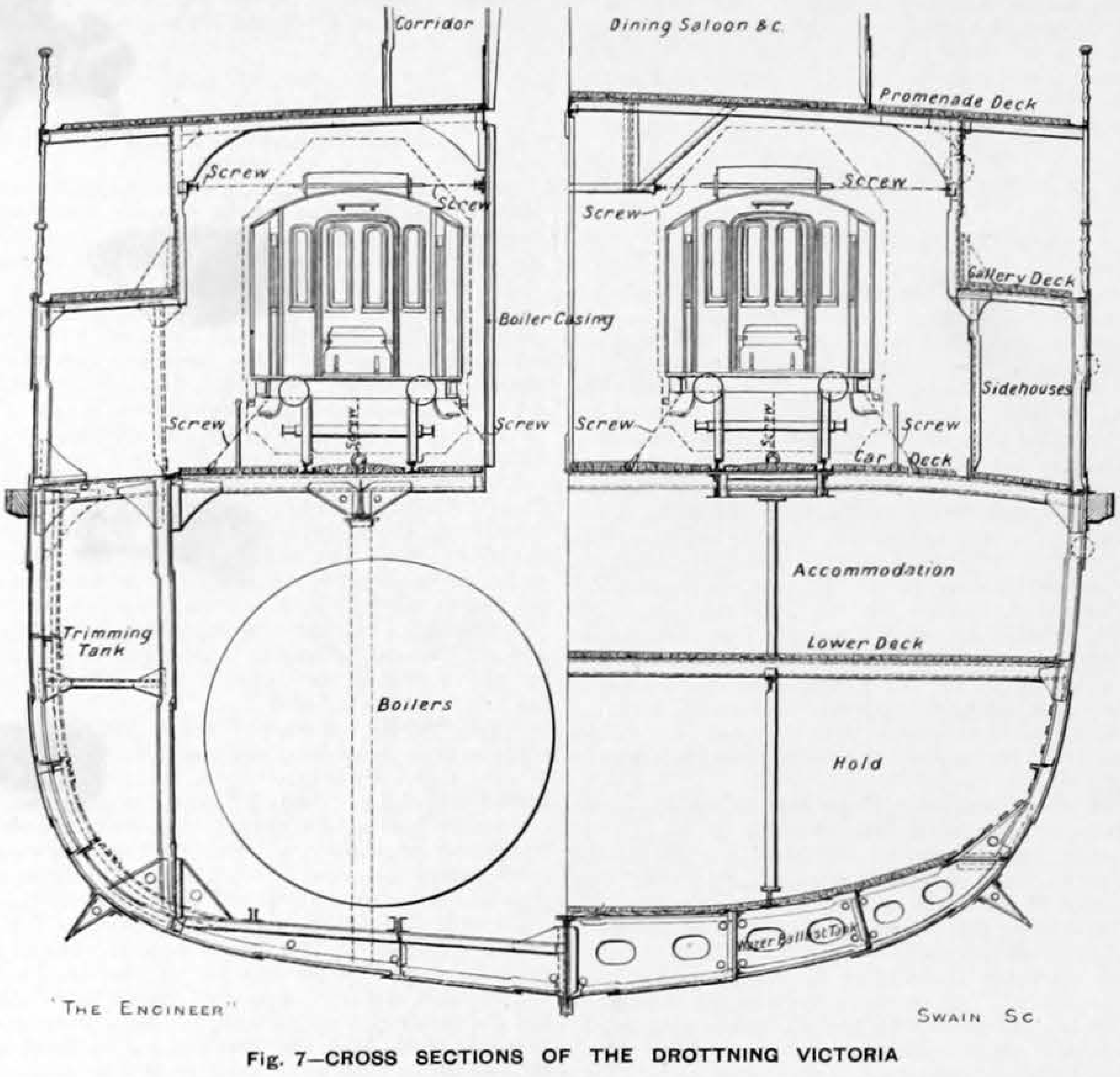


Fig. 7—CROSS SECTIONS OF THE DROTTNING VICTORIA

saloon, smoking-room, lounge, ladies' room, and regal apartments, all on the promenade deck, whilst below the car deck there is sleeping accommodation for no fewer than ninety-six first-class and forty-five third-class passengers. In the case of the night services between Berlin and Stockholm, it is probable that the occupants of the sleeping cars will not think it worth while to leave them; but as amongst the travelling public there will, no doubt, be some who prefer to move about, spacious accommodation is provided to meet their various needs. From the car deck, side entrances—one on each side—lead down to the first-class accommodation, which is situated aft of the machinery spaces. There are ten two-berth rooms, and nineteen four-berth rooms. Each room is furnished in pine, panelled and finished, enamelled white, with Molyn's japanlac enriched with gilt mouldings, the ceilings being similarly treated. Each berth has two Hoskins' folding iron beds, and an Orient spring mattress. The two berth cabins are generally of uniform dimensions, 7ft. square, and the four-berth cabins measure 7ft. by 9ft. Folding lavatories and washstands of large size are in each cabin, the floors are covered with linoleum and Brussels carpet, and there are sofa seats. The corridors are of considerable width. From the car deck two side stairways give access to the third-class accommodation, which is situated forward of the boiler spaces. There is a special apartment on the port side, measuring 32ft. 4in. by 14ft., which, by means of fourteen iron beds and eight sofa berths, provides accommodation for twenty-two passengers. This room is panelled in pine, finished enamelled white, and the ceilings are similarly treated. The floors are covered with inlaid linoleum and Brussels runners, and there are green repp sofa seats. On the starboard side is an apartment measuring 32ft. 4in. by 14ft., giving the same accommodation, and between these is the third-class dining saloon, 32ft. 4in. by 16ft. 6in. The framing is in polished ash, with oak panels and oak frieze similarly treated. The ceiling is panelled in pine, finished in enamel white, and there are seats for twenty-two passengers at a centre table. The sofa seats are of green pegamoid, and the floor is covered with green inlaid linoleum and Brussels runners. At the aft end of the dining and sleeping rooms is a large corridor leading to pantry, stewards' stores, and engineers' mess-rooms. The corridor framing is in polished oak, with ash panels and ash frieze, and the ceiling is in pine, painted enamel white. Forward of the dining and sleeping-rooms are lavatories, and the space forward of these is entirely devoted to accommodation for the stewards and crew.

Aft of the first-class sleeping-rooms, and separated therefrom by a bulkhead, is sleeping accommodation for six Customs, ten Post office, and eight railway officials and servants. These compartments are entered from the car deck by two side stairways aft. From the lower deck a grand staircase, starting from the centre of the first-class accommodation, leads to the promenade deck. The sides of this stairway are handsomely framed and panelled in polished mahogany, and the ceiling is in pine, painted in white enamel. On the car deck there are two tracks, each 295ft. in length, and forward of the spring buffers is mess accommodation for the sailors and firemen. Stairways lead to the stewards' room on the lower deck and to the promenade deck.

The port side of the car deck is devoted to a companion-way to the Customs, Post-office, and railway officials' stores, stairway down to first class sleeping accommodation, and up to the gallery deck. There are mail and sorting rooms, each measuring 23ft. by 4ft. 6in., a third-class galley, and a stairway leading to the third-class accommodation on the lower deck. On the starboard side of the car deck is similar accommodation, with the exception that rooms, measuring 15ft. 2in. by 14ft. 6in., are here provided for the Customs officials. Reached from the car deck by two side stairways is the gallery deck, which has a uniform width of 6ft. 6in., and from which stairways lead to the promenade deck. On the promenade deck there is a verandah at the aft end of the smoke-room. The smoke-room, 21ft. 8in. by 24ft. 6in., is in fumed oak, Old English in style, and in colour harmonises with the covering of the furniture, which is in blue antique morocco leather; a touch of colour is given by the inlaid metal marqueterie in the pilasters and by three beaten copper panels at the fore and aft ends of the room. The ceiling is divided into panels by the oak beams, and the panels are filled with plaster ornament in relief. An octagonal skylight is in the centre of the ceiling, and is filled with antique leaded glass, richly coloured. The fireplace at the fore end of the room has blue antique tiles, and there is a radiator of beaten copper. The floor of the smoke-room is laid with inlaid parquet linoleum, covered with blue Brussels carpet runners, and the windows are finished with festooned hangings of blue art linen.

Leading from the smoke-room is a passage to the lounge, and here are situated gentlemen's lavatory and w.c. accommodation. The lounge, 24ft. 8in. by 24ft. 6in., is treated as a drawing-room, and the woodwork is of grey sycamore, finished with a high polish in a free treatment of German Renaissance. The panels are quartered, and show to advantage the figuring of the wood. A plant stand, with panelled mirror behind, adds to the general effect of the room. The furniture is inlaid mahogany Sheraton, covered with fine French repp in two shades of rose pink, and the curtains are silk tapestry of a similar delicate shade. The carpet is Axminster, and harmonises in colour with the rest of the furniture. In this room also is provided a radiator with coloured tiles behind, and mirror and mantelshelf above. Leading from the lounge is the ladies' ante-room, which is in dark mahogany with grey panels—a contrast to the lounge colours. From the lounge access is had to the first class entrance hall which leads up from the car deck. The grand entrance, 12ft. by 22ft., is Grecian in style, and has been carried out in dark mahogany. Over the main staircase is a plant and flower gallery, in the centre of which is placed a marble bust of Queen Victoria of Sweden. Leading forward from the grand entrance is the Regal room, 10ft. 10in. by 16ft. 6in. This compartment, set aside for the exclusive use of Royalty, is carried out in the Adams style. The wood is sycamore with grey silk panels. The fireplace is richly carved, and the white tiles behind the radiator are decorated with purple Adams ornament. The decoration of the ceiling is enhanced by the provision of four domed lights set in the corners of the ceiling. The furniture is inlaid mahogany, with fine silk tapestry upholstery of delicate purple ground. The floor is entirely covered with a fine Axminster Royal grey carpet.

On the starboard side there is a main corridor in oak and teak, the floor of which is covered with green linoleum and Brussels carpet runners, extending forward to the first-class dining saloon. Leading off from this main corridor is a cosy-corner, which is fitted up with large green curtains and upholstered in green and velvet. On the port side of the main corridor are situated pantry, galley, scullery, and store-rooms. The dining saloon, 39ft. 4in. by 32ft., is treated in Italian Renaissance, and has seating accommodation for eighty persons. The woodwork is oak finished with a dull waxed surface. The panels are inlaid in coloured marqueterie. The ceiling in this, as in all the other first-class social rooms, is covered with Tyne Castle in low relief ornament and picked out in gold. There is a richly carved sideboard with silver case at the fore end of the saloon. The upholstery is in crimson buffalo hide. The floors are covered with inlaid parquet linoleum, and on this are laid crimson Brussels carpet runners. The windows, as in the rest of the first-class social rooms, are large, and of an unusual size for a ship, and give a charming and light appearance. In this room the windows are hung with cream silk tapestry curtains. Forward of the first-class dining saloon is accommodation for the captain and the first and second officers, and at the aft and fore ends are ladders leading to navigating bridges, whilst at the fore end is situated the chart-house. Six lifeboats and two cutters are situated outside the promenade deck.

The electrical equipment of the Drottning Victoria is an exceptionally complete one, and there are no fewer than 800 electric lights fitted throughout the vessel. The fittings in the public rooms are handsome, and were specially designed. Mention should be made of the brackets on the frieze of the Regal room in the Adams style, the double-light wall brackets in the lounge to suit the German Renaissance architecture, and the Old English lanterns fitted on the roof beams in the smoke-room. Each first-class sleeping berth has a lamp having two filaments, one of 16 candle-power, switched from the door, and one of 2 candle-power switched from the bed. On the car deck, besides the lights used for ordinary illumination, a large number is fitted about 2ft. above the deck and also overhead, in order to give light to the men securing the trains. At each stair or entrance for passengers' use a large illuminated sign lantern is fitted, the lettering being in German and also Swedish. In all seventeen of these sign lanterns have been provided. Two large searchlights are fitted, one at the fore end of the ship and one at the aft end. These are operated, and the direction of the beam of light controlled, by electrical means from two control pillars, one on the forward bridge and one on the aft bridge. Fresh air, heated or cooled as required, is forced through galvanised iron trunks into the accommodation by three thermo-tanks, whilst the foul air is exhausted by a number of exhaust fans arranged in connection with exhaust ventilation trunks. The exhaust system is confined to the lavatories, galleys, pantries, and store-rooms. An automatic electric goods elevator, serving four decks, is fitted between stores, pantries, and galleys.

To supply current for this installation, three dynamos are fitted, each having an output of 600 ampères at 65 volts. Each dynamo is direct-coupled to a compound engine of 65 horse-power. The electrical power is controlled by a large switchboard, mounted on marble, and arranged so that the engineer has complete control of the lighting arrangements required at any hour of the day. In order that the engineer and captain may both know the speed of the main engines, a small electric generator is driven by chain gearing from each main engine shaft. Each generator (or transmitter) is connected by electric wires to two receivers, one in the engine-room and one on the bridge, and these indicate not only the speed of rotation, but also the direction in which the propeller is revolving. The vessel is fitted with steering gear forward as well as aft, to enable it to be navigated astern as well as ahead. When steaming ahead only the aft gear is in use, but when steaming astern both the forward and aft gear may be controlled at will from the aft bridge. Each steering engine is fitted with an electric transmitter connected to indicators on the bridges, which show the angle of the rudder; thus on the forward bridge there is an indicator showing the angle of the aft rudder, but not of the forward rudder, while on the aft bridge there are two indicators, one showing the angle of the aft rudder, and the other showing the angle of the forward rudder.

There is also fitted on board the Stone-Lloyd system of water-tight doors with electric indicating lamps in the chart room. Apparatus with two telephone receivers, also placed in chart room, is provided for the detection of submarine signals. The electric bell system is so arranged that the train wiring is connected to that of the ship by a connection at the buffers, so that passengers on the train may be enabled to call the ship's stewards to attend to them. The train accumulators are also similarly replenished from the ship's mains while the train is on board, and there is steam connection at the buffers, by which means steam is transmitted to the railway vehicles whilst on the car deck. The standard compass is fitted on a long pole at the height of about 28ft. above the navigating deck, so that it is out of the range of the effect produced by the cars.

The contractors for the electrical installation were W. C. Martin and Co., Glasgow. The projectors and electric equipment were furnished by Clarke, Chapman and Co., Limited, Gateshead-on-Tyne, which firm also supplied the steam capstans and windlass. The steam steering gears (forward and aft) were supplied by John Hastie and Co.; the telemotor gear by Mactaggart, Scott and Co.; the compasses, &c., by Kelvin and James White, Limited, Glasgow; the stockless anchors by W. L. Byers and Co.; the thermo-tank installation by the Thermo-Tank Ventilation Company; the steel lifeboats by the Seamless Steel-Boat Company, Limited; the boats' davits by the Axel Welin Company, and the cooking ranges and hot press by Thomas Grieve and Co. The design of the furnishing and fittings for the social rooms on the promenade deck was entrusted to Messrs. Matkin and Speight, architects, Sunderland, and the upholstery of these and all the other apartments throughout the vessel was carried out by W. E. Harker, of Newcastle-on-Tyne.

The steaming and other trials of the Drottning Victoria took place on the measured mile at Whitley Bay, off the Northumberland coast, on June 15th, and the contract speed was then not only easily maintained but exceeded. The vessel since she has been in regular service has given further evidence of her sea-going qualities, and there seems no doubt whatever that the enterprise of the Swedish Government and the great skill and experience which has been brought to bear upon the construction of the Drottning Victoria by Swan, Hunter and Wigham Richardson, Limited, will be rewarded with the fullest measure of success.

At the official trials held last month Mr. F. W. S. Pegelow, the director-general of the Swedish State Railways, took the opportunity to express the indebtedness of his department to Swan, Hunter and Wigham Richardson, Limited, for the attention and excellent workmanship bestowed upon the vessel; and upon the occasion of the opening run from Sassnitz to Trelleborg this month the King of Sweden personally conferred upon Mr. J. Denham Christie the Order of the Wasa as a token of his appreciation of the conspicuous part which Mr. Christie, as a director of Swan, Hunter and Wigham Richardson, Limited, had taken in the construction of the train ferry.

The Drottning Victoria is under the charge of Captain C. E. Ljungberg, of Trelleborg. She was built from designs prepared on behalf of the Swedish Government by Mr. William Hok, of Stockholm, a naval architect whose name is equally familiar in this country as on the Continent.

SHIPBUILDING NOTES.

A MEASURE of some importance to shipyard workers has recently been put in operation on the Clyde, and is now proposed to be introduced in the North-East Coast yards. We refer to the "discharge-note" system, under which a workman when he leaves or is discharged from his employment will be supplied with a discharge-note certifying that he has finished his contract and returned his tools to the store. Upon entering new employment he will be required to produce this note, which will be signed by the employer he has left. This, of course, is a common enough business arrangement, not unknown in other industries, and no excuse need be made for reference to it in this place, since, if the system fulfils the expectations of those who have initiated it, there will result a better organisation of shipyard labour. It need hardly be pointed out, too, that the new system is an eminently sensible one in this respect, that it is open and above-board, and is calculated to allay instead of arousing suspicion in the worker's mind.

AT the time of writing, the summer holiday on the lower reaches of the Clyde has ended, and that on the upper reaches is in full swing. Some firms are this year making a special effort to secure a punctual re-start, and to effect this they have intimated that work will be resumed on the Tuesday instead of the Monday, and that failure to start then will be regarded as synonymous with leaving the firm's employment. It is, indeed, regrettable that so much expense should be incurred year after year by shipbuilders in respect of these futile re-starts. In this connection, we have heard of a scheme adopted with success by a large Clydeside engineering firm. The New Year holiday was contracted to a day or two and the summer holiday correspondingly extended. This was found to work well, both from the point of view of employers and employed.

TWO cases of shipping sales have recently created considerable interest, as throwing some light on the depreciation to which ships of a special class are liable. The first of these is the case of the Heliopolis and Cairo vessels built by the Fairfield Company for the Egyptian Mail Steamship Company. They were turbine, shelter-deck passenger steamers of a very high class indeed, designed for Mediterranean service, of dimensions 525ft. by 60ft. by 30ft., and steaming over 20 knots. It will be obvious that vessels such as these are not suited for any and every kind of passenger trade, and therefore no surprise was felt at the difficulty experienced in disposing of them. As stated above, however, they have now been sold. The other case is that of the much-discussed Thames steamers. The figures here are sufficiently significant, the price paid for the remaining fourteen vessels of the fleet being £5500.

ON the North-East Coast there is not much improvement to report in the general shipbuilding outlook. In the Newcastle district, the Walker yard of Messrs. Armstrong, Whitworth and Co. has had its share of the prevailing depression, but the two cargo vessels recently booked by the firm will introduce a welcome change. At Messrs. Palmer's work is proceeding on the new battleship Hercules, which is being built in the berth formerly occupied by the Lord Nelson, the firm's last contribution to the Navy. Mention of Messrs. Palmer's reminds us that the newly appointed manager—Mr. A. B. Gowan—has just been presented with a handsome testimonial from his former colleagues at the London and Glasgow yard.

IN other parts of the district the most considerable orders that have recently been placed are the two cargo steamers secured by Messrs. Craig, Taylor and Co. on the Tees, and the three vessels placed by Sir Alfred Jones with Messrs. Irvine's Shipbuilding and Dry Docks Company. The contracts were intimated by Sir Christopher Furness at the launch of the Shenga, built for Elder, Dempster and Co. by his firm. Sir Christopher took occasion to allude to the serious depression in shipbuilding and shipowning now prevalent, and made a remarkable statement to the effect that fully 50 per cent. of British shipbuilding berths were vacant at the present time.

CONSEQUENT upon the very successful work done at the Sewri-Mazagon Reclamation, Bombay, by the suction cutter dredgers Jinga and Kalu, the builders of these dredgers, Wm. Simons and Co., Limited, Renfrew, have applied for Letters Patent for a suction hopper cutter dredger, fitted with a suction pipe and cutter. This new design of vessel is called the "Simons" dredger, and incorporates a number of special features, all of which have been protected. It is claimed for this vessel with its special fittings, that she will in most cases do the same duty as a dredger fitted with a bucket ladder and chain of buckets. Having neither upper nor lower tumblers, buckets, links, nor pins, the "Simons" dredger has not so many wearing parts as bucket dredgers, and it is therefore confidently anticipated that this new type of dredger will be much less costly in maintenance and repairs. Economy in working is naturally of the greatest moment, not only to contractors carrying out large projects, but also to harbour authorities who have to meet the exigencies for deep water and other requirements in their harbours and channels to suit the dimensions, and especially draught of water, of the many large vessels built and building. In addition to dredging a channel, the vessel can carry the material dredged to some other point where ground requires to be reclaimed, and can then lift the material out of its hopper and deposit it on the shore or over a quay wall; or the material can be discharged through the doors in the bottom of the dredger.

EXPLOSIVES.

THE annual report of his Majesty's Inspectors of Explosives for the year 1908 has just been issued. From the perusal of Part VIII., which has reference to accidents in this country, we notice that the number of accidents by fire or explosion of which the department had cognisance during the year was 392, causing, so far as is known, 44 deaths, and injuring 402 persons. The total number of accidents shows a decrease, viz., 392, against 414, and is above the average 347 for the last ten years, and is also above the average 374 of the last eight years. The number of deaths from accidents is less than in 1907, viz., 44, against 63, and is less than the decennial average 53·3. The number of persons injured last year was 402, as against 422 in 1907, and is considerably above the decennial average 366·4. It is also above the average 395 of the last eight years. The instructions issued in 1900 under which H.M. Inspectors of Mines now report all accidents in the use of explosives, irrespective of the nature of the explosive involved, necessarily have the effect of making the figures larger than they had been before 1901, and make them appear disproportionate to those of former years.

It is to be noted that over 92 per cent. of the accidents, causing death or personal injury, occurred in the use of explosives under miscellaneous conditions to which the controlling provisions of the Act do not apply, and that such accidents caused 39 out of the 44 deaths, and 369 out of the 402 cases of injury; this leaves a balance of 27 accidents causing 5 deaths and injuring 33 persons in manufacture, storage, and transport, these being the conditions to which the Act does apply. The result in the number of persons killed is three less compared with the previous year, viz., 5, and the number of persons injured shows an increase 28 to 33. The number of such accidents is the same as in 1907, viz., 27.

The accidents in factories for explosives numbered 57, which is above the average—53·8—for the last ten years. The number of deaths in manufacture was three. The annual average of deaths for the decade now stands at 7. There were five ignitions of ballisite during the operation of rolling, but in only one case did a work person sustain injury. It is noteworthy that all these ignitions took place in the same factory and within a short time of one another. There were two accidents in connection with the manufacture of cordite, neither of which was attended with personal injury. One was due to the ignition of a shell which was being rolled. The other occurred at Cliffe on April 1st, when a cordite stove built on the cellular system became ignited. The contents of nine compartments were destroyed. The actual cause of the fire could not be conclusively determined, but it appeared probable that it was due to the ignition of a piece of cordite which had fallen on to the gauze over a steam pipe. The steam pressure at the stoves was about 60 lb. per square inch, giving rise to a temperature of about 300 deg. Fah. One accident occurred during the manufacture of dynamite cartridges. While two girls were filling cartridges with "dynamite pumps" an explosion occurred. There is little doubt, the report states, that the kieselguhr in this dynamite contained large pieces of quartz, in some cases one-tenth of an inch across, and the explosion was probably due to one of these pieces being jammed between the plunger and the socket. Another accident, which like that just referred to, forms the subject of a special report, occurred at Roslin during the conveyance within the factory area of a 50 lb. box of gelignite. It was thought to be due to the faulty construction of the 5 lb. inner packages. An experimental nitro-compound was being pressed in a cordite press when an explosion occurred. The ignition, it is stated, was probably due to the use of a washer in the press which was high to gauge. Ten accidents occurred in connection with the manufacture of detonators. Eight of these, all of which occurred in the factory at Polmont, were unattended with personal injury. The excellence of the arrangements at this factory for the protection of the workpeople from injury was again demonstrated.

Of the other accidents one occurred at Faversham during the operation of a hand-sieving, by which two persons were injured, and the other occurred at Chesterfield, by which four persons were injured. In the former case, while a workman was sieving by hand 100 pressed No. 6 detonators in a hair sieve over water in order to remove any loose composition, an explosion occurred, and was communicated to 100 unpressed detonators in a jig on the pressing machine. The second lot was about 5ft. distant from the first lot of detonators and in the same compartment of the hut. No other explosive was present. The foreman had just entered the compartment, and he and the workman were both injured. The cause of the accident, the report states, was probably that a small portion of dry composition adhered to a capsule, or to the hair mesh of the sieve, and was detonated by the friction set up in the sieving. In the case of the other accident one of the workwomen was pulling a jammed fuse out of a detonator when an explosion occurred, and was communicated to 122 detonators on the table in front of her. The report states that the accident was probably due to a streak of composition in the interior of the capsule of the detonator, and the friction caused in pulling out the fuse.

Nine accidents occurred in firework factories, but only one of these calls for special comment. In this instance some packages of self-igniting aluminium torches were lying unloaded from a van when the case ignited spontaneously. The authorised composition of aluminium torches does not admit of the use of an igniting tip. These are some of the most interesting accidents which occurred in factories. The number of accidents which occurred during the year in keeping explosives is given as 5, against 10 in 1907. In one case a youth of sixteen was making chemical experiments in his father's house at Weymouth, when an explosion occurred, blowing off his left hand, and inflicting serious injuries from which he died in a few minutes. There were no accidents during conveyance outside factories throughout the year. The number of accidents grouped under the heading "Uses and Miscellaneous" is less than that for 1907, viz., 330, against 360. By these accidents 39 persons were killed and 369 injured, as compared with 55 killed and 394 injured in 1907.

MANSFIELD WATER SUPPLY.

ON Wednesday, last week, the formal opening ceremony took place of the new waterworks recently constructed by the Corporation of Mansfield for the supply of the borough and the adjoining districts supplied by them under agreements. The town has hitherto been supplied by the Rainworth pumping station, erected about thirteen years ago, but the growth of the town in consequence of the development of collieries in the district has been so rapid that a further supply from another watershed became imperative, and an Act was obtained by the Corporation in 1905, and a well sunk in the new red sandstone at Clipstone, about 5 miles north-east of Mansfield.

The new works are designed for a similar duty to that of those at Rainworth, namely, 750,000 gallons per day. The contract for the well specified that it should be sunk to the depth of 150ft., and headings driven from the bottom, but water was obtained so freely that it was unnecessary to carry the well to the full depth or drive the whole of the headings provided before the test quantity of 1,680,000 gallons per day was continuously pumped. Borings were also put down further to increase the yield, so that the designed quantity might be maintained after many years of continual pumping.

When the well had been proved to the satisfaction of the corporation's consulting engineer, Mr. F. Walter Hodson, M. Inst. C.E., the erection of the permanent works was proceeded with. The pumping station is a compact and substantially built block placed immediately over the well, comprising engine-house, 38ft. by 28ft., boiler-house, coal store, fitting shop, and store. The fitting shop communicates with the engine-room, and is provided with lathe drill and other tools for maintaining the machinery in first-class condition, and effecting all ordinary repairs. The engine driving the tools also drives the dynamo for the electric lighting of the pumping station. A pair of cottages have been erected on the site for the accommodation of the engine-drivers. The pumping main, 15in. diameter and 5 miles long, is connected to the existing gravitation main from the reservoir, so that water is pumped direct from Clipstone to the town, any excess over the consumption for the time being passing direct into the reservoir.

The pumping machinery consists of two duplicate sets of compound surface-condensing steam engines, each driving through gearing a set of treble-barrel deep well pumps of the stand-pipe type, and has been manufactured by Tangyes Limited, of Birmingham. Each set is capable of pumping 40,000 gallons per hour a total height of 468ft. to the reservoir. The steam cylinders are 12in. and 21in. diameter, with the stroke of 24in., the steam pressure being 125 lb. per square inch. A pair of steel Lancashire boilers are installed, and a 4-ton overhead traveller fixed in the engine-house. The pumping station is connected by telephone with the offices at Mansfield, and also with the Rainworth works, and an apparatus is provided for showing a continual record of the water level in the reservoir, and also in the well, and a Venturi meter fixed to check the pumping and assist in prevention of waste. The total cost of the works, including land, will, we understand, be under £30,000.

ENGINEERS AND SMOKE ABATEMENT APPLIANCES.—On Saturday afternoon (17th inst.) about thirty members of the Rochdale and District Motive Power Mutual Improvement Society visited the works of Ed. Bennis and Co., Limited, Little Hulton, Bolton. They were conducted through the shops by Mr. A. W. Bennis, and shown the different branches of coal and labour-saving apparatus in their various stages of manufacture. Amongst the objects of attention were the Bennis machine-stoker, fitted with natural draught furnace, the same apparatus fitted with self-cleaning compressed air furnace, the firm's improved smokeless chain grate stoker, various elevating and conveying plants in course of erection, and the moulding appliances installed by the company for the production of its own castings. Other apparatus inspected were the new balanced shovel arm, and also the improved 1909 model high-duty smokeless and gritless coking stoker fitted with a self-cleaning compressed air furnace.

RAILWAY MATTERS.

FROM a report of comparative tests made by an American trunk line on the new ferro-titanium steel rails and those of the Bessemer type it is noted that the wear on the former showed 1.45 lb. per yard, as against 4.18 lb. per yard on the latter, which is nearly 300 per cent. in favour of the new alloy steel.

THE Earl of Scarborough, presiding at the ordinary meeting of the Niger Company, Limited, said the Baro-Kano Railway had been pushed on with extraordinary rapidity. Over 100 miles of rails had been laid, and it was expected that the remaining 300 miles to Kano would reach completion during 1911.

THE electrified portion of the Brighton Railway between Peckham Rye and Victoria Stations will, it is understood, be opened early next month, and it is expected that the full service between Victoria and London Bridge will be in operation by October 1st. Naturally, fares on this section will be revised to take advantage of the new system of working.

Two American railway engineers have just completed a journey from Edmonton to Prince Rupert over the proposed route of the Grand Trunk Pacific. Mr. Parker, the former chief engineer of the Rock Island system, one of the travellers, was greatly pleased with the route selected. He says that easy grades have been secured, so that the company will be able to work the mountain section at a comparatively low cost.

GOVERNMENT surveyors are engaged in carrying out a survey for a tunnel which is to be pierced through the cliffs, giving Dover Naval Harbour access by rail from the eastward, which it does not now possess. This would bring the dockyard centres of Chatham and Sheerness and the Kentish garrison into close touch with the Navy at Dover. The tunnel would be very valuable for sending ammunition and stores direct to the fleet.

AN order for two goods locomotives, to be employed on main line work, has been placed by the New York, New Haven, and Hartford Railroad Company. One of these locomotives is to be equipped with side rods, and the other is to be of the geared type. It is understood, states the *Electrical Engineer*, that tests will be made with these locomotives to determine the relative performance of electric and steam locomotives for goods service and the relative advantages of the two types of locomotives which are to be employed.

THE Grand Trunk Pacific Railway (Canada) has commenced a novel undertaking whereby a record of the growth of the West so far as the railway is a factor in its growth will be kept. The official photographers of the company have begun to work on the plan of the company, and towns along the line will be photographed, each photograph being duplicated yearly, so that a continuous record may be obtained and kept of each individual town from the time it sprung up throughout the period of its growth. The record kept is expected to be of invaluable importance in years to come.

THE North-Eastern Railway, like its other two partners in the East Coast route, still believes in the efficiency of the Atlantic type of express locomotive. Some ten more of these are about to be built to haul the heavy East Coast expresses between York and Edinburgh. They will have coupled wheels of 6ft. 10in. diameter, bogie wheels of 3ft. 7¼in., and trailing wheels of 4ft. diameter. The wheel base will be 28ft. in length and the cylinders 20in. by 28in., and piston valves will be used. The boiler will have a total heating surface of 2455 square feet. The weight of the engine in working order will be 72 tons and the tender 43½ tons, with a capacity for 4125 gallons of water and five tons of coal.

THE Pennsylvania Railway is planning to set out more than 1,000,000 trees. This will make a total of 3,430,000 trees planted in the last three years to provide for some of the company's future requirements in timber and sleepers. This constitutes the largest forestry plan yet undertaken by any private corporation. Heretofore, the company's forestry operations have been confined to a limited area between Philadelphia and Altoona. This year, however, 65,000 trees are being set out on tracts of land near Metuchen and New Brunswick, N.J. In addition, there are to be planted within the next month 207,000 trees near Conewago, Pa., 186,000 in the vicinity of Van Dyke, 334,000 at Lewistown Junction, 7000 at Pomeroy, and 205,000 at Denholm.

THE following information is from the report by H.M. Consul at Helsingfors—Mr. C. J. Cooke—on the trade of Finland in 1908, which will shortly be issued:—"For new railway lines a sum of about £380,000 has been granted. It is proposed to build a line through Vichtis to Högfors, forming a continuation of the projected line from Sockenbacka, near Helsingfors, to Nurmijärvi, north-west of Helsingfors. So far the project has reached the preparatory stage only, there being many difficulties in the way. The Finnish Senate have decided that a railway should be built from Seinäjoki station to Kristinestad and Kaskö, but the course of the line is not fixed yet. The line would begin at Seinäjoki, and run along the Kyrö River to the village of Perälä, where it would fork off into two branches.

THE railway from the Piræus to the Turkish frontier (246 miles) may be said to be practically completed, the section from Bralo to Larissa having been opened to traffic since October last, and trains now run in twelve hours from Athens to Larissa. The construction of the final section of 28 miles to the frontier is in an advanced state. There remains, then, in order to release Greece from the isolation which she is the last of European States to suffer, but 70 miles between the frontier and the nearest station on the Ottoman railway system. There appears no indication, however, of any disposition on the part of the Ottoman Government to facilitate the construction of the junction line, and it will be regrettable if the reformed Government of Turkey continues to oppose a project so evidently appertaining to an era of civilisation and progress.

ON December 12th, 1908, states a consular report, the new Mexican Central Railway line from Guadalajara to the sea port and harbour of Manzanillo, *viâ* Colima, was formally declared open for traffic by the President of the Republic, General Porfirio Diaz, although trains have been running regularly since November 2nd. The opening of this new line, built at a heavy cost, and the completion of which has been delayed time after time by disastrous floods, marks the commencement of a new era in the history of Mexico. The entire Pacific coast, one of the richest districts of Mexico, has hitherto been neglected, undeveloped, and only partially known to the civilised world owing to its remoteness and difficulty of access. With the new railway, Colima, which is the largest city on the Pacific coast, is brought within 24 hours of the city of Mexico.

REINFORCED concrete telegraph poles have now been in use on the Pennsylvania Lines West for two years, and while erected in only a few places, are reported to be giving satisfaction where sufficient time for observation has elapsed. The first poles of this description, erected near Maples, Ind., were built after an elaborate series of experiments on both wooden and reinforced concrete poles, which were described by Mr. Robert A. Cummings at the 1907 meeting of the American Society for Testing Materials. These poles are still in service, and though they were within the belt of influence of the severe sleet storm of February 15th of this year, none of them showed any signs of failure. The latest installations are those near Crestline, O., and through the town of New Brighton, Pa. The poles are 30ft. long, 14in. in diameter at the bottom and 6in. at the top, and at present carry one cross-arm, accommodating eight wires.

NOTES AND MEMORANDA.

IN 1907 the United States produced 166,000,000 barrels of oil, and in 1908, according to unofficial estimates, the total was in excess of that amount. The United States produces 63.12 per cent. of the entire oil production of the world.

ALUMINIUM paint is made by blowing air or gas through molten aluminium while it is setting and at the same time stirring violently. This forms a spongy or granulated metal that is easily pulverised. The powdered metal is sized and polished.

THERE were 32 dredges at work in New South Wales at the close of 1908, in the recovery of tin ore, or stream tin; three being bucket dredges and 29 pump dredges. The quantity of stream tin saved during the year was 1562 tons, of £126,480 estimated value.

A RUST-PREVENTING coating for iron, used by a German manufacturing company, consists in coating iron and steelware first with lead, then electrolytically with zinc, and finally heating this coating, so as to obtain an alloy of the two metals which has the same potential as zinc.

A NEW pyrometer for the measurement of high temperatures, known as the Féry spiral pyrometer, has been brought out recently. The new instrument is simple in principle and construction. Instead of the heat rays being concentrated on a thermo-electric couple, as in earlier instruments, they are focussed on a small bi-metallic strip made of two metals rolled into the form of a spiral, which unrolls when heated, owing to a difference in their coefficients of expansion.

AN interesting experiment to determine whether the strength of iron and steel was affected by magnetism was carried out at the Technical Institute of Belfast with the following reported result:—Bars of mild steel and wrought iron 8in. long by ⅛in. to 1in. in diameter were used, part of which were magnetised by being saturated in a solenoid. When tested, the elongation of the magnetised parts decreased 3 to 16 per cent., and the average breaking load seemed to be increased.

THE mica produced in the United States during 1908 amounted to 972,964 lb. of sheet mica and 2417 short tons of scrap mica, with a total value of £53,585. In 1907 the production of sheet mica was 1,060,182 lb., of scrap mica 3025 tons, and the total value was £78,422. The average price of sheet mica in the United States during 1908 was 24.1 cents per lb., as compared with 33 cents in 1907. North Carolina is the largest producer, supplying in 1908 599,234 lb. of sheet mica and 1308 short tons of scrap mica.

THERE are in the United States over 250 makers of automobiles, and this number does not include makers of commercial motor vehicles and trucks. In short, it refers to makers of cars primarily for pleasure purposes. Upward of 100,000 workpeople are directly engaged in these factories, and not less than 4000 allied industries and works are more or less dependent upon the motor-car industry. Truly this is remarkable growth, and if, by reason of its years, this is still an "infant industry," all must admit that it looks like a thriving infant.

A REPORT on the resistance of rivets is presented by M. Ch. Fremont to the *Bulletin de la Société d'Encouragement* for April. It is pointed out that the resistance of riveted plates to statical forces or shocks should be borne as much as possible by the adhesion of the plates, and as little as possible by shearing of the rivets themselves, and the author emphasises the necessity of standardising the heads of rivets and of regulating the maximum temperature during the process of heating, so as not to destroy the elastic qualities of the rivet. The increased efficiency obtained by the application of continued pressure during the riveting is also mentioned.

A MONOPLANE of a new type, designed by Mr. John Neale and housed in a shed on the Aëronautical Society's ground at Dagenham, has been recently completed. The machine consists of a triangular girder of spruce stayed with steel piano wire. At the front end, in solid wooden supports, is the engine, of 12 horse-power. At the extreme front of the machine is the 6ft. 6in. wooden propeller, geared to the engine to revolve once to every three revolutions of the latter. The main plane is 18ft. across by 5ft. in width. At each end of the plane are vertical wooden fins to "hold" the air, and, slightly to the rear, at each extremity are disposed "flaps" for steering and equilibrating. The tail consists of two superposed planes with a vertical rudder behind.

CONSIDERABLE finds of asbestos have been made in the Urenberg district, covering large areas and of great body and fine quality. The discovery refers to two places named Peyan-Tchin and Ak-Zigit respectively, the area of the latter asbestiferous ground being estimated at 48 square versts. The deposits are found in the form of large strata of serpentine lying amongst silicious schist and porphyry. The strata are intersected by many veins of serpentine which contains the asbestos. These veins in many cases rise right to the surface, and where the ground is stony and there is no soil on the top they are quite visible. The veins extend to various lengths, varying from 350ft. to 1400ft. and even 2100ft., and it has been found that at that depth the mineral does not change in form and that the quality rather improves. The fibre taken singly seems to be quite white, but in the bulk the colour is olive green. It is beautifully soft and woolly. The land on which the discovery has been made is in the Orsk district.

IT may be affirmed, states a consular report, that the State of São Paulo has been the cradle of the utilisation of hydraulic power in Brazil for generating electricity. That at present, however, turned to account is but insignificant in comparison with the immense undeveloped resources which the State possesses in the numerous large waterfalls, mostly State property, and to a large extent still unexplored. The principal hydro-electric installations constructed in the State are that of the São Paulo Tramway, Light, and Power at Parnahyba, with a capacity of 8000 horse-power, and those of various other companies, viz.:—Jundiahy, generating 1000 kilowatts; Sorocaba, 1000 kilowatts; Rio Claro, 580 kilowatts; Mococa, 500 kilowatts; Piracicaba, 450 kilowatts. The important hydro-electric station in course of construction by the Santos Dock Company at the Itatinga Falls, near to Santos, which should be completed in a year's time, will transform and transmit electric energy of 3000 kilowatts, which will be used in the working of the cranes on the quay at Santos and the supply of light and power to that city.

"WITH the advent of the airship and aëroplane as practical machines," states a contemporary, "there arises the enormous possibility of their being used for illegal purposes, namely, smuggling. Within the next year or two the science of aviation is certain to grow to an extraordinary extent, and then we shall behold a gradual revival of the old smuggling days, only by air instead of by sea. According to reports, a privately owned airship recently started from its hiding place somewhere in the south of England and calmly journeyed to Ireland in one night, encamped during the day within a few miles of a large town, and returned to its home the following night without being discovered. Now, if that is true, continues our contemporary, how simple it would have been for the owner of that airship, had he so desired, to have done a little smuggling of illicitly-distilled whisky. And so airships in their present embryonic state are in reality an unknown danger to the Customs, for who knows that there are not other secret airships in construction in this country and abroad? How the possible evil is to be encountered is a problem which the authorities should consider at once."

MISCELLANEA.

THE sixth German Dreadnought, the Ersatz Oldenburg, will be launched at Wilhelmshaven in the middle of September.

THE next international congress of mining and metallurgy is to be held in June, 1910, at Düsseldorf. The last Congress was in 1905, and the place of meeting Liège.

A CONSULAR report dealing with the trade of Japan states that machinery is one of the very few items which not only shows a substantial increase over the 1907 figures, but which establishes an easy record as regards all previous years.

ELABORATE provision has been made at Portishead for the importation and storage of motor spirit. This is a new enterprise developed at Bristol docks, which are to serve as a centre for the distribution of supplies to the West of England, the Midlands, and South Wales.

THE difficult navigation in the Sound in the winter season, on account of the ice, not only in the traffic with Copenhagen, but in the passage through, to and from the Baltic, has given rise to the idea of making a deep-water harbour north of Elsinore, at the entrance to the Sound.

THE first steel steamship ever built in the maritime provinces of Canada is under construction at Yarmouth, Nova Scotia. A great development is expected in this industry, which, in the days of wooden vessels, was such an important factor in the prosperity of the provinces bordering on the Atlantic Coast.

THE new graving dock which the Clyde Trustees propose to construct at Renfrew is, states a contemporary, hardly likely to commend itself favourably to the Admiralty, owing to its situation so far up the river, with its restricted width and depth, which would prove a stumbling-block to its use by such Dreadnoughts as might reach the Clyde in a damaged state under abnormal draught conditions—the very contingency which has to be provided against, and which a floating dock appears to be best suited to cope with.

A MATTER of great importance for Leipzig, states a consular report, is the building of a canal, which will give the town a direct waterway to the sea, and will thus facilitate commerce with foreign countries, and not least with the United Kingdom. The scheme has developed considerably in the year 1908, after careful preparatory consideration extending over thirty years. Shortly before Christmas a Leipzig company, the Leipzig Canal Company, Limited, was formed to provide capital for the initial and technical expenses of a connection between Leipzig and the river Saale.

THE Carnarvonshire County Council have passed the following resolution:—"That the attention of the Chancellor of the Exchequer be called to the unfairness of imposing a tax on petrol when used for commercial purposes, when steam motor lorries are not subject to any tax or duty, and that, whereas soft-tired motor cars have to pay a carriage duty varying at present with the weight, and next year with the horse-power, of the car, and traction engines are subject to an annual licence of £10, heavy motor cars, which do an incalculable amount of damage to the roads, are exempt from all impositions of the kind."

OWING to the extreme lightness of the hull plating of torpedo craft, it has been found necessary strictly to carry out the "drill testing" of the bottom plating of these vessels periodically, in order to check deterioration and ensure their being maintained, as regards the hulls, in a state of efficiency. Postponement of these important tests having recently led to the development of weakness in certain cases, with consequent leakage, thus necessitating special docking, orders have been issued that in future the instructions governing the tests are to be strictly adhered to, advantage being taken to carry out the drill tests while the vessel is in dock for her regular overhaul of the underwater fittings.

As the result of several representative meetings of electrical engineers held recently, it was considered advisable to form a South African Institute of Electrical Engineers, and at a largely attended meeting, held on the 12th inst. at the Grand National Hotel, Johannesburg, the Institute was duly founded, and draft rules approved. A provisional committee was elected to act as the council until the first general meeting of members, when the officers and council will be elected. All those joining the Institute prior to July 7th, 1909, will be considered foundation members. It is hoped that the hearty co-operation of the electrical engineers of South Africa will be given to this new society.

REPLYING to Mr. Arthur Lee, in Parliament, recently, Mr. McKenna said that neither the submarine C 11 nor C 17 carried the new safety helmets for enabling the crew to escape in the event of the vessel foundering. These life-saving helmets were a new invention, of which it had not been possible to obtain supplies sufficient to equip all submarine vessels. Delivery of the whole quantity ordered would not be completed until November next, but supplies were being distributed to submarines as the deliveries were received. The air traps required to enable the helmets to be used had been fitted to C 17, and were to have been fitted to C 11 at the first opportunity of the boat being in dockyard hands.

THE work of building the engines for submarine C 19 in the engineering factory of the dockyard has been completed, and they were recently subjected to a very severe test. No difficulty was experienced in securing the requisite horse-power, and the machinery worked smoothly. The engines will now be placed in position on board the boat which is lying in dock. Considerable progress has also been made with the building of the engines for C 33 and C 34, the last pair of boats to be ordered. It is expected that orders will be received next month for a commencement to be made with the construction of two boats of a larger and improved type. The new submarines are to be fitted for burning oil fuel.

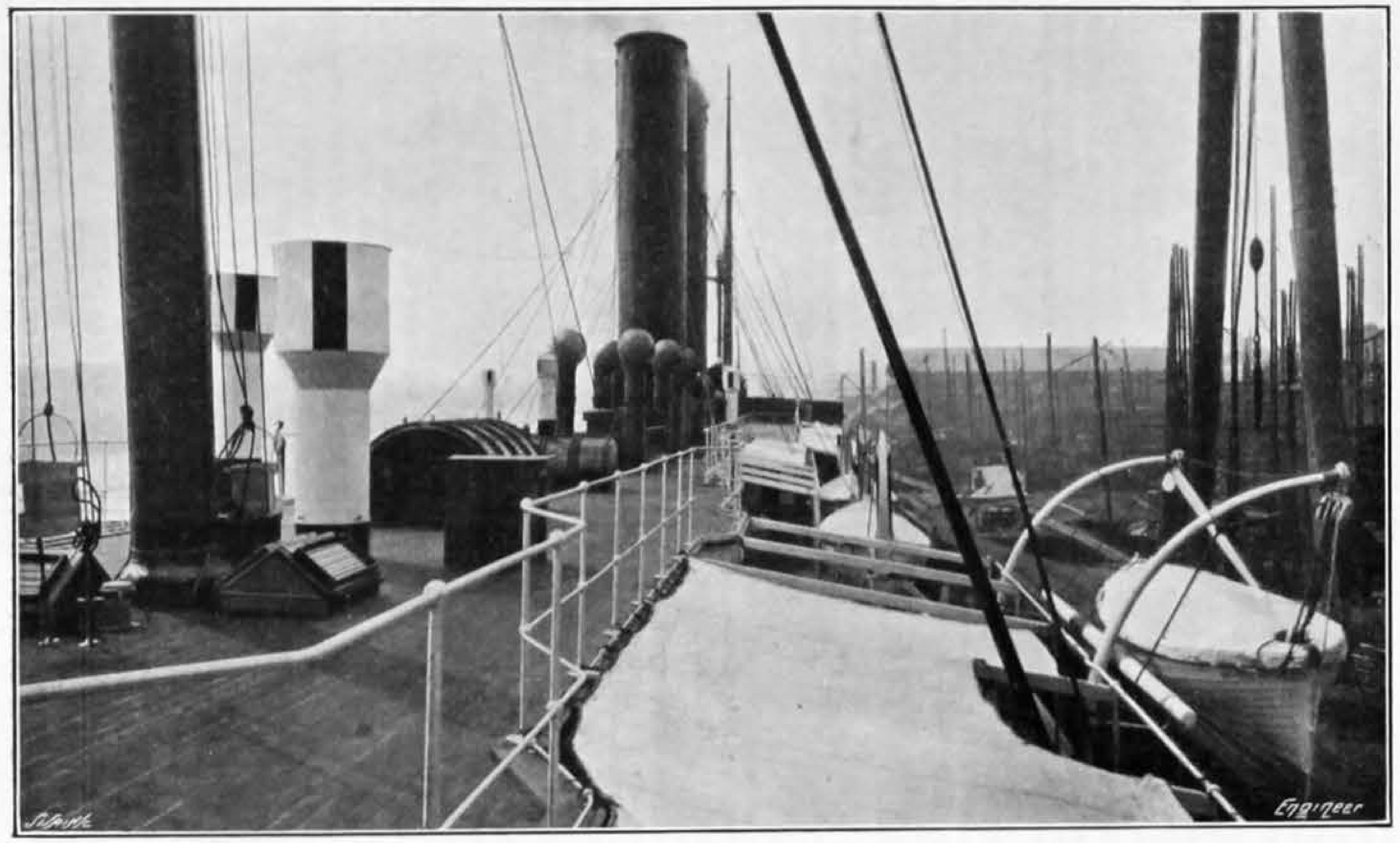
THE destroyers Bonetta and Albacore, which were directly purchased, have during the recent operations been subjected to a thorough test of their steaming and sea-going qualities, with satisfactory results. These destroyers differ considerably in design from previous vessels of the type, and may be considered as a compromise between the 30-knot and River class, possessing the curved deck of the former and the high bow of the latter class. They differ, however, from both classes in having the upper strake of plating hollowed out to form a "flam" bow, which gives them a very striking appearance, and steadies the vessel when pitching. The stern section of the Bonetta and Albacore is almost identical with that of the Scout class. They are now being prepared for receiving their gun and torpedo armament.

IN the House of Commons recently, Captain Craig asked the First Lord of the Admiralty whether the Great Central Railway Company had at any time offered to construct a dry dock on the East Coast at Immingham, capable of accommodating a battleship of the Dreadnought class, for a yearly subsidy or for the difference in price between such a dock and one satisfying commercial requirements; if so, when was such an offer made; and had it been accepted by the Admiralty? Mr. McKenna said that an offer had been received from a company in close connection with the Great Central Company to construct a dry dock for a yearly subsidy. It was made last month, and was declined, as the subsidy was so high as to be prohibitive. Mr. Renwick (U., Newcastle-on-Tyne) asked if negotiations were still going on. Mr. McKenna said that he could not answer that question.

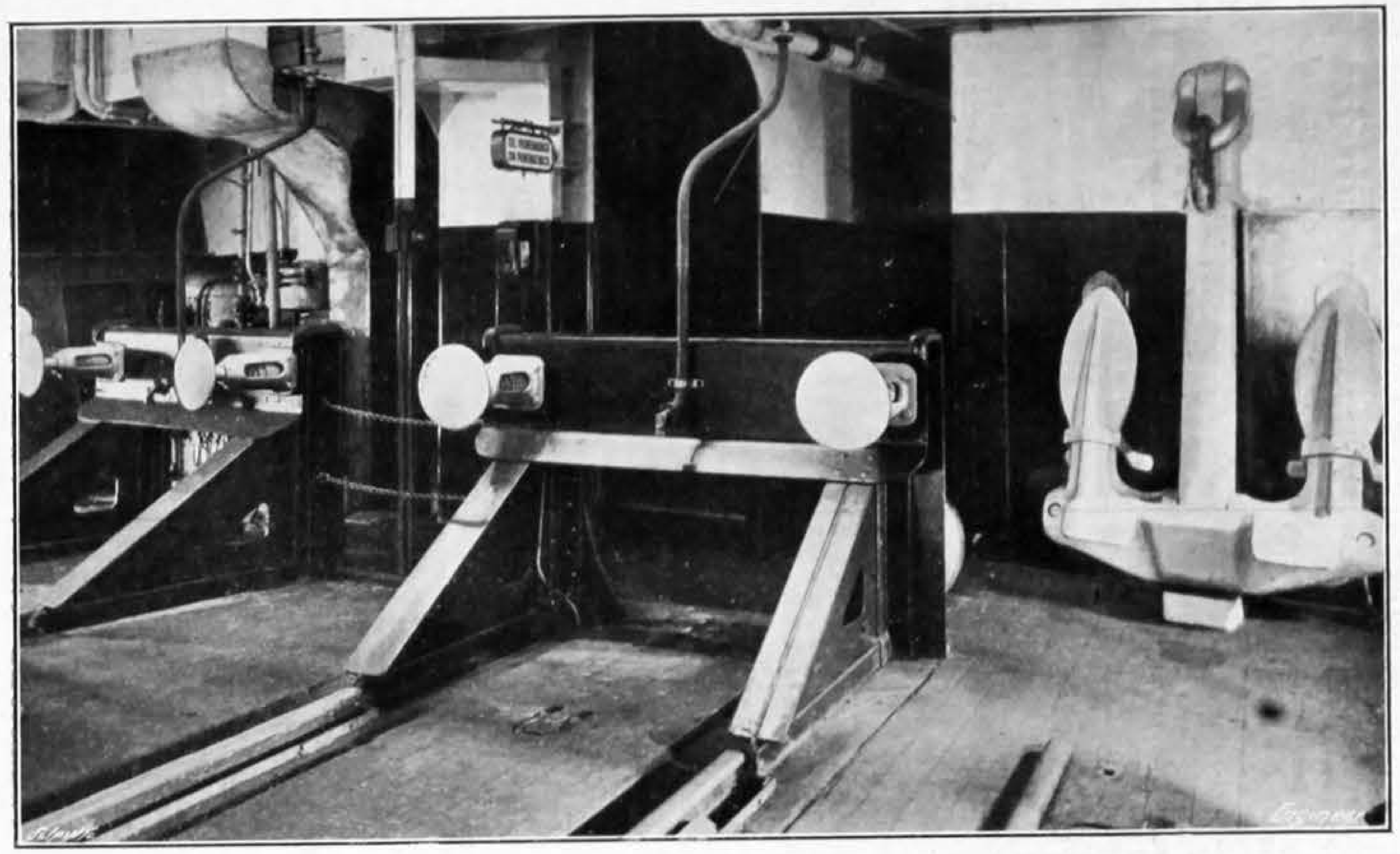
THE TRAIN FERRY STEAMER DROTTNING VICTORIA

SWAN, HUNTER, AND WIGHAM RICHARDSON, LIMITED, WALKER-ON-TYNE, BUILDERS

(*For description see page* 107)

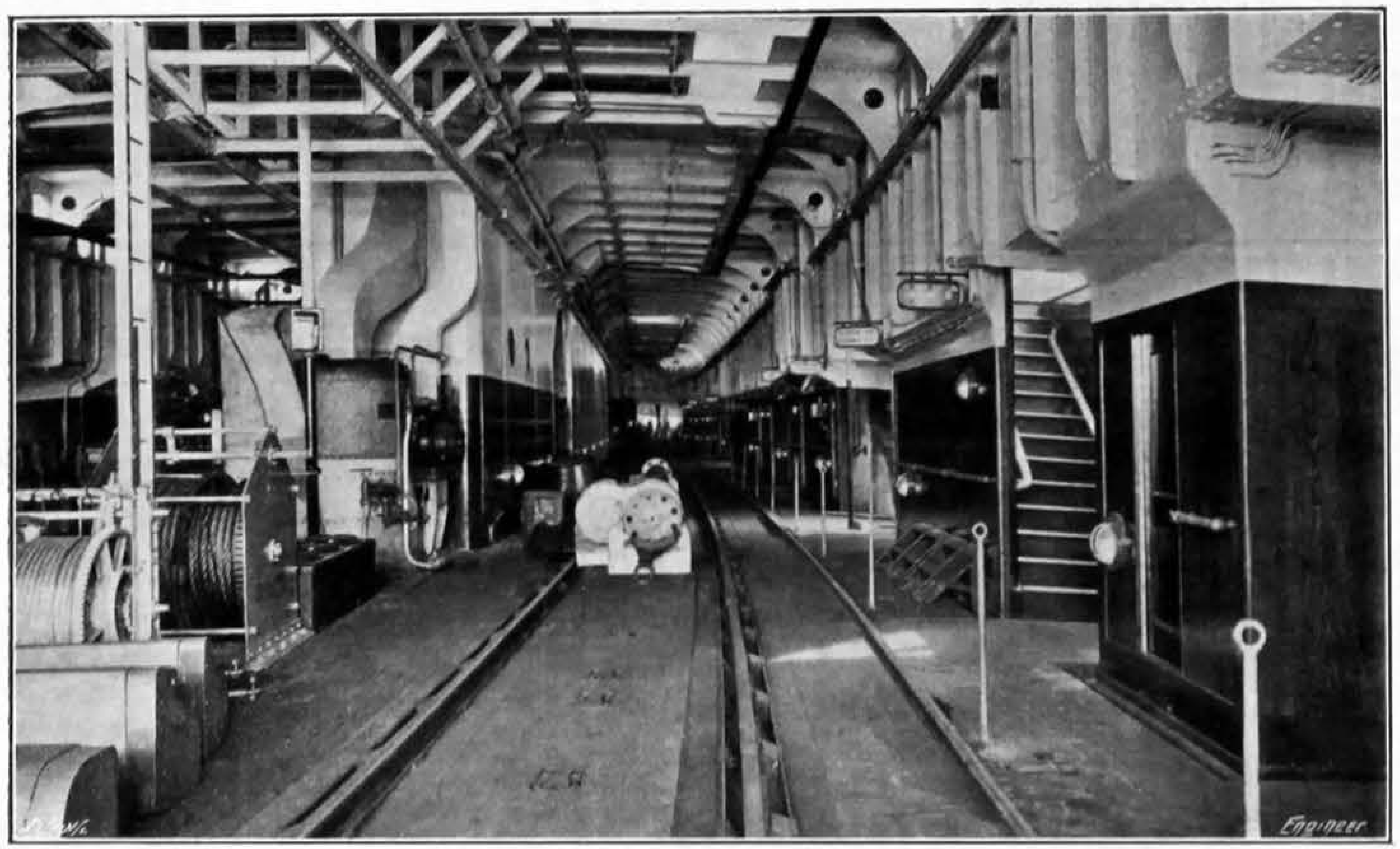


THE NAVIGATING DECK, LOOKING FORWARD



SPRING BUFFERS ON THE CAR DECK

THE CAR DECK, LOOKING AFT



THE CAR DECK, LOOKING FORWARD

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THE ENGINEER, 30th July, 1909.

TO CORRESPONDENTS.

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

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INQUIRIES.

COATING COPPER WITH LEAD.

SIR,—I shall be much obliged to any reader who can tell me how to coat plates of thin copper, about 8in. square, with lead on one side. I can tin these plates easily enough, but I cannot lead them. I have tried resin, killed spirit, sal-ammoniac, without success. CUPRUM.
July 28th.

THE ENGINEER.

JULY 30, 1909.

The Coal Trade Situation.

THE best that can be said about the Scottish coal trade dispute at the moment of writing is that negotiations between the Miners' Union and the coalowners, under the auspices of the Board of Trade, have not been broken off. But the prospects of a peaceful settlement are less bright than they were a week ago. As a result of last Thursday's conference the Scottish coalowners agreed to suspend the notice of a $12\frac{1}{2}$ per cent. reduction of wages, which was to become operative on 26th inst., for a week, and, in the meantime, negotiation was to proceed upon a reference as to the "conditions" which "ought fairly to be attached to the recognition of a new minimum, both as regards the limits and the rates of variation of wages above the minimum, and the procedure by which changes of wages should be regulated." On Friday, in London, and again on Tuesday, in Glasgow, the terms of this reference were discussed. No settlement was arrived at, and another joint conference is to be held in London to-day, Thursday. Possibly the threatened conflict may even yet be avoided, but the attitude—we may almost say the temper—displayed by the miners' leaders on Tuesday, both in conference and in conversation after the conference, renders the hope of avoiding rupture somewhat meagre. We may still hope that a strike, and all that that implies in financial loss and human suffering, will be averted; but frankly, we view the prospect with grave misgiving. Even if the Scottish dispute—the merits of which we discussed on 16th and 23rd inst.—is settled peacefully, the question of a 5 per cent. reduction in the wages of English miners will have to be faced a fortnight hence. Besides this, the difficulties connected with the operation of the new Eight Hours Law are not being smoothed out very well, and are of such a character that in some districts both miners and managers are having their tempers sorely tried. We hear many mutterings, and we know that in some quarters there is a disposition to welcome the prospect of a great national strike merely to "clear the air." With the question of a new minimum wage and sliding-scale for Scotland; the demand of the coalowners in the Federated districts of England and Wales for a five per cent. reduction of wages; with a serious diminution of output in Wales and some other districts consequent upon the reduced working day; and various other inconveniences which are being suffered by miners as well as owners—notably the interference with mealtimes and Saturday half-holidays—it is not too much to say that the mining industry was never in a more widespread state of unrest than at the present moment. Anything may happen. The whole situation is being aggravated by the Eight Hours Act, by the vapourings of untruthful Socialists, and by the existence of the infamous Rule 20 of the Miners' Federation.

Rule 20 stipulates "That whenever any county, federation or district is attacked on the wages question, the members connected with the Society shall tender notices to terminate their contracts, if approved of by the conference called to consider the advisability of such joint action being taken." It is the knowledge that the great majority of the miners in England and Wales are prepared to enforce this rule that is encouraging the leaders of the Scottish Miners' Union not only to resist the demand of the owners for a reduction of wages, but in refusing to submit the matter to arbitration. What justification is there for Rule 20? And what justification is there for its enforcement, in case the Scottish coalowners persist in their demand for a reduction? Why should there be a national strike, or the threat of such a strike, over a local wage dispute? It is a physical impossibility to work all our mines on one hard and inflexible principle. Not only have we widely varying qualities and prices of coal, but we have widely varying *per capita* outputs of coal, in the various districts. In one part of the country the output of coal, per worker employed, exceeds 373 tons a year; in another district the *per capita* production is less than 260 tons. As with the natural conditions of mining, so with the market value of the mineral. Roughly, the pit mouth price of coal in Scotland is, on the average, from 1s. 3d. to 1s. 6d. per ton less than in England, and from 3s. to 4s. per ton less than in Wales. In face of such facts as these we can do nothing but condemn the Miners' Union for seeking to set local conditions at defiance. Surely the wages of Scottish miners might be ruled by the circumstances of Scottish industry, and fixed by mutual bargaining and independent judgment on the spot by responsible persons, rather than by the strength of organised labour in England, manipulated by irresponsible agitators. The real object of this Rule 20 is the ultimate establishment of one uniform wage for all the miners in the country, regardless not merely of the abilities of the men, but of the natural conditions of the mines. Obviously, the ultimate end is as impossible as the immediate means are unwise. Besides, granting for a moment that Rule 20 was drafted with a practical, or legitimate, object in view—that the miners in one district are entitled to support, even to the extent of a sympathetic strike, their comrades in another district, in accordance with the terms of the rule—what cause, we may ask, is there for the application of this rule on the present occasion? Where is there in the demand of the Scottish coalowners any "attack" on the wage question? In 1904 the Scottish Miners' Union was a consenting party to an agreement under which wages might, by sliding scale, drop to a minimum of 5s. 6d. per day. All that the owners have asked is that this agreement be adhered to. Failing this, they have offered to submit the point to arbitration, or to the judgment of the independent Chairman of the Coal Trade Conciliation Board. They have offered to support their case by documentary proof of market conditions, and then to abide by the result. Where, then, we repeat, is the "attack" upon wages which justifies the enforcement of Rule 20? The machinery of the sliding scale was quite good enough for the Miners' Union when trade was "booming" and prices rising; but now, in a moment of deep depression and acute unemployment, and when cheap coal is the cardinal essential of industrial recuperation, the sliding scale agreement which has served so well in the past is to be abrogated, and either the price of coal is to be put up permanently, or its supply is to be cut off temporarily. For, indeed, if the coalowners consent so to revise the "basis price" of coal, or the sliding scale, so as to permit of the establishment of the 6s. minimum for which the miners are contending, it will be the public, and not the coalowners, who will inevitably be called upon to pay the difference between the new "basis" and the old one. Strike or no strike, we are about to pay dearly for having elevated coal-mining to the rank of a petted industry, and for giving a too attentive ear to the gospel of Socialism.

Ever since 1842 the State has been interfering with working conditions in the interests of the miners. Much has been done—and rightly so—to promote safety. But in enacting the Eight Hours Law the State has gone too far. The granting of this unjustifiable concession, coupled with the dissemination of Socialist doctrines, is working mischief among the miners. That the wiser heads of the Miners' Federation recognise the nature of the mischief may be gathered from some significant remarks made at Durham last Saturday. Speaking at a mass meeting of miners, Mr. Charles Fenwick said: "It grieved him more than he could tell when they had men coming amongst them free from responsibility counselling extreme measures amongst men whose passions were easily inflamed, but not easily allayed. These men occupied a position wholly detached from the association, and if industrial war should take place, would not be there to share with the leaders of their association the responsibility of guiding it to a correct issue. He regretted more deeply still that these men should be listened to." And there is ample cause for regret. These Socialists come into the big cities and tell the public that the miners raise coal for a mere fraction of its selling price, and then they go among the miners and inform them that no matter what course they—the miners—adopt, both public and Parliament will support them.

Locomotive Fire-boxes.

WE all know that the weakest part of a locomotive engine is the internal fire-box, in the sense that it wears out quickly and costs much money for renewals and repairs. It is therefore not a little remarkable that no complete study of fire-boxes has ever been made. Much has been written about them, no doubt, but the literature of the fire-box is desultory and unsatisfactory. No principles of dimensions or form have been settled. As to material, there is a wide diversity of opinion, resulting in an equal diversity of practice. Theory has been invoked, limited practice has been cited, and so at this moment the duration of the fire-boxes in any particular group of engines seems to be more a matter of luck than guidance.

The internal fire-box presents itself for consideration in two aspects—first, as a chamber in which to burn fuel to the best advantage; secondly, as a chamber whose external superficies constitute heating surface. In so far as combustion is concerned, the proportions of the fire-box are largely determined by the quality and formation of the fuel burned. Thus, to cite extreme cases, we have the anthracite pea coal, which must be burned on a close barred grate, in a thin stratum, with a gentle draught; a sharp draught would lift it off the bars and send it flying unburned up the chimney. Thus, grates as much as 8ft. wide and 9ft. long have been used. Again, in Belgium, fine bituminous slack coal is well watered until it resembles mud, and this is burned on grates of about the same dimensions. For good bituminous coal a grate 3ft. 5in. wide and 9ft. long is freely used in this and other countries. To get a still larger grate, the fire-box has been made to overhang the side frames, and we have in this way grates 5ft. wide and 6ft. long. The distance from the crown sheet to the grate bars is an important point, varying with different kinds of coal. Some coals must be fired "thin," some "thick." A thick fire in a shallow box will usually make a great deal of smoke; a thin fire in a deep box will not keep steam. But the locomotive boiler is very accommodating, and unless there are outrageous defects in proportion, a skilful fireman will usually surmount difficulties. Theoretically the level of the fire bars ought to admit of adjustment with the character of the coal and the load behind the tender. In practice this idea could not be carried out, save, indeed, to the extent that grates may be altered both in level and width of opening to suit the coal of particular districts on which the engines are working for the time being. The difficulties met with in securing complete smokeless combustion are fairly well understood. We have no intention of discussing them here. It is enough to say that none of the refinements dictated by theory can be applied in practice. The regulation of the air supply can only be done roughly; everything depends after all on the coal and the fireman. The first consideration with him is to keep the safety valves very nearly lifting. After that he will take account for economy and smokelessness.

The way in which coal is burned seems to have little effect on the life of a fire-box. That depends in the main on the performance of the outside of the box as heating surface. We have shown not long since that if the surfaces are clean, and kept really wet, the presence of the plate may be disregarded, the temperature of the plate at the fire side not being much greater than that of the water in the boiler. But the "if" involves a great deal, and some facts learned in practice are rather curious. Thus it seems to be proved that fire-boxes with narrow grates will last much longer than those with wide grates. There are so few locomotives with wide grates running in Great Britain, that experience had with them is far too limited to count for much. In the United States it is not so. We find much information in a paper by Mr. Seley, read before the Western Railway Club not long ago. Mr. Seley is mechanical engineer of the Chicago, Rock Island and Pacific Railway. He finds that one of the special troubles with the wide fire-boxes on several roads has been the short life of the side sheets as compared with those of narrower boxes, involving a large increase in the maintenance and repair expenses. Discussing this paper, Mr. J. F. De-Voy, assistant superintendent of motive power of the Chicago, Milwaukee and St. Paul Railway, was very emphatic. Of 18 passenger locomotives of the 4 : 4 : 2 class with narrow (42in.) fire-boxes, only 4 have had new door, tube, crown or side sheets in ten years. Of 28 engines of the same class with wide (66in.) fire-boxes, each had had at least one new sheet in seven years, and some had had as many as three sets of side sheets in that time. In one year, 140 stay bolts were applied to the narrow boxes as against 585 in the wide boxes. Of 16 freight locomotives of the 4 : 6 : 0 class built in 1900, and having narrow fire-boxes, all retained their original boxes in 1906. Of 66 locomotives of the same type, but with wide fire-boxes, built during 1901 to 1903, 14 had had new door, tube, crown, and side sheets in 1906. Tubes lasted nearly twice as long in the narrow boxes. During 1½ years there were 152 new stay bolts applied to the narrow boxes, as against 1127 for the wide boxes.

At first sight it is very difficult to account for these rapid failures. Generally speaking, the water spaces in the fire-box legs are wider with the large than the small box. The water is the same for all the engines. It is reasonable to suppose that the combustion is less fierce in the wide than in the narrow box; indeed, to secure slower combustion is one of the objects had in view. So far as we can learn, there is small difference in the explanation given by various engineers. It has been argued that to slope the sides of a fire-box inwards over the fire must be a good thing, as it favours the absorption of heat by the water, and facilitates the rise of steam bubbles, instead of permitting them to cling to the metal. But in practice it is found that somehow this theory does not work, and it is best to make the side sheet either stand up straight, or, still better, incline outwards. There is reason to believe that although water cannot, if left to itself, be heated from above downward, save with extreme slowness, yet that a rapidly flowing current will freely take heat from a plate above it. It is known that the currents in water legs are very rapid. The explanation given of the injurious effect of sloping the plates inwards is that the rising current is so rapid that it interferes with the descending current, the result being that the leg is filled with foam instead of solid water, and the plate is overheated; whereas, when the plate inclines outward, the action is not so violent, and clashing of currents does not in effect take place. It may be added, we think, that deposit is far more likely to cling on a sheet inclined inward than under a sheet inclined outward. However, be the explanation what it may, it seems to be clear that the wide fire-box will not stand as well as the narrow box.

Mr. Hughes, chief mechanical engineer of the Lancashire and Yorkshire Railway, read this week, during the Liverpool meeting of the Institution of Mechanical Engineers, a paper on the locomotives built at Horwich which contains a great deal of useful information. Nothing is said, however, concerning fire-boxes which throws any light on the questions we have raised. We find, however, that the water spaces have been made wider, as constantly advocated in our pages, with the best results. Mr. Hughes has not found the Hoy corrugated circular fire-box a success. No fewer than 108 large eight-coupled coal engines were built in 1900 with Belpaire boxes, and a further twenty-one with the corrugated fire-box. Particulars will be found in the paper itself. The point which claims particular attention here is that these furnaces became distorted, coming in, not at the top, but at the sides. They were set out again with a 200-ton hydraulic jack in the usual way. Up to the present it appears that fifteen of the boxes have been twice jacked, with an average mileage of 61,700. It is obvious that there is something exceptionally wrong here. We can cite the case of a large steamer, with six double-ended boilers, and thirty-six furnaces carrying 160lb.; only two furnaces have needed jacking in eighteen years. Mr. Hughes says that the circulation in the Hoy boiler is bad; but he does not say why, nor can we see any reason why the furnace plates should become short of solid water. It is, of course, true that the combustion is much more rapid and the heat intense than it is in a marine boiler. It is suggestive that the sides come in, tending to raise the crown, instead of the crown coming down. This seems to support the contention that the sides of a box should not turn in over the fire.

Of course there are a great many factors to be considered, as, for example, the material of the box, and the treatment which it receives. Information is too small to permit of any dogmatic assertion of opinion. Facts, however, whether they can or cannot be explained, must not be ignored. Those we have given are too consistent and too serious not to possess a great deal of value if they are properly used. In this country extraordinary and indeed unaccountable differences are met with in the duration of fire-boxes. No satisfactory conclusions can be drawn until facts are collected and compiled—a work well worth doing.

The Treatment of Rail Steel.

IN our last impression we dealt with the information supplied and the opinion expressed during the recent meeting of the American society for testing materials. We confined our attention, it will be remembered, to the breakage of steel rails; and we expressed the opinion that for the breakages it was not so much the chemical character of the metal or the method of its production that was responsible as the treatment which the steel received during the process of its conversion from the ingot into the rail. Papers were read, and much discussion took place, particularly on the treatment of the ingot. Much ground with which the steel manufacturer and the rail maker ought to be quite familiar was traversed over again once more. The apparent ignorance of men who are esteemed skilful and competent concerning what has been done years ago at this side of the Atlantic is at once curious and interesting. For example, let us take the consolidation of ingots.

Last week we mentioned a rail which had a fissure in it extending from end to end, the result of a blow-hole in the ingot. This was but one of many cases cited. The question turned not on the prevention of the formation of these blow-holes in the ingot, but on the possibility of welding them up subsequently. In this country a certain proportion of every ingot has to be cut off because it is "piped" or otherwise unsound. In the whole report of the paper and discussion which lie before us we can find no reference whatever to the cutting off of the tops of the ingots. We, of course, do not say that it is not done. Indeed, we know that it is done frequently. But we gather that the cutting is not popular; and all the speakers dealt, not with the removal of blow-holes, but the possibility of welding them up. That they could be welded efficiently was contended by many speakers. Indeed, the point was brought out on behalf of the steel manufacturers that the closing of blow-holes is the very purpose of certain methods of working, such as the raising of the steel to a very high temperature, and then cogging it with a heavy draught. It is contended that fissures in an ingot treated in this way will all be welded up, the occluded gas being squeezed out. On the other hand, it is argued with perfect soundness that if any scale or oxide is in the original fissure, as it cannot escape no welding can take place. It is not easy to see how oxidation can occur inside an ingot, and it appears to be indisputable that soundness can be imparted by proper treatment. One speaker attributed all the defects of modern rails to the cogging mill. Thus, forty years ago, ingots instead of being cogged were treated by the hydraulic squeezer, which was, if not introduced, much used by the late John Haswell when locomotive superintendent of the Austrian State Railway. At Pencoyd works a 20-ton steam hammer was used to reduce ingots for the rolling mill, with, it is said, the result that broken rails were unknown. But it must not be forgotten that more time was available. The enormous output of rails in the States is inimical to leisurely processes and methods of manufacture; and the problem is complicated by the necessity for speed. If, that is to say, more time is required to hammer an ingot than to cog it, it will be cogged, not forged.

The question next comes up, can soundness in the ingot be obtained by fluid compression? This is a very, very old story with English steel manufacturers. Much water has run under the bridges since Whitworth patented fluid compression. The contention was then, and is now, that no amount of compression will get rid of occluded gas, simply because it cannot get out. Among the papers read was one by Mr. Bradley Stoughton, of New York, "On the Physical Quality of Steel which has been subjected to Compression during Solidification." The conclusions at which he arrived may be thus stated:—"Compression during solidification lessens the liability of steel to contain the remnants of pipes, blowholes, segregation and external cracks, and partially prevents the development of a weak structure during crystallisation. So far as is shown by the tests we have been able to find, it also slightly increases the strength of finished steel and increases its toughness under impact, besides making the different parts of ingots more uniform in quality both before and after rolling. There are at least eighteen plants in England and Europe equipped with a total of three to forty presses, and at least three or four plants, so far as we are informed, with about an equal number of presses in America."

Professor Howe, who opened the discussion, confined his remarks almost entirely to the Harmet process, which consists, as is pretty well known, in the forcing up through a tapered ingot mould of the molten metal. This he terms a forging operation taking place at an unusually high temperature. But as to what really goes on he did not pretend to know any more than other people—that is to say, next to nothing. About all that could be said was derived from Harmet's own reports, which showed that finished steel rolled or forged from compressed ingots showed an enormously high elastic ratio, suggesting that the steel may have been finished at lower temperatures than material from ordinary ingots with which comparisons were made. Similarly the impact tests give evidences of colder finishing of the steel from compressed ingots than of that from ordinary ingots. The question is thus raised whether the superiority indicated for the fluid compressed steel is not due to treatment subsequent to the compression.

Steel makers will see that all this leaves matters very much where they were. It must be remembered that all compressing plant intended to deal with a very large output is enormously expensive, occupies much ground, and may cause serious delay. This question of cost was not forgotten, and Professor Dudley asked the meeting whether it was worth while to make better steel. It is proper to add that he meant that the true remedy lay not in making better rails, but in supporting incompetent rails better. In other words, by making permanent way better as a whole. He went on to make the extraordinary statement that while the question of rails is a balance between the cost of the rail and the cost of supporting the rail, "No data as to methods or cost of better track construction and maintenance are now available. Engineers of maintenance-of-way must obtain them, and so lay a foundation for answering the question. The problem will come up prominently during the next five years; and if it turns out that it will cost more to give the rail better support than to get better rails, we must get better rails." This is to attribute an ignorance to the railway engineers of the United States, an ignorance which they will no doubt hasten to repudiate. So far as our own experience goes, the men who design the permanent way of the better class of railways in the United States and are responsible for its efficient maintenance know quite well what it costs, and can supply Professor Dudley with the information for which he asks—if they think it desirable. It may be added that one speaker said that he did not see what was to be got by putting ties—sleepers—closer together, as he had broken rails on bridges where the ties were only 4in. apart. Professor Dudley forgets that there is a limit to the closeness of sleepers beyond which they cannot be packed up.

It is a pity that none of the great rail makers were present, or, if present, took no part in the discussion. There are so many things to be considered in the production of really good rails that little is to be expected from discussions carried on by men who only possess a half knowledge of the subject. The proceedings as a whole added nothing to the existing store of information in so far as it might lead to the production of better rails. The American question is really, it seems to us, not, how shall we make a better rail? but, why do we not make a better rail? The reply to the first question can be obtained by studying the practice of this country, France, Germany or Italy. The answer to the second question will only be obtained when the people of the United States insist that it shall be given.

LITERATURE.

Cane Sugar and its Manufacture. By H. C. Prinsen Geerligs. Amsterdam. 1909.

At the first glance one may be disposed to consider this book, if not fitful, at least somewhat fragmentary, but judging it purely as a compilation its encyclopædic nature will make it a valuable addition to the literature of sugar, and as a work used in conjunction with other works on this subject, as also for purposes of rapid reference, the clear definitions and concise paragraphic style will make it exceedingly helpful.

Touching now upon one or two details, we must first commend the use of Fischer's nomenclature for the purpose of differentiating between the varieties of sugars, and we are in entire agreement with the author that confusion is frequently caused by the usual want of clear definitions of such important terms as invert and reducing sugar, sucrose, fructose, &c., which should, and in this case has been made to, constitute actually the very alphabet of sugar chemistry.

The first portion of this work is devoted to dealing with the raw material, and is really an index of chemical conditions; being explanatory of the principal phenomena occurring in sugar chemistry, it thus serves as a useful preface to the all-important subject dealt with in the second part, viz., the manufacture of sugar.

In Chapter I. of Part I., dealing with the constituents of the sugar cane, very complete tabulation has been resorted to for illustration of such matters as the solubility of sucrose at different temperatures, and its contraction on being dissolved in water; also Scheibler's interpolation formulæ from computation of Gerlach's formula for the specific gravity of x per cent. of sucrose dissolved at 17.5 deg. Cent., is a useful adjunct to the Brix. spec. grav. tables of sucrose solutions at a temperature of 15 deg. Cent. The author has given a very full determination of the refractive index of pure sucrose solutions at a standard tropical temperature, and this, followed up with a table of corrections for temperature, makes it universally useful.

The second chapter, on the proportions and distribution of the constituents of sugar cane, contains much useful information; but perhaps the most noticeable feature here is the manner in which the separate joints of the cane stalk has been treated with a view to their analysis and for the accurate determination of the places of maximum sucrose content at variable periods of growth and season.

In Chapter I. of Part II., dealing with mills, the subject of maceration takes a prominent part, and receives careful analysis; also the recorded results of tests on 12-roller mills will not fail to interest those whose plans for central factories are in the initial stages of formulation.

The stress laid on the regulation of crushing and maceration by striking a judicious compromise between these two important factors, shows the very comprehensive view the author takes of this subject.

From the chapter on diffusion and those immediately preceding it, one is able to draw a very fair comparison between the advantages and disadvantages of milling and diffusion, a most important consideration, before committing oneself to either process.

Clarification and carbonatation methods, together with the chemistry of lime kilns, crystallisation-in-motion process, and the problems of megass as fuel, &c., occupy most of the last portion of the work. We feel that the author was right in restricting his work to a purely chemical treatise, as in many cases where elaborate analysis of constructive engineering details is intermixed, the very multiplicity of information is liable to defeat its own ends.

SHORT NOTICES.

A Practical Treatise on Bridge Construction. By T. Claxton Fidler. London: C. Griffin and Co., Limited, 12, Exeter-street, Strand. Price 30s.—Since the previous edition of this book was published in 1901, the author has naturally acquired more up-to-date knowledge, and he has taken the opportunity of embodying it in this fourth edition. The problem of finding a rational determination for the safe working stress is again taken up at the end of Chapter XIII., and the new information given is based on the author's observations and laboratory experiments. In Chapter X. the table giving the calculated breaking weight of columns is now given in more extended and convenient form. The figures have been obtained as before, but they are worked out for closer intervals in the ratio of length to radius of gyration. In Chapter XI. the deductions of Art. 144 regarding the calculable stresses in the various members of a brand strut are compared with the evidences afforded by Professor Burr's recent experiment, as quoted in the report of the Royal Commission of Inquiry upon the fall of the Quebec Bridge. Some of the results of Dr. Stanton's wind experiments are also dealt with. The author points out that the design of the Quebec Bridge was in many respects different from those which he illustrates on the plate of cantilever bridges, and he briefly mentions the general effects that have to be considered in connection with such special features.

Theory of the Recoil of Guns. By F. Rausenberger. Translated by Alfred Slater. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. Price 10s. 6d. net.—This book is the outcome of some lectures on the theory and calculation of recoiling-gun mountings, which were delivered by the author in 1905, at the Military Technical Academy in Berlin. The book is divided into six sections, and each section is again sub-divided. In the first section the author gives a short general explanation of the subject. He then considers the external forces on a recoiling-gun mounting which come into action on firing. The determination of the brake pressure and the length of recoil is next considered, and following this the running-forward device is dealt with. The fifth section has reference to recoil brakes, and the last section is devoted to the running-forward brake. In the translator's preface it is pointed out that, owing to the extreme secrecy with which the science of gunnery is regarded in this country, there is very little important English literature dealing with guns and gun mountings available; but on the Continent such literature is far more plentiful. The book is one which enters into a good many calculations, and should therefore prove useful to the designer; but at the same time the user of artillery should find the work interesting.

Azimuth. By G. L. Hosmer. London: Chapman and Hall, Limited, Henrietta-street, Strand. Price 4s. 6d. net.—The object of this book, the author states, is to present in compact form certain approximate methods of determining the true bearing of a line, together with the necessary rules and tables arranged in a simple manner, so that they will be useful to the surveyor. It is a handbook rather than a text-book. In all the methods dealt with the author's aim has been to secure sufficient accuracy for the purpose of checking the measured angles of a survey with the least expenditure of time. The author points out in his preface that the necessity for making astronomical observations from azimuth is confined chiefly to geodetic work, and arises so seldom in general engineering practice that many persons engaged in surveying are not familiar with astronomical methods, and therefore are likely to avoid making use of such observations. In this book an endeavour has been made to present the subject so that any one unfamiliar with astronomy will be able to apply these methods, and obtain satisfactory results, without taking the time completely to master the theory underlying the method used.

The Building Foreman's Pocket Book and Ready Reference. By H. G. Richey. London: Chapman and Hall, Limited, Henrietta-street, Strand, W.C. Price 21s. net.—As the title implies, this book is intended for the use of building foremen and for others associated with the various trades which enter into building operations. It is an American publication, and therefore deals with American practice, but at the same time a considerable portion of the information which it contains is equally as useful in this country as it is in America. In the first part of the book the author deals with duties, &c., of foremen, excavating and stone work, brick and terra-cotta work, lime and cements, mortar and concrete, miscellaneous cement and concrete work. Then he goes on to consider carpentry and woodwork, heating and plumbing, miscellaneous trades, drawing and laying out work and the strength of materials. The last three sections of the book are devoted to the weight, size, &c., of various materials; mensuration and time-saving tables, useful receipts, &c. A large amount of information is given in tabular form, and the work throughout is arranged for ready reference.

Automatic Screw Machines and their Tools. By C. L. Goodrich and F. A. Stanley. London: Hill Publishing Company, Limited, 6, Bouverie-street, E.C. Price 8s. 6d. net.—This is an American publication, which is intended for the use of tool designers, tool makers, and machine operators. One section of the book is devoted to various types of machines and their construction, general tool equipments and methods of camming, &c. The other section deals with tools in detail, and it contains specific information, and making and using these tools, the speeds and feeds at which they should be operated, and other particulars are given which should be of service to mechanics connected with screw machine work. The chapters on camming, and on different types of cutting tools, originally appeared in the *American Machinist*. In Section I. some of the machines dealt with are, strictly speaking, of the chucking-machine type, and semi-automatic in their operation. The book is well illustrated, and is probably one of the most exhaustive of the kind.

Slide Valve Motion for Marine Engineers. By Peter Youngson. Glasgow: James Munro and Co., Limited. Price 5s. net.—The slide valve with its gear, the author of this book states, is the pulse of the engine, and is of paramount importance in providing economy in full combined with sweetness in running. The book has been specially written for marine engineers, but at the same time it is not without value to others who are interested in reciprocating engines. It is intended to illustrate the working and management of marine valve gear in a simple and complete manner. The drawings and diagrams which the book contains are well done, and they are very clear. A noteworthy feature about the book is that the last chapter contains one hundred verbal questions and answers on slide valve motion, which makes the book of particular value to marine engineers who are desirous of gaining Board of Trade certificates. The book, which is divided into eight chapters, constitutes a useful addition to the literature on the subject.

The Instanter Decimal Tables of Weights, Measures, and Monies. By O. G. Winzar. London: Simpkin, Marshall and Co., Stationers' Hall-court, E.C. Price 1s. 6d. net.—Although this is a small book, it is nevertheless a useful one. It gives at a glance the decimal equivalents of the monies, weights, measures, angles, fractions, &c., in general use in the British Empire and the United States. For convenience of comparing our weights and measures with those of other countries, or *vice versâ*, tables of metric and other equivalents are given at the end of the book. The author points out that hitherto slide rules and other calculating machines which are so universally used in every class of commercial work on the Continent, have been of comparatively little value to us, as they only work in decimals; but with the aid of this book it should be possible to take more advantage of these time-saving instruments. A noteworthy feature about the book is that it is provided with a thumb index.

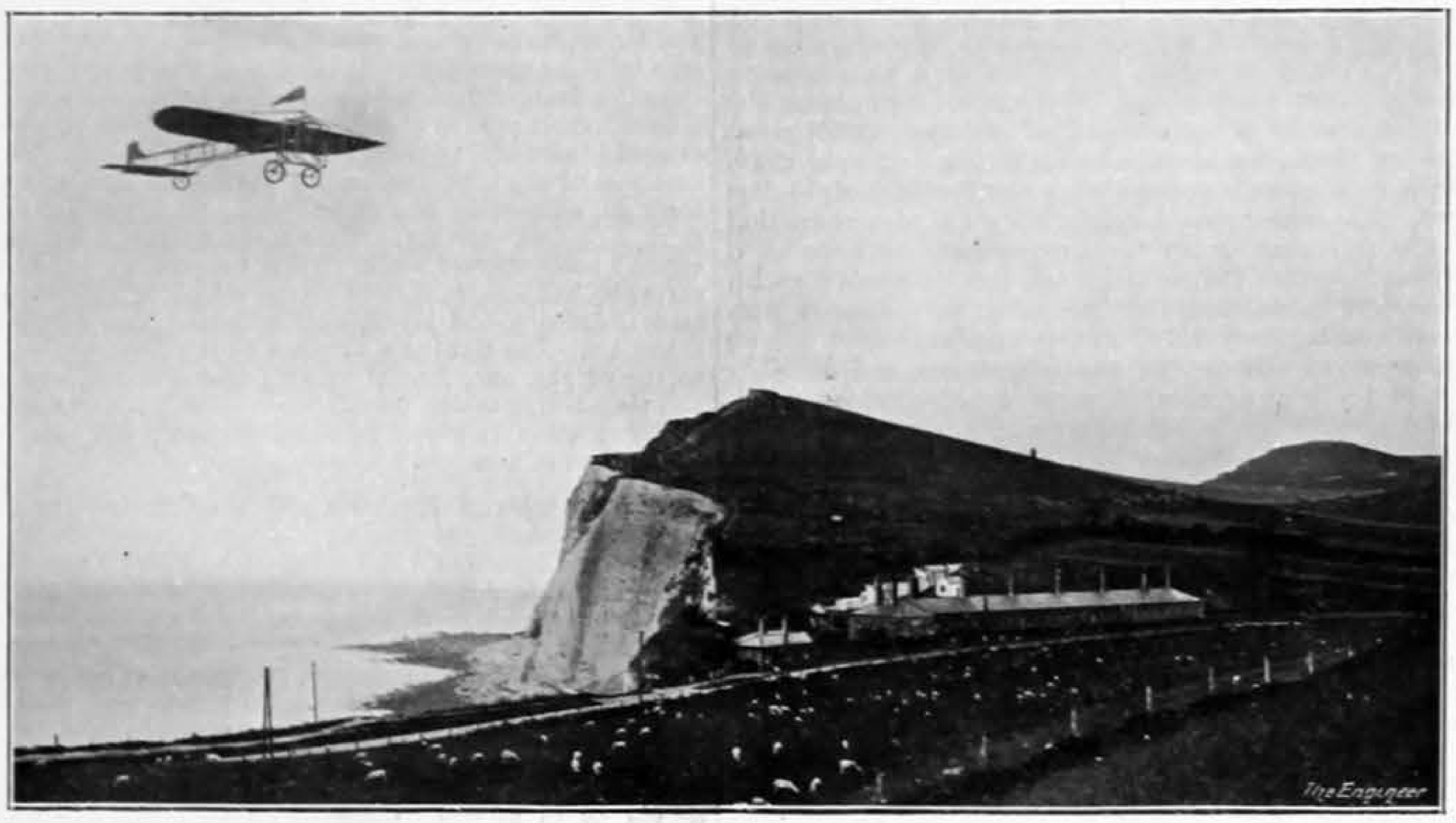
Steam Turbines. By Hubert E. Collins. London: Hill Publishing Company, Limited, 6, Bouverie-street, E.C. Price 4s. 6d. net.—The object of this little book, which is the ninth of the series of "Power Handbooks," is to provide instruction for the adjustment and operation of the principal types of American steam turbines. As in the case of the other books in this series, the majority of the information originally appeared in our contemporary *Power*. The book deals with the Curtis turbine, the Allis-Chalmers turbine, and the Westinghouse-Parsons turbine; and there are chapters on testing a steam turbine, auxiliaries for steam turbines, trouble with steam turbine auxiliaries, and getting the values of a Curtis turbine. The book, which is the first of its kind we have seen, gives a very good insight into the operation and adjustment of steam turbines; but it is by no means exhaustive, and, as already stated, it deals only with turbines of the American types.

Practical Testing of Gas and Gas Meters. By C. H. Stone, B.Sc., M.S. London: Chapman and Hall, Limited, Henrietta-street, Strand. Price 15s. net.—It is doubtful whether this book will prove of much value to English readers, for it deals with American methods of gas manufacture and testing, and as the author points out in his preface, there are many points of difference between the procedure in this country and America. Those, however, who are desirous of gaining knowledge of American methods will find the book useful. The book is divided into four parts, which deal with photometry, chemical tests, calorimetry, specific gravity and pressure, and the testing of meters respectively.

The Ore Deposits of South Africa. J. P. Johnson. London: Crosby Lockwood and Sons, 7, Stationers' Hall-court, E.C. Price 5s. net.—This book is intended to meet the demand among those technically connected with the mining industry for a co-ordinated and condensed account of the ore deposits at present known in South Africa. It is also intended as a guide to the prospector. There are chapters on titaniferous and chromiferous iron oxides, nickel, copper, cobalt, tin, molybdenum, tungsten, lead, mercury, antimony, iron, and hints to prospectors. The book is one which can be understood by anyone possessing an elementary knowledge of geology, and who has had some mining experience.

THE CROSS-CHANNEL FLIGHT.

IMMEDIATELY following the attempt made last week by Mr. Latham, M. Blériot, a French engineer, has succeeded in crossing the English Channel on an aëroplane. Starting from Baraques, a village on the French coast, two miles west of Calais, M. Blériot landed at Dover on Sunday morning after safely accomplishing the cross-Channel passage.



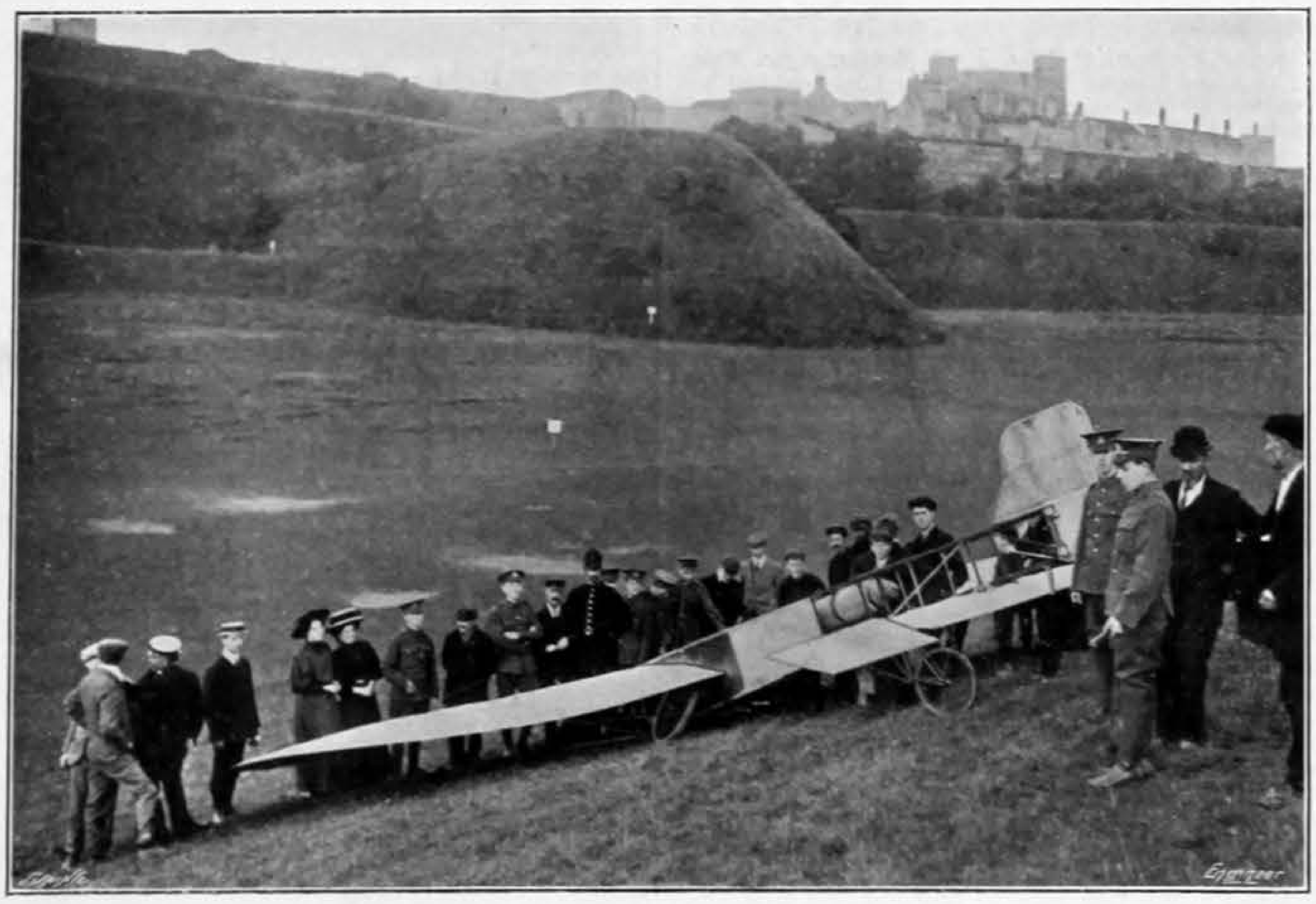
THE BLERIOT AEROPLANE JUST BEFORE ALIGHTING AT DOVER

The journey across was not made without difficulty and danger, although the aëroplanist appears to have had complete confidence in the construction of his machine and in the trustworthiness of his motor. That such confidence is absolutely necessary is obvious, and we are inclined to believe that M. Blériot owes his success largely to this reason.

Favoured by a light south-westerly wind, the aëronaut, after making a trial flight of about 3½ miles, left the French coast at 4.35 a.m., and headed his machine for Dover by the shortest route, being guided at first by the direction in which the destroyer Escopette, which was acting as escort, was steering. The destroyer, however, although steaming at full speed, was soon left behind, and M. Blériot found himself for about ten minutes unable to determine the direction in which he was flying. Proceeding on his journey, he, however, shortly afterwards sighted the English coast, but saw that, owing to the wind, he had been carried to the eastward of his predetermined landing place, and hence, keeping a little over a mile from the coast, he steered his machine in a westerly direction.

On reaching Dover he turned and flew over the cliffs until he arrived above the spot chosen as suitable for the descent. Circling round twice he alighted safely, although some slight damage was done to the aëroplane.

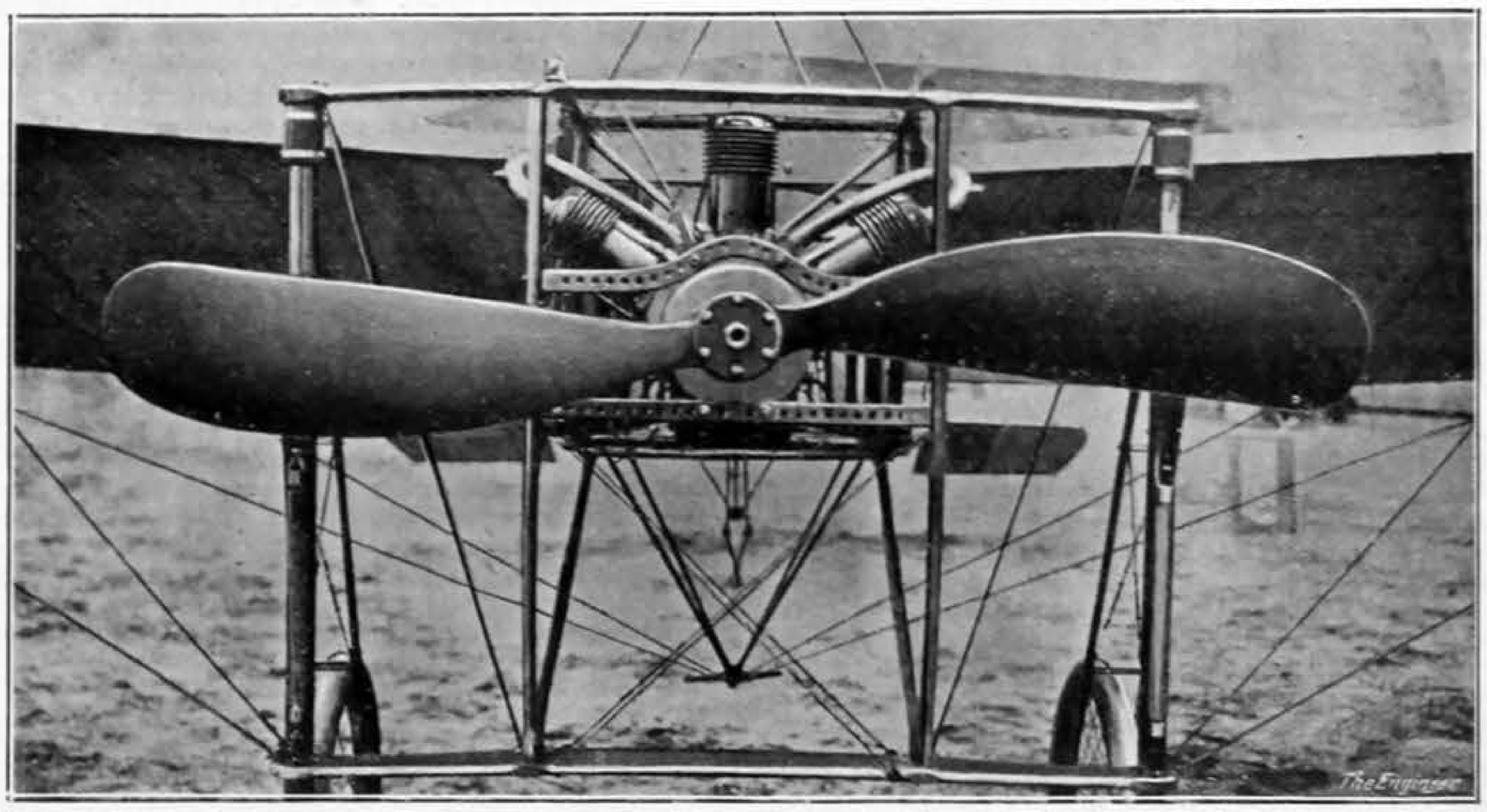
The distance traversed has been estimated at 26 miles and the time taken was 35 minutes. Supposing the estimate of distance to be correct, the average speed works out to about 45 miles per hour. M. Blériot states that he had no difficulty in regulating the height at which he wished to fly, and gives this at about 250ft. above the sea, although he says that he could with ease have doubled this figure.



THE BLERIOT AEROPLANE AFTER ALIGHTING AT DOVER

The aëroplane used on this occasion by M. Blériot is of his own design and construction, and is of the monoplane type, as is that of Mr. Latham.

It consists of a light framework formed of ash and poplar, piano wire being employed for bracing. Attached to the forward end are two curved and inclined planes having a total sustaining area of 17 square yards, the spread of these being 25½ft., while the breadth is about 6ft. A vertical rudder and a horizontal elevating plane are hinged at the after end of the framework, the motions of these being easily controlled from the driver's seat. Suitable means are also provided for changing the inclination of the wings whereby the stability of the machine may be controlled. Immediately in front of the operator's seat is placed the motor, which is directly connected to the propeller. The motor is a three-cylinder Anzani machine, the bore of the cylinders being 4.13in. It is rated at 22·25 horse power, and during the flight on Sunday M. Blériot estimated its rotations at 1200 to 1400 per minute. As regards the weight of the machine, the following have been given as some of the items:—Motor, 132 lb.; framework, 45 lb.; landing chassis, 66 lb. Its total weight, including operator and a supply of petrol, is about 600 lb.



FRONT VIEW OF THE BLERIOT AEROPLANE, SHOWING ENGINE AND PROPELLER

The machine, which is the eleventh made by its inventor, was exhibited at the Salon du Grand Palais, and since its construction in December, 1908, it has been continuously tested and its design improved in the directions indicated by experience gained as to its powers. On July 3rd M. Blériot flew in this machine from Etampes to Chevilly, a distance of twenty-six miles.

Whether or not M. Blériot's performance constitutes a real advance in the science of aëronautics, one perhaps would hesitate to say. There is no doubt, however, that he has greatly increased the interest taken by the outside public in the doings of his fellow-experimenters. In the meanwhile, it is interesting to note that he is reported as having stated that he is prepared to construct a machine capable of carrying six people across the Channel.

We are enabled to reproduce in the accompanying engravings several photographs taken of this aëroplane. One of these shows the machine just completing the passage of the Channel. Another shows it as it lay on the Downs above Dover after the descent, and the third is a front view showing the motor and propeller.

A second attempt made by Mr. Latham on Tuesday to cross the Channel in his aëroplane has, like the first, ended by the aëronaut's falling into the sea. Starting as before from Sangatte, he followed the line of the French coast for a few hundred yards, then turning, proceeded seawards. A flotilla of destroyers was detached to form a convoy, and profiting by M. Blériot's experience, these vessels were spread out at distances of about five miles, so that Mr. Latham had little chance of losing his direction, although rain was falling at the time. He expressed his intention before leaving of flying to Dover, and then continuing, to land somewhere in the neighbourhood of London.

It would appear that everything went well in connection with the machine until the aëronaut had reached a distance of about one and a-half miles from the English coast. At this point, Mr. Latham afterwards stated, the motor, from some cause unexplained at present, suddenly stopped, and the aëroplane dived rapidly from a height of about 200ft. to the surface of the sea. The shock in this case was somewhat more severe than previously, and the operator received some minor injuries. He was quickly rescued and conveyed to land. An estimate puts the distance traversed by Mr. Latham before his mishap at 21 miles, and the time of flight at 20 minutes.

Accepting these figures as correct, it will be seen that he was travelling at a rate greater than sixty miles an hour, a figure which may be compared with the average of 45 miles an hour attained by M. Blériot on Sunday. It is to be noted, however, that Mr. Latham, in his second attempt had substituted a 100 horse-power motor for the 50 horse-power motor which he used in the first instance. The new motor seemed, however, to give some trouble in the earlier part of the day while trial flights were being conducted.

It is reported that a third aëronaut, Count de Lambert, is preparing to cross the Channel. Should this take place, the results will be observed with added interest, since in this case the machine is of the biplane type.

SIX new electric motor coaches have recently been put to work on the North-Eastern Railway. Each coach is equipped with two motors with commutating poles, both carried on the leading bogie, the controllers and other gear being provided at each end of the cars. A feature of the design of the motors is the way in which it is possible for the armatures to be removed from the shafts in case of damage. Each coach accommodates 64 passengers and weighs 33⅜ tons.

THE PORHYDROMETER.

AN opportunity was recently afforded us of inspecting the instrument known as the Porhydrometer. This apparatus has for its main object the estimating of the weight of cargo loaded into or taken out of ships, barges, &c., and it is claimed that, owing to its simple construction, it can be readily applied to vessels either at the time of building or later. The engraving—Fig. 1—which shows the apparatus in diagrammatic form, will help to make clear the following description of its construction and mode of working.

Erected vertically over the longitudinal and transverse centre of the vessel, a pipe A is in communication with the water in which the vessel floats by means of a smaller pipe B. Thus the water in the pipe A rises to the same height as that outside. Inside this pipe a float C is suspended from a horizontal lever D, which has its fulcrum at E. The other end of the lever D is connected to a steelyard weighing machine situated at F, and shown diagrammatically in Fig. 2. All parts of the apparatus are standardised with the exception of the float C, which requires to be specially constructed for each vessel. This float extends downwards, far enough to bring its lower end below the plane of flotation for light loading, and far enough upwards to bring its upper end

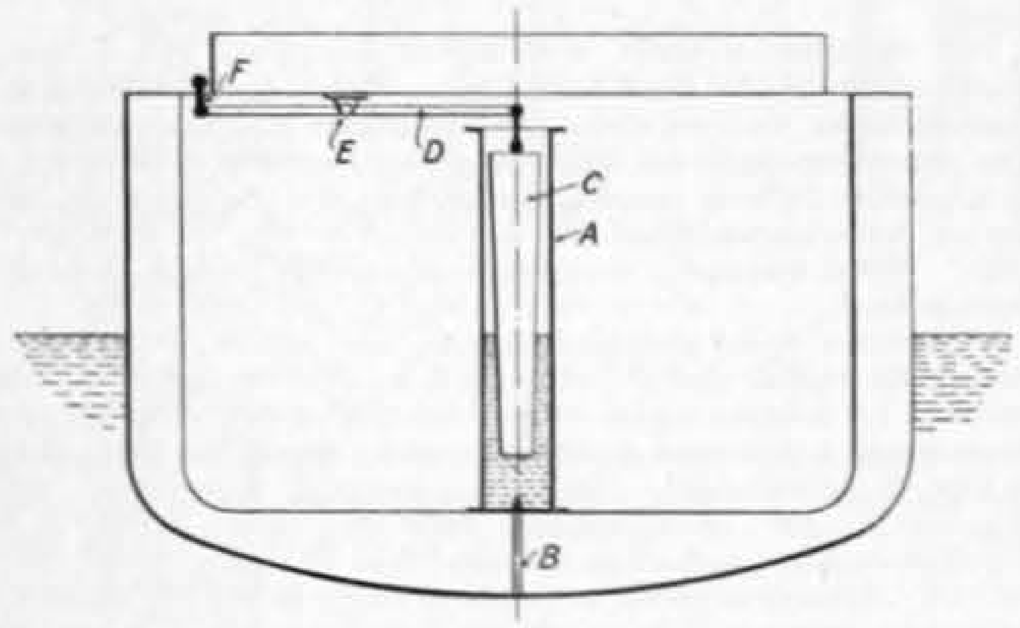


Fig. 1.

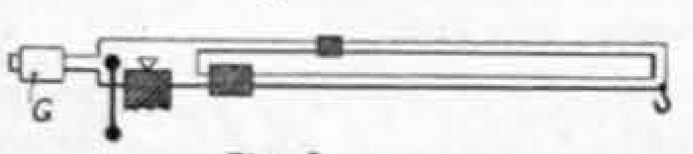


Fig. 2.

THE PORHYDROMETER

above that for maximum draught. Its profile is such that the area of the float at any cross section bears a constant ratio to the area of the ship at the same level. Thus, if a weight w be placed on board the vessel, the latter will be depressed in the water to an extent h, say, and Z being the area of the plane of flotation at this particular draught, and w the weight of unit volume of the water, the following relation holds:— $W = w Z h$. At the same time, the lever D must experience an additional upward force, due to the further immersion of the float C, this force being of amount $w z h$, where z represents the cross-sectional area of the float at this particular draught. This force is measured on the weighing apparatus, and is found to be of amount f, say. Then $f = w z h$.

Therefore, $W = \frac{Z}{z}, f = k f$, where k is a constant. Hence the reading on the steelyard can be arranged to read directly the weight placed on board.

In the actual example inspected, where it was applied to a barge of 200 tons carrying capacity, the weight of the float itself was counterbalanced by a weight attached permanently to the extremity of the other arm of the lever D. All the bearings are carried on knife edges, and the makers claim to be able to read to within $\frac{1}{100}$ per cent. The machine was demonstrated to be capable of giving the weight of a man stepping on board.

When commencing to read the weighing apparatus is first set to zero by means of a movable weight G attached as shown. When a balance has been obtained the reading of the weight of cargo added to or extracted from the vessel is proceeded with, two scales being provided for this purpose. The upper scale in the example inspected was graduated so as to read hundredweights, the lower scale being divided into 100 equal divisions, each one corresponding to a load of one ton. A small weight equivalent to 100 tons can be attached at the extremity of the arm; thus the total measurable load in this case was 201 tons.

The instrument can be adopted to vessels of any size, and the makers are, we understand, in negotiation regarding its application to a vessel of 10,000 tons burden. In this case the diameter of the float will be about 9in.; for the barge inspected this was $3\frac{1}{4}$in. at the top and $2\frac{3}{4}$in. at the lower end.

At first sight it might be thought that a variation in the density of the water would introduce discrepancies into the weight of a cargo as estimated by the porhydrometer, but it will be seen by an inspection of the principle on which the apparatus depends that this is not so. Again, by placing the float in the position described the makers hold that the weight of the cargo is given independently of the trim of the vessel; that is to say, that a load placed forward or aft will be weighed exactly the same as if placed near the centre of the vessel, since the draught directly under the instrument is the mean of that forward and aft.

In addition to its primary use, the porhydrometer can be conveniently used for checking the amount of water in the ballast tanks, and for indicating any leakage. For the latter purpose the instrument can be fitted with an electric alarm bell, which will give warning of any leakage taking place.

The Italian Government has, we hear, tested the invention, and has authorised its Customs officials to accept as correct the weighings given by it.

SECRECY IN NAVAL CONSTRUCTION.

AT the present time four Professors of the Maritime Architectural Department of the Technical College of Charlottenburg, Germany, accompanied by twenty students of the College, are in this country on a tour of inspection of some of the important British shipbuilding establishments. Before the party left home attempts were made with the help of the British Ambassador in Berlin to obtain permission from the British Admiralty for the party to inspect those shipbuilding yards in England in which warships of various types are now being constructed, but the British Admiralty refused to grant this request. That the British Admiralty in their policy of observing secrecy in affairs connected with naval construction are being strongly seconded by British builders themselves, would appear from what has just been made public in connection with the forthcoming joint meeting to be held in Glasgow, between the North-East Coast Institution of Engineers and Shipbuilders and the Institution of Engineers and Shipbuilders in Scotland. Besides the reading of papers on professional subjects, the members of the two societies will pay visits, on the invitation of the respective firms, to a large number of important shipbuilding, engineering, and steel manufacturing establishments on the Clyde and around Glasgow. In the list of these, however, there are notable omissions, such as the works of Fairfield, Clydebank, Beardmore's, Scott's, and Denny's, although in most cases members of these firms have a close connection with the Scottish Institution. The reason for these omissions is that, after fully considering the question of inviting the members of the joint meeting, all the firms in whose works British naval contracts are on hand decided to respect the wish of the Admiralty that as much secrecy as possible shall be observed regarding the structural character and progress of contracts. The only establishment to be visited where naval work is proceeding is that of Yarrow and Co., Limited, at Scotstoun, where almost all the work on hand is of a naval character, but is all for foreign countries.

A NEW STARTING SWITCH.

FOR use with electrically-operated printing machines, the Adams Manufacturing Company, of Bedford, and of 106, New Bond-street, London, has introduced a new type of

Fig. 1—STARTING SWITCH

starting switch which is illustrated in the accompanying illustrations, Figs. 1 and 2. It is well known by those associated with printing machine work that the starting of presses is very hard on the switch gear on account of the constant "inching," which is necessary when preparing the press. By "inching" is meant that the minder keeps starting up the motor, and immediately stopping it again,

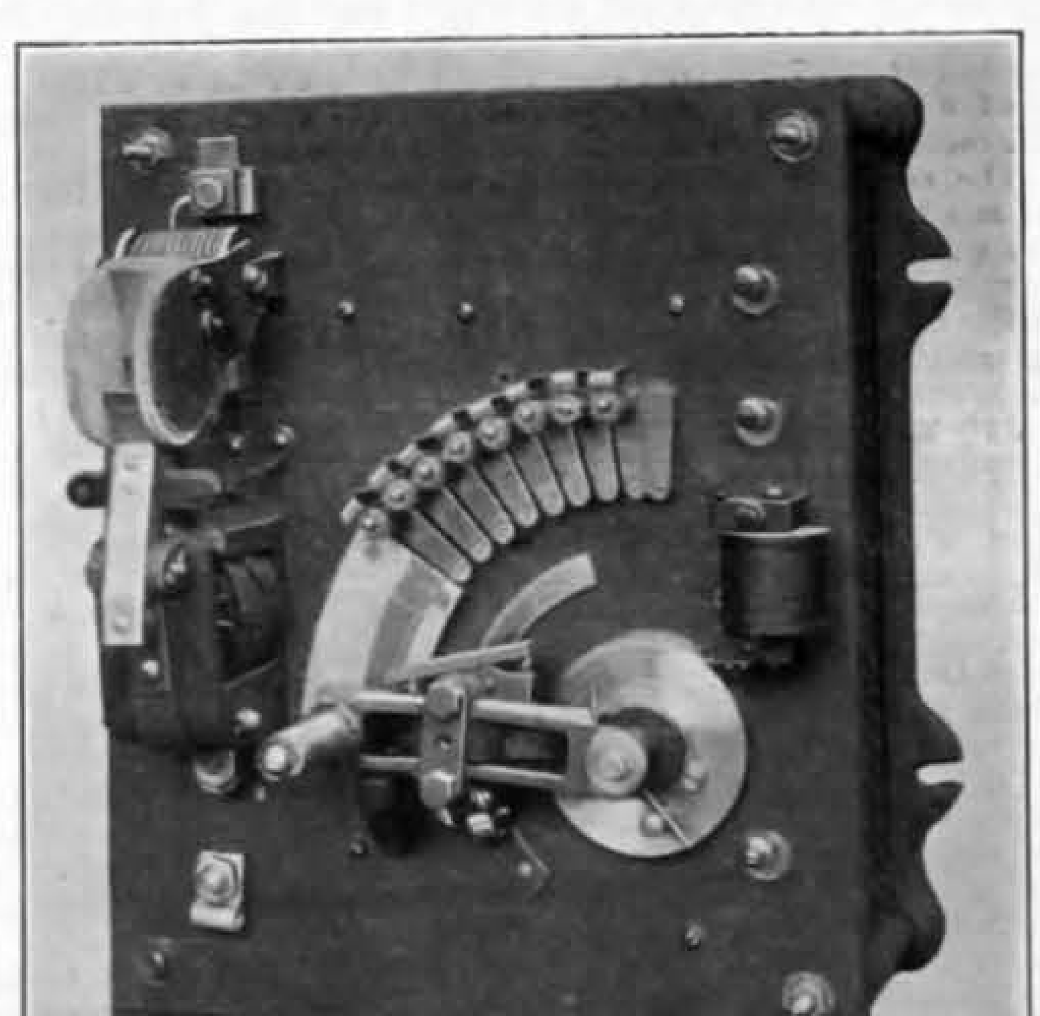


Fig. 2—STARTING SWITCH

the object being to move the press forward a very small distance. This process constantly repeated may cause injurious arcing on the contacts of the starting switch, with the result that ordinary types are liable to be soon destroyed, and even though renewable contacts may be used, the renewals may be so frequently required as to become a nuisance, as well as an appreciable expense.

To prevent this arcing various devices have been introduced, but in the starter illustrated a new method has been adopted which it is claimed is far more satisfactory than anything which has hitherto been placed upon the market. The manufacturers of this new starter maintain that other devices have failed because they have only protected the first step, whereas the minder, whose eyes must be on the machine and not on the starter, pushes the handle when "inching" over to the third or fourth contact, or perhaps further, and in moving it back draws a destructive arc across the contacts.

As will be gathered from the illustrations, this new switch is provided with an interlocked magnetic circuit maker and breaker. The special feature of this arrangement is that no matter how far the operator pushes the handle over in a forward direction, the slightest backward movement instantly opens the circuit breaker. Consequently no arcing can occur on the starter contacts, because they are made dead by the opening of the breaker. The circuit breaker has carbon contacts and magnetic blow-out, and will consequently open the circuit an infinite number of times without injury. It is claimed that with this starter "inching" may be practised to any extent. We are told that a recent extended trial in a large printing works, under ordinary working conditions, left the contacts as good as new. In addition the interlocking of the circuit breaker with the starter makes it impossible to close the motor circuit unless all the starting resistance is in circuit, thus the motor receives proper usage, for the starting switch is practically fool-proof.

THE "TIME-SAVER" AUTOMATIC INJECTOR.

THE injector illustrated in Figs. 1 and 2 herewith differs from others at present before the public in that the body which contains the nozzles can be dismounted by removing four T bolts, and without disconnecting any pipe joints. The instrument consists of three main parts, a branch piece, body,

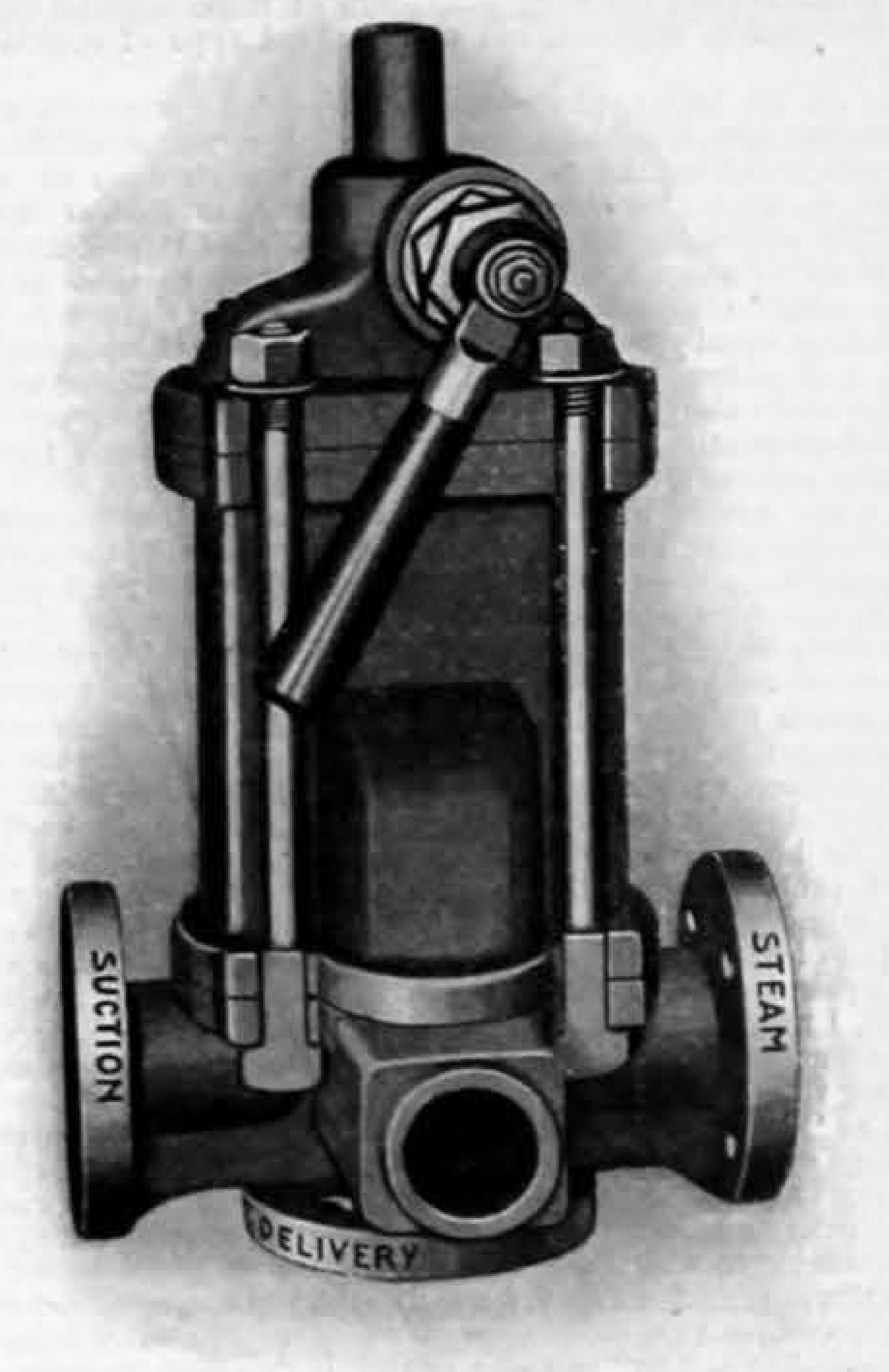


Fig. 1—THE "TIME-SAVER" INJECTOR

and cap. The bottom section has four branches—for the steam A, water B, delivery C, and overflow D. Attached to it is the overflow valve, consisting of a small bend with inclined seat, on which an automatic hinged valve seats. After the body has been removed, this valve and seat can be easily withdrawn for examination. In the body are arranged the steam, water, mixing, and pressure nozzles, which can be removed with ease. The working of the injector is not interfered with by the joints, as the nozzles are fitted in such a

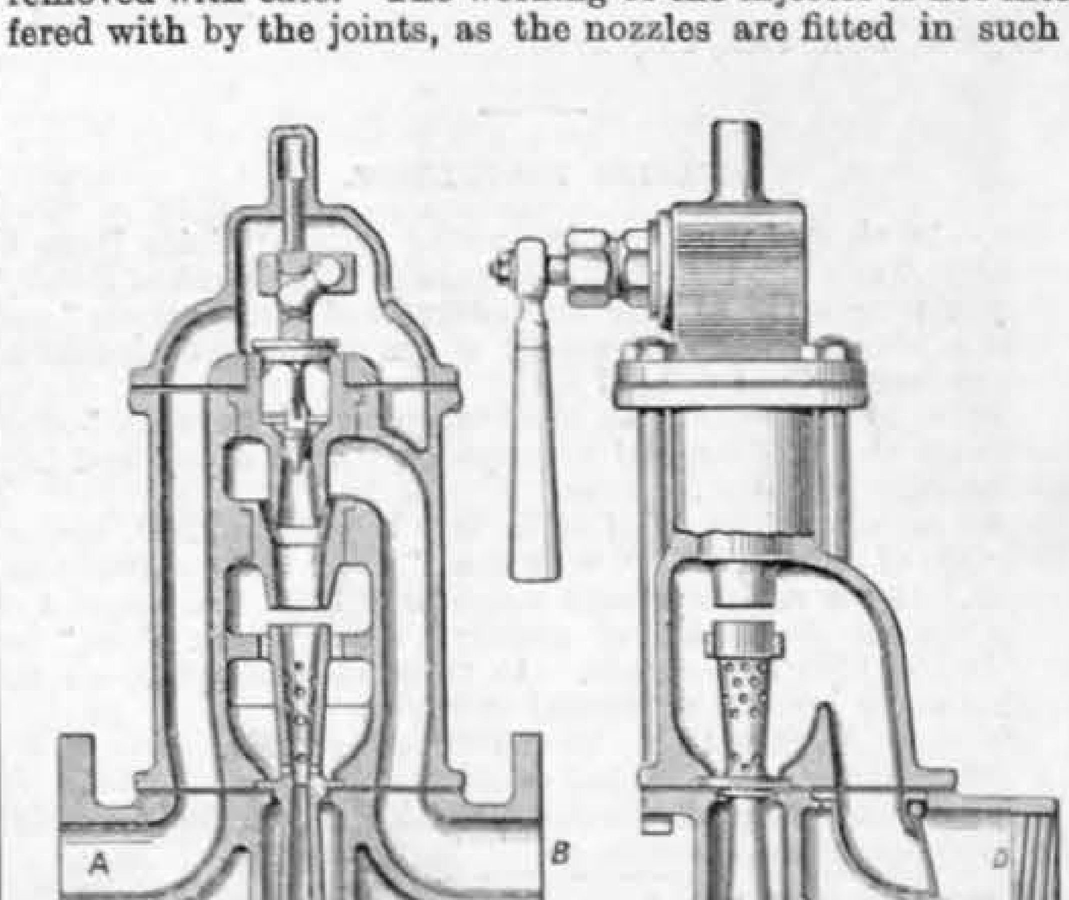


Fig. 2—DETAILS OF INJECTOR

manner that the thickness of the jointing material does not affect the distance between the nozzles and their proper setting. It will be seen from the sectional views that there are no moving cones. The steam valve is contained in the cap. The injector is made according to Dikker's patent by W. H. Bailey and Co., Limited, Manchester.

EXPERIMENTS are being conducted under the supervision of the Ordnance Department of the United States Army with a light-running motor designed to carry small rapid-firing guns, ammunition or rations. The idea is to devise a high-speed light-running car that may be applied to the numerous uses necessary in a flying campaign.

LETTERS TO THE EDITOR.

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

BRITISH LOCOMOTIVE PRACTICE OF TO-DAY.

SIR,—I have read Mr. Henry W. Dearberg's letter, as also the one signed "Excelsior," which appeared in your issue of July 23rd, with great interest. In reply to Mr. Dearberg, I should like to point out that although the diagram of the express simple engine may appear to leave nothing to be desired as regards expanding the steam down to a low terminal pressure, we know that the Worsdell type of compound engine also did excellent work when expanding the steam in two cylinders, and that it was also able to maintain a high rate of speed when so doing. As the power developed and economy attained by both simple and compound engines is practically the same, it may be assumed that each use an equal weight of steam; there are, therefore, two methods of using up steam expansively in the cylinders of a locomotive; the question is which method is the better when seeking to increase the power of the engine?

In face of the good work which is being done by the De Glehn type of compound, I cannot agree that the greatest field for compounding lies with the slow heavy pulling type of engine. The whole question is one of enhanced power. The engine which has the power to pull the heaviest load will also have the power to climb gradients at a high speed. Let us assume, for instance, that the power of the locomotive requires to be enhanced by as much as 50 per cent. It must be obvious that the cylinders would require to be of large capacity to meet this demand, probably with the assistance of high steam pressure. When we consider that an engine on the compound system can be designed to meet this demand from the use of a combination of high and low-pressure cylinders, and that the simple engine could only be designed to meet the demand by enlarging the high-pressure cylinders up to the capacity of the low-pressure cylinders of the compound engine, the apparent failure of the compound can only be attributed to engineers not making that type of engine more powerful.

Let us, for instance, analyse the Worsdell compound engine, which has one 20in. high-pressure cylinder, and one 28in. low-pressure cylinder. In the first place, the work done by a compound engine is that of referring the steam to that of the low-pressure cylinder. The area of this cylinder is practically the same as two cylinders 19¾in. in diameter, so that had the "Worsdell" engine been fitted with two such cylinders it would have done equally as well as the compound. Compounding an engine, therefore, without increasing the total cylinder capacity brings about absolutely no gain. This, however, is practically how British locomotive practice stands to-day; at the same time continental engineers are making progress but slowly.

I quite agree with Mr. Dearberg as to the necessity for standardising, and consider that there is not the slightest difficulty in designing a compound engine which will answer all purposes having one type of engine only.

In reply to "Excelsior." He begins his letter by referring to that much discussed question of over-cylindering the locomotive, than which nothing has done more to delay its improvement. In this connection we have surely been taught a lesson by the motor car engineer, who designs engines to develop as much as 250 horse-power and places them on frames, to which they also fit engines of only 40 horse-power, the adhesive weight on the wheels of the latter probably being the greater. It is, however, due to this over-cylindering that the high-powered motor car is able to get up a speed of 125 miles an hour, or twice that possible with the 40 horse-power car. If our locomotives were similarly over-cylindered, I think we could safely rely on the drivers making use of the steam in a similar manner to that of the chauffeur when controlling the carburettor.

If, as "Excelsior" states, there is a disadvantage from the use of large cylinders—I found none from the use of a 31½in. cylinder—it can only be due to faulty design, and can therefore easily be remedied.

I quite agree with "Excelsior" that the introduction of very high steam pressure would speedily settle the question, for very high pressures can only be used to advantage in a compound engine. Any attempt to make use of high steam pressure in a simple engine would necessitate a reduction in the cylinder area, which would merely be a distinction without a difference, nor would the use of multiple high-pressure cylinders be of much avail.

"Excelsior" states that the trial of a Serpollet boiler would be interesting to watch—at a distance. Why at a distance? He must surely be aware that there can be no disastrous explosion from such a boiler. Personally I sit within a couple of feet of a Serpollet boiler when the pressure gauge records a pressure of 1000 lb. Nor is there the slightest danger in working the boiler at this pressure. I can see no difficulty in designing a boiler of this type which would be suitable for a high-powered engine.

JOHN RIEKIE.

Argaith, Dumbreck, July 26th.

MARINE PROPULSION.

SIR,—In view of your very interesting article "Going Down to the Roots," and also Sir George Greenhill's "The Work of Recoil," will you permit me to give some aspects of "momentum" and "kinetic energy" when the energy of one moving body is used to cause momentum on another?

In order to avoid confusion or unnecessary controversy, I shall start with the fundamental principle of "work done," and only use generally accepted formulæ.

If we raise a weight W of 50 lb. to a height H of 20ft. against the action of gravity, then "work done" = 50 × 20 = 1000 foot-pounds. If we raise a second weight w of 10 lb. to a height h of 100ft. against the action of gravity, then "work done" = 10 × 100 = 1000 foot-pounds. In these elevated positions the weights would represent potential energy =

$$W\,H = 50 \times 20 = 1000 \text{ foot-pounds},$$
$$\text{and } w\,h = 10 \times 100 = 1000 \text{ foot-pounds}.$$

To allow these respective weights to fall freely under the action of gravity we obtain velocities:—

$$V = \sqrt{2\,g\,H} = \sqrt{2 \times 32{\cdot}2 \times 20} = 35{\cdot}9\text{ft. per second.}$$
$$v = \sqrt{2\,g\,h} = \sqrt{2 \times 32{\cdot}2 \times 100} = 80{\cdot}25\text{ft. per second.}$$

At these velocities the kinetic energy would be:—

$$W\frac{V^2}{2g} = 50\frac{35.9 \times 35.9}{64.4} = 1000 \text{ foot-pounds},$$
$$w\frac{v^2}{2\,g} = 10\frac{80.25 \times 80.25}{64.4} = 1000 \text{ foot-pounds.}$$

We have now two certain masses with two certain velocities possessing equal kinetic energy.

To use the same figures for weight and mass will here make no difference in the results. If, now, the two masses were to impinge on one another in a straight opposite direction, taking the masses to be abstract, perfect solids, then, according to the conservation of momentum, we obtain:—

$$V_1 = \frac{M\,V - m\,v}{M + m} = \frac{(50 \times 35.9) - (10 \times 80.25)}{50 + 10}$$
$$= V_1 = 16.54\text{ft. per second.}$$

So that after the impact both masses would move with velocity V_1 of 16.54ft. per second in the direction of motion of the greater mass before the impact.

Accordingly the energy (1000 foot-pounds) of M or W has not only overcome the equal energy (1000 foot-pounds) of m or w, but retained itself:—

$$W\frac{V^2_1}{2\,g} = 50\frac{16.54 \times 16.54}{64.4} = 212 \text{ foot-pounds},$$

and given to m

$$w\frac{V^2_1}{2\,g} = 10\frac{16.54 \times 16.54}{64.4} = 42.4 \text{ foot-pounds.}$$

If only the greater mass were moving and the smaller one were stationary, then we obtain

$$V_2 = \frac{M\,V + m}{M + m} = \frac{50 \times 35.9 + 10}{50 + 10} = 30\text{ft. per second.}$$

$$\text{Energy left} = W\frac{V^2_2}{2\,g} = 50\frac{30 \times 30}{64.4} = 697.5 \text{ foot-pounds},$$

$$\text{and in} \quad = w\frac{V^2_2}{2\,g} = 10\frac{30 \times 30}{64.4} = 139.5 \text{ foot-pounds.}$$

Energy apparently disappeared = 1000 − 837 = 163 foot-pounds.

If, however, the smaller mass only is moving, and it impinges on the greater mass, we find that much more energy seems to disappear, and if this is done with the shot cited by Sir George Greenhill, and allowed to impinge on the mass of the gun and carriage, then we find that the energy of the shot is just about sufficient to produce the same velocity in the gun which the recoil did originally. In figures:—

$$V = \frac{w\,v + W}{w + W} = \frac{850 \times 3000 + 112{,}000}{850 + 112{,}000} = 23{\cdot}5\text{ft. per second,}$$

which is very near the recoil velocity given by Sir George Greenhill, namely, 20 f/s about. This seems to justify my logical deduction that as the shot cannot produce more velocity on the gun than the original recoil, the energy expended in producing the original recoil must be equal to the energy expended on the shot. It is this that I have maintained throughout this discussion, namely, that the magnitude, or amount of work done by action and reaction, in foot-pounds, foot-tons, or metre kilogrammes, is equal and opposite, whilst, of course, it is evident that the kind of work may differ to any extent, like moving large masses slowly or small masses quickly. It does not seem logical to me that when estimating any "total work done," it is only necessary to ascertain the "available kinetic energy."

Regarding marine propulsion, kinetic energy need really not at all be brought in, and the whole matter could be settled by pressure, which I endeavoured to do in my letters published in THE ENGINEER on June 11th, May 21st, April 23rd and March 19th.

It must be evident that not only 5 per cent. or 10 per cent. or 50 per cent. of the engine energy is transmitted on to the water, but the whole 100 per cent. which reaches the propeller, and it is on the reaction of the water on which the speed of the vessel depends. It must also be evident that a column of water of a certain cross section moved twice as fast as originally also means twice as much water, and the resistance or reaction must be in proportion to the energy absorbed by the water.

July 26th. W. PREIDEL.

MOMENTUM, ENERGY, AND WORK.

SIR,—If, as "Fuse" assumes, the gun recoils freely 2ft. while the shot advances 48ft. along a chase 50ft. long, he implies that the gun is only twenty-four times the weight of the shot, while the energy is as 1 to 24; so that, taking the figures given in Lieut. Dawson's lecture, the energy of the shot being 53,000 foot-tons, the energy of the gun is 53,000 ÷ 24 = 2208 foot-tons—much too great to be manageable.

Lieut. Dawson tells us that 53,000 foot-tons is the energy of the shot at a velocity of 3000 f./s., and this implies that, if the shot weighs w lb.,

$$\frac{w}{2240}\;\frac{v^2}{2g} = 53{,}000,$$

when v = 3000; or, with g = 32, w = 2240 × 64 × 53,000 ÷ (3000)² = 844.23 lb., and this becomes 850 lb., the official figure, on raising g to 32.2.

We should have been spared the trouble of this calculation if the weight of the shot had been stated in the lecture; but, now, a gun twenty-four times heavier than this shot will weigh 24 × 850 = 20,400 lb. = 9.1 tons, and the energy of 2208 foot-tons of recoil would be enough to lift the gun vertically 2208 ÷ 9.1 = 242.6ft., which will show the liveliness of the recoil of so light a gun.

But the real gun weighs more like 50 tons = 112,000 lb., or 132 fold; and then the length of recoil during the passage of the shot up a chase 50ft. long is only 50 × 850 ÷ 112,850 = 0.376ft., say four inches and a-half.

If F is the average thrust in tons of the powder on the base of the shot, F = 53,000 ÷ (50 − 0.376) = 1068 tons, equivalent in a 12in. gun to a pressure 1068 ÷ (0.7854 × 144) = 9.44 tons/inch², instead of the 7.25 given previously; the discrepancy was due to the fault of taking round numbers with the small figures, cutting the recoil velocity down to 20 f./s., and g down to 32.

The recoiling velocity of the gun as the shot is leaving the muzzle is 3000 × 850 ÷ 112,000 = 22.8 f./s., and the energy of the gun is then 53,000 × 850 ÷ 112,000 = 402 ft./tons—enough to raise its weight of 50 tons vertically about 8ft.; or an average buffer resistance of 100 tons would check the recoil in 4ft.; and at an average velocity of 11.4 f./s. this takes 4 ÷ 11.4 = 0.35 seconds.

July 26th. G. GREENHILL.

COLOMBIAN MINING.

SIR,—Your article in THE ENGINEER of 23rd inst. was very interesting to me as an engineer who has been there, and having some knowledge of interior conditions—no doubt there are hundreds of persons with more—I think I can give some useful information amplifying your article.

(*a*) Communications:—It may be said that—roughly—communication with the interior is wholly dependent on the rivers and on mules. The navigation of the Magdalena is impeded by numerous shoals and by baffling and perplexing cross currents and limited by low water in the dry season. Thus goods landed at Barranquilla may have to lie there for weeks before they can be sent up the river, and *en route* the steamer may swing suddenly round, and, drifting into the bank, wreck her stern wheel and come to complete destruction. Such an accident may seriously spoil a mining company's prospects for half a year. This is on the main river where steamers drawing 4ft. 6in. can pass. On the smaller rivers—*e.g.*, the Nechi—navigation is still more difficult, and impossible to the larger steamers. Thus it is out of the question to do work quickly, and the best laid plans are often defeated by causes beyond the control of anyone.

The railways, such as there are, only serve as feeders to and from the river Magdalena, and to pass absolute bars to navigation of any sort, *e.g.*, the railway from Savanilla to Barranquilla. Thus the river governs everything.

Mules:—A fair average load may be taken at 250 lb. Some exceptional animals will carry 300 lb., and some poor beasts will die under less than 200 lb. A great deal depends on the route and season. It is obvious that a beast can carry much more weight, and with less distress on a good, hard trail than it can on a road formed on a tough sticky clay, into which it sinks to the girths at frequent intervals. This latter may be taken as the common condition of the roads at the close of the wet season.

The practicable load also depends on the class of load and its packing. The essential point is to get as evenly balanced a load as possible each side of the fore-and-aft line, and so arranged that it is as little topheavy as possible. Thus we have a load of 125 lb. slung each side of the animal by the lashings—raw hide, dried—passing over the pack saddle. It is possible to carry a heavy load, such as a casting, on the back of the animal, provided that its shape is such that it naturally fits, or can be made to fit the saddle, and also can be effectively lashed. It must not be of any great height, for in the—inevitable—event of the beast leaning to one side, the weight tends to pull him over, and on rough ground he may either roll down a hill and destroy himself or the load, or fall into a mud hole and stick there. Note: In both cases the load will quite likely lie where it has fallen for months. There must be hundreds of tons of machinery lying on the banks of the river which is abandoned, owing to the impossibility of transporting it farther.

(*b*) Engineering:—What precisely is meant by "First-class Engineers?" Book knowledge is at a heavy discount, for the reason that it is useless designing elaborate and delicate machinery to be run by more or less careless native labour, perhaps entirely without supervision whilst the English boss is in bed with fever. What is wanted is ability to scheme ways out of difficulties caused by breakdown and losses in transport, fair health, and—for this country—muscular strength. Muscular strength will largely fail when an Englishman tries to make long continued exertion of any kind, even in the higher country of Antioquia. The real cause of so many failures is the total inability of men at home to realise the difficulties and needs of their concerns. Thus, machinery is designed and sent out, which may be reckoned extra first-class in this or any civilised country, but which proves a miserable failure from the simple cause of insufficient consideration of climate and labour.

For example, a plant is designed and sent out, I have no doubt admirable for better conditions, but quite unreliable in the circumstances and requiring an electrician's skilled supervision. The generators built for 3000 volts after repeated breakdown, due to insulation failures caused by the mouldy tropical dampness of the air, have necessitated the lowering of the pressure to 1700 volts. What was really required was a special design to meet the conditions.

Departures from standard designs cost money, it is true, but reasonable capital cost is less important than having a rich level drowned for months together by a short failure of pumping power. To unwater a drowned shaft takes vastly more time than it takes to keep it unwatered. Thus, if a pumping plant has a reserve capacity 10 per cent. beyond ordinary needs, a single day's stoppage causes a collection of water that will require ten days to get out. Electrical power is put to a vastly more vital duty when applied to drainage than in any other department. Such points as this are liable to be overlooked.

Angmering, July 24th. GEO. T. PARDOE.

Δ FALLACIES.

SIR,—Your correspondent "W. J. H." is distressed that he is unable to find out the correct displacement of our ships, and finds a general unwillingness on the part of owners and naval architects to disclose the Δ of their productions. But surely he must know that this is because they do not know what Δ is themselves.

You will remember, Sir, doubtless if you have studied your "Alice," that the White Knight sang a song, and he was careful to explain what it was before he began. First of all, there was the name of the song, then there was what the song was called, and, lastly, there was what the song really was, and these were all different.

A similar state of affairs rules with Δ, especially in the case of warships. First of all, there is the name of it, which, being interpreted, is the displacement at the designed draught. A warship passes through this stage once during completion. When the designed draught has been reached within ¼in., an urgent telegram is sent to the Admiralty. The next day a constructor arrives, and, having walked round the ship, and noticed that everything—or nearly everything—is on board, he proceeds to row round the vessel in a boat, and notes the draught. In the meantime, a few hundred more men have been sent on board, and, hey presto! the vessel is exactly down to the designed draught. Much cheering, and a special meeting of the Admiralty Mutual Admiration Society, at which pats on the back are administered all round. Some months elapse before we come to the second stage—what the displacement is called. It is called "deep draught." By this time the vessel has undergone trials, several junior officers have joined, with their sea chests and bicycles, the ward-room piano is on board, and the washing has all come back from the laundry. These items, and possibly some others, account for the deep draught. The last stage—what the displacement really is—does not arrive until the vessel is in regular commission, and, presumably, ready for battle. At this time a few unconsidered trifles of weight, such as coal in reserve bunkers and ammunition, have been added. But when we arrive at this stage, the upper edge of the armour belt is getting perilously near the water-line, and it is discreet to say as little about this stage as possible. Hence the mystery of Δ.

July 28th. WETTED SURFACE.

LAUNCHES AND TRIAL TRIPS.

WOODMERE, steel screw steamer; built by the Blyth Shipbuilding and Dry Docks Company, Limited; to the order of Messrs. Falconer, Ross and Co., Newcastle-on-Tyne; dimensions, length, 193ft. 8in., beam 26ft. 6in.; engines, triple-expansion; constructed by Mr. G. T. Grey, South Shields; launch, July 15th.

SHONGA, steel screw steamer; built by Irvine's Shipbuilding and Dry Docks Company, Limited; to the order of Elder, Dempster and Co., Liverpool; dimensions, 355ft. by 46ft. by 25ft. 3in.; engines, triple-expansion, 25in., 40in., 67in. by 45in. stroke, pressure 180 lb.; constructed by Richardsons, Westgarth and Co., Limited, Hartlepool; launch, July 19th.

APPENINE, steel screw steamer; built by Irvine's Shipbuilding and Dry Docks Company, Limited; to the order of the Gulf Line, Limited; dimensions, 360ft. by 51ft. by 25ft. 6in.; to carry 6300 tons; engines, triple-expansion, 25in., 40in., 67in. by 45in. stroke, pressure 180 lb.; constructed by Richardsons, Westgarth and Co.; launch, July 20th.

ROSENDAL, steel screw steamer for passenger and cargo trade; built by the Laxevaags Engineering and Shipbuilding Company, Bergen; to the order of "Hardanger Sondhordlandske Selskab," Bergen; dimensions, 151ft. by 23ft. by 11ft. 3in.; launch, July 20th.

ARMSTOR, steel screw steamer; built by Irvine's Shipbuilding and Dry Docks Company, Limited; to the order of Furness, Withy and Co, Limited; dimensions, 336ft. by 47ft. by 24ft. 10in.; engines, triple-expansion, 32½in., 36in., 64in. by 42in. stroke, pressure 180 lb.; constructed by Richardsons, Westgarth and Co.; trial trip, July 24th.

NYLAND, turret deck steamer; built by William Doxford and Son, Limited; to the order of Axel Broström and Son, Gothenburg; trial trip, July 27th.

TYNEMOUTH, steel screw steamer; built by Wood, Skinner and Co., Limited; to the order of the Burnett Steamship Company, Limited; engines, triple-expansion, 21in., 34in., 56in. by 36in. stroke, pressure 180 lb.; constructed by the North-Eastern Marine Engineering Company, Limited; trial trip recently.

LOCOMOTIVES DESIGNED AND BUILT AT HORWICH, WITH SOME RESULTS.*

By Mr. GEORGE HUGHES, Member, Chief Mechanical Engineer, Lancashire and Yorkshire Railway, Horwich.

Before discussing the design and performance of locomotives the critic must have some knowledge of the railway upon which they run and the nature of the work they perform. Particulars will be found by referring to the appendices and the subjoined diagram—Fig. 1—and statement, which give the power and weight of the various locomotives operating this traffic—see also Figs. 2 to 10.

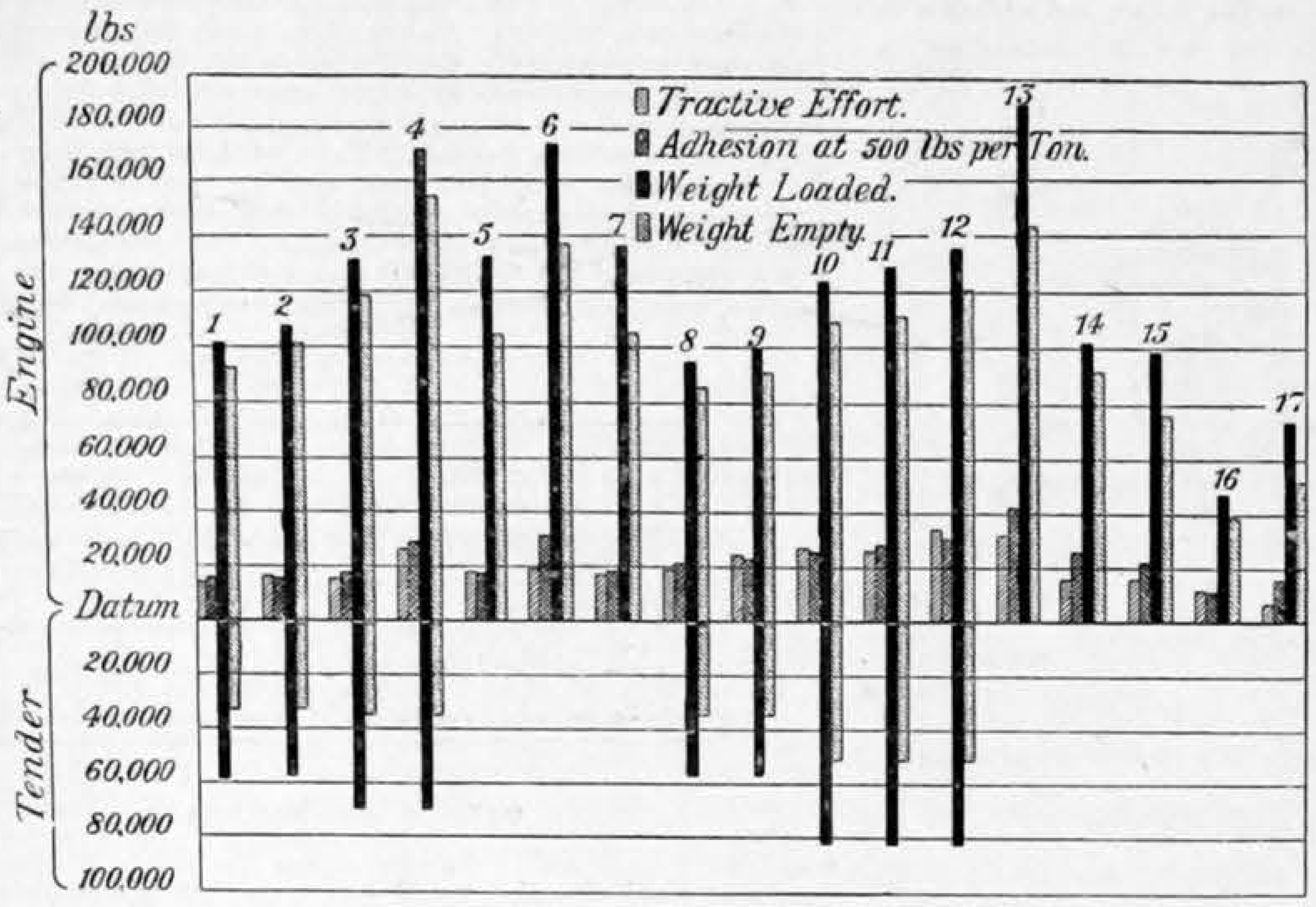
The Lancashire and Yorkshire Railway Company possess 1517 locomotives, 1052 of which have been constructed at Horwich, and there are about 1100 engines in steam daily, varying, of course, according to the demands of the traffic.

When the works at Horwich were opened the company had 1000 engines, namely, 353 passenger, and 647 goods. There were twenty-nine different types of passenger engines, and twenty-six types of goods engines. Realising the great importance of having as few classes as possible, Mr. Aspinall, then chief mechanical engineer, resolved to reduce the number, and to introduce standardisation, and, wherever possible, interchangeability. This policy, no doubt, from a commercial point of view, is correct, but requires to be judiciously handled, and at the right moment, otherwise it may have a tendency to impede progress. After due consideration and from the running experience of a number of engines, some fitted with Joy gear, and others with the Stephenson link motion, but otherwise of the same design, Mr. Aspinall decided to adopt the Joy gear, as it was found that the mileage between repairs was greater, and also that there was a slight economy of coal per engine mile. Consequently, the Joy motion was adopted for all future new engines—Fig. 11. At the time this gear was designed, the cylinders were 17½in. by 26in. stroke, with a working pressure of 160 lb. per square inch, but bearing the fact in mind that the size of trains was increasing rapidly, and having decided upon interchangeability, the motion was designed on such liberal lines that it has stood the test of over twenty years, and has actually been used for engines with 21½in. diameter cylinders, and a working pressure of 180 lb. per square inch. Until the advent of the fast heavy passenger and goods trains, this gave every satisfaction. However, the increasing size of cylinders, demanded by heavier trains and accelerated speeds, has now rendered it necessary to strengthen this motion.

As regards interchangeability of boilers, the flanged plates were common to each class for a number of years, with only a slight difference in the lengths of the barrels, but this uniformity was disturbed by the introduction of the larger types, and Figs. 12 to 16 illustrate the different boilers, and Fig. 17 gives specimens of the flanged plates now in use. Interchangeability was also extended to cylinders, valves, axles, axle-boxes, springs, wheels, and boiler mountings.

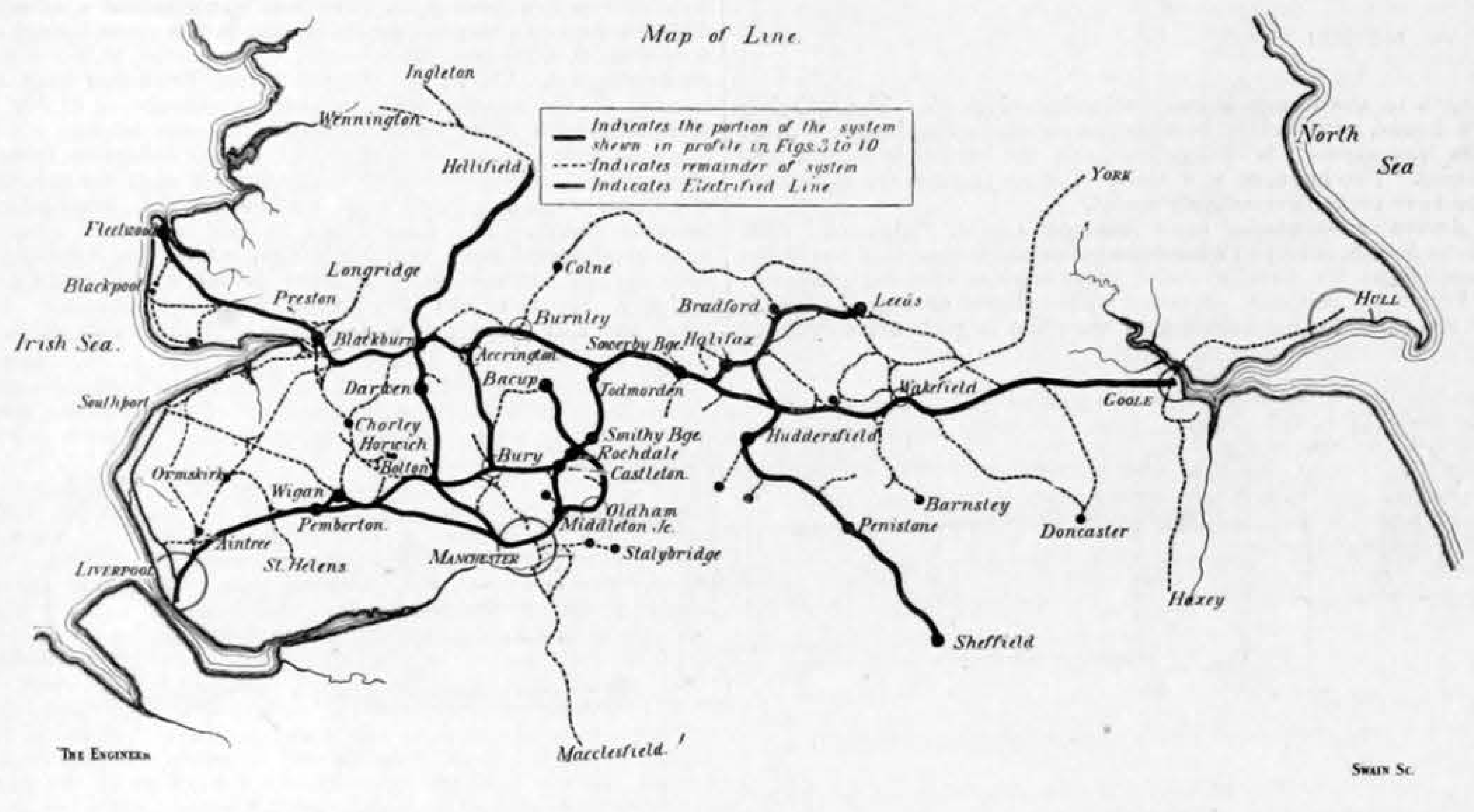
Aspinall's standard radial passenger tank engine. (Built February, 1889.)—The first type of engine built was the eight-wheeled tank engine, four wheels coupled, with a radial box at each end—Fig. 18—an arrangement possessing many advantages for engines which have to work equally well in either direction. The number of engines built of this class is 270, and their usefulness is shown by the fact that they run 56 per cent. of the total passenger engine miles. The cylinders are inside, with valves on the top, thus giving ample steam-chest room and easy access to valve faces. The earlier engines of this class were fitted with unbalanced D valves, but a number are now running with the Richardson balanced form of valve, and some also with a circular balanced back-to-back valve of Mr. Aspinall's design. Water is carried in side and back tanks, fitted with a scoop to pick up when running in either direction. The lowering and raising of the scoop is accomplished by means of Aspinall's well-known vacuum arrangement, which has been used on all subsequent engines. These engines haul trains of 270 tons behind the draw-bar, at an average speed of 36.5 miles per hour, over grades shown on Fig. 6.

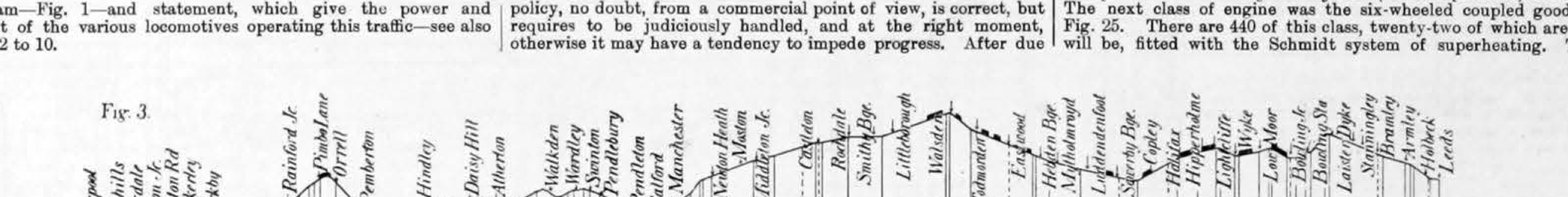
Aspinall's six-wheeled goods engine. (Built September, 1889.)—The next class of engine was the six-wheeled coupled goods—Fig. 25. There are 440 of this class, twenty-two of which are, or will be, fitted with the Schmidt system of superheating. The cylinders, with the exception of those fitted with superheaters, are similar to those on the radial tank engines, having either unbalanced D valves or the Richardson balanced type. These



	Class.	Tractive Effort 80% of Boiler Pressure	Adhesion at 500lbs per Ton	Weight of Engine Loaded	Weight of Engine Empty	Ratio of Weight on Drivers to Tractive Effort	Ratio of Weight on Drivers to Total Weight	Ratio of Weight Loaded to Weight Empty
		LBS	LBS	LBS	LBS			
1	Aspinalls Eight Wheeled Passenger.	13843	15500	100352	92512	4.97	.69	1.08
2	Eight Wheeled Passenger with Superheater.	17214	16175	107604	101248	4.21	.67	1.06
3	Aspinall's Ten Wheeled Passenger.	15535	17500	131600	118300	3.04	.50	1.11
4	Hughes' Four Cylinder Passenger.	25539	29500	172648	158704	5.17	.76	1.09
5	Aspinall's Eight Wheeled Radial Tanks.	17839	17375	132244	103096	4.36	.59	1.28
6	Hoy's Ten Wheeled Radial Tanks.	19876	26175	173628	136668	5.9	.68	1.27
7	Eight Wheeled Radial Tanks with Thermal Storage.	17839	18425	135184	104524	4.63	.61	1.20
8	Aspinall's Six Wheeled Goods.	19886	21075	94164	85120	4.74	1.00	1.10
9	Six Wheeled Goods with Superheater.	24551	22125	99120	91728	4.03	1.00	1.08
10	Aspinall's Eight Wheeled Goods.	27133	26875	120372	109732	4.34	1.00	1.09
11	Eight Wheeled Goods with Corrugated Boiler.	27133	28975	129680	112672	4.68	1.00	1.15
12	Hughes' Four Cylinder Compound Goods.	33535	30400	136220	121716	4.06	1.00	1.12
13	Hughes' Banking Engine.	32049	42000	188160	146468	5.87	1.00	1.28
14	Aspinall's Six Wheeled Shunting Tanks.	16441	25000	112000	91924	6.8	1.00	1.21
15	Converted Saddle Tanks.	16515	21925	98224	76160	5.94	1.00	1.29
16	Pug Engines.	10704	10625	47600	39068	4.44	1.00	1.21
17	Rail Motors.	7605	16350	78248	51656	9.63	1.00	1.18

Fig. 1—POWER AND WEIGHT OF LOCOMOTIVES





Figs. 3 to 10—GRADIENTS ON THE LINE

* The Institution of Mechanical Engineers.

engines are employed in hauling goods loads up to 760 tons, and, possessing a moderately-sized wheel, are very useful for passenger traffic during the excursion season. Being simple in design, and the parts accessible, they are light on maintenance, and easy to repair. Several are fitted for steam heating of carriages. The six-wheeled tenders, which carry 1800 gallons of water and 3 tons of coal, have the water pick-up arrangement.

Aspinall's eight-wheeled bogie passenger engine. (Built March, 1891.)—These engines—Fig. 27—followed the goods engines.

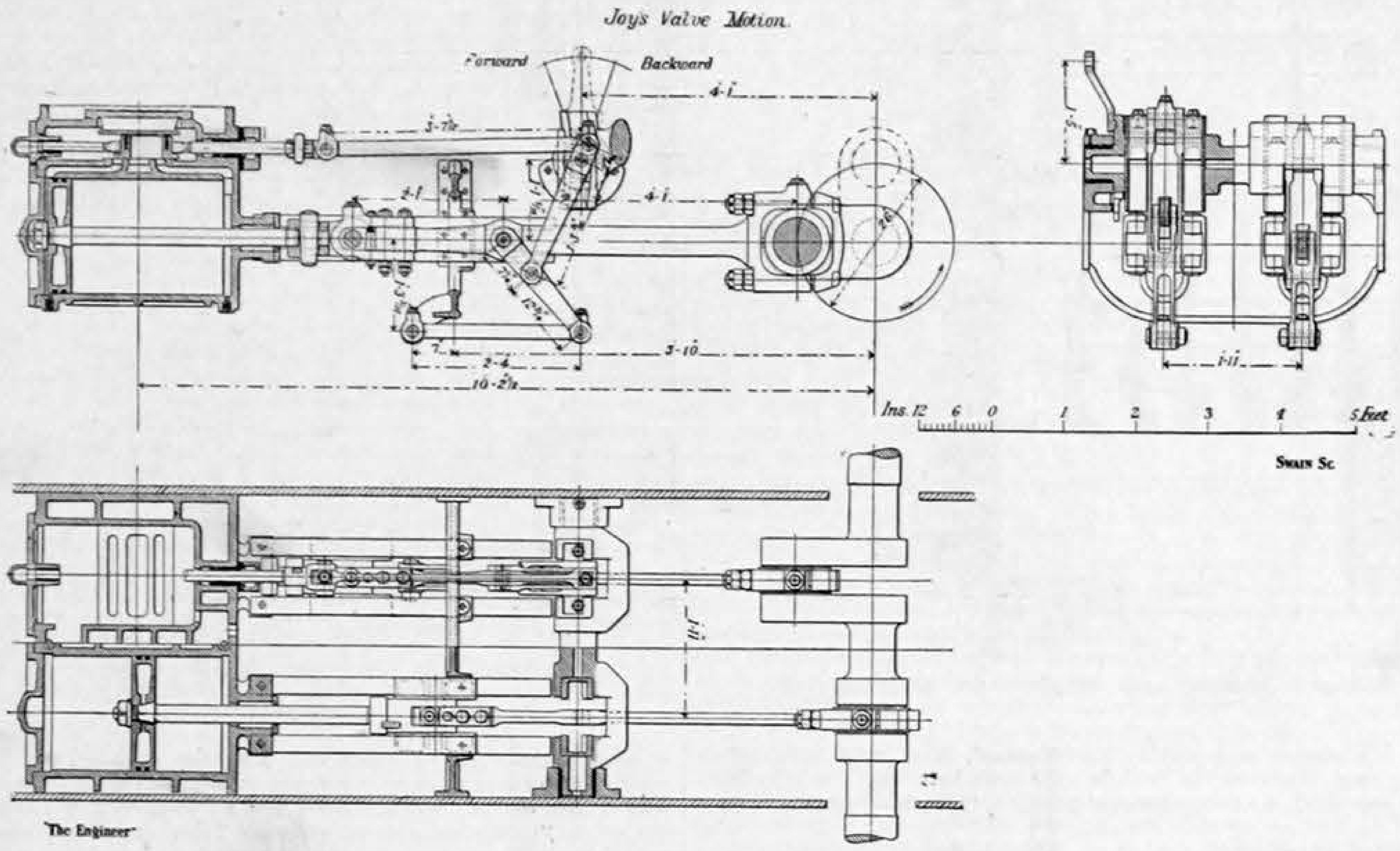
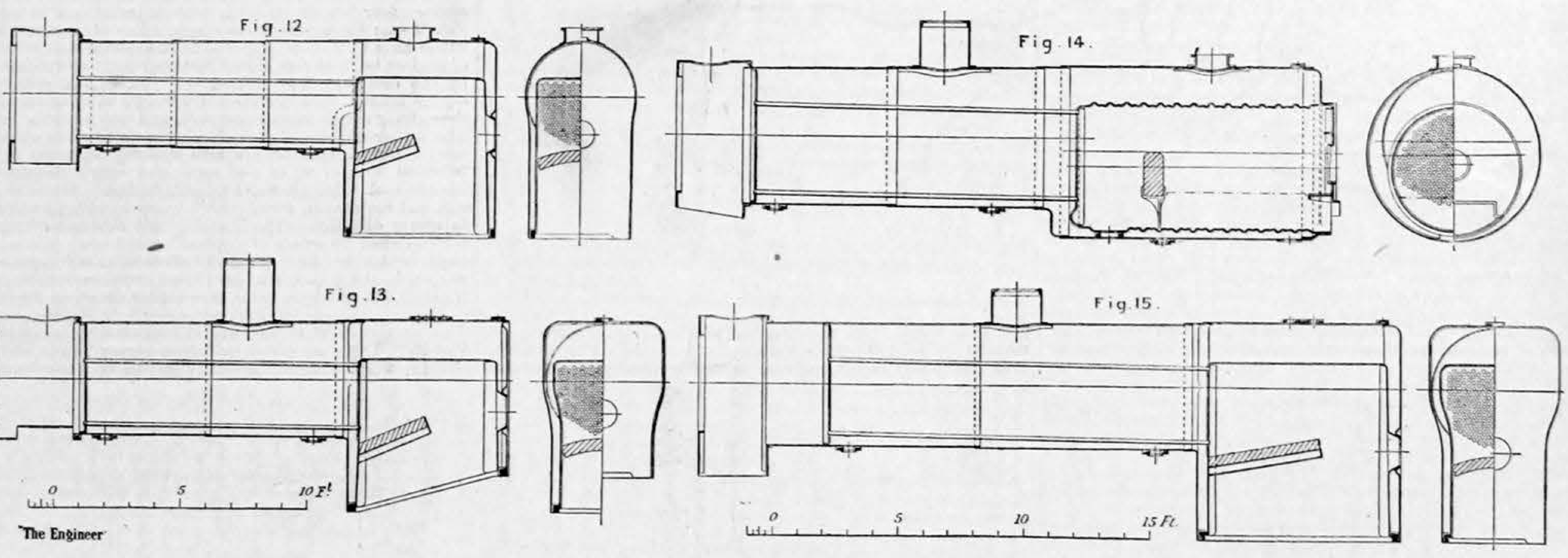


Fig. 11—JOY'S VALVE MOTION

They were designed to work the fast passenger traffic between Manchester and Southport, Manchester and Liverpool, Manchester and Blackpool, and Manchester and Leeds, and have similar cylinders to the goods engines, and unbalanced valves. When designed, they had the largest coupled driving wheels in this country—namely, 7ft. 3in. diameter. The tenders are interchangeable with those of the goods engines. The maximum loads hauled are 220 tons over routes shown on Fig. 3, at an average speed of 42.8 miles per hour. Forty of these engines have been constructed.



Figs. 12 to 15—TYPES OF BOILERS

Aspinall's small four-wheeled shunting tank engine. (Built November, 1891.)—The next engine constructed was the small shunting tank, or "Pug" engine—Fig. 24. The aim in this design was to attain lightness and power. They have outside cylinders, with valves placed inside the frames, Stephenson motion, and are employed to work the traffic on the dock sides at Liverpool, Fleetwood, and Goole. Possessing good hauling power for their weight, and having a short wheel base, they are useful for handling the traffic round the sharp curves with which these dock sides abound. There are thirty-seven of this type.

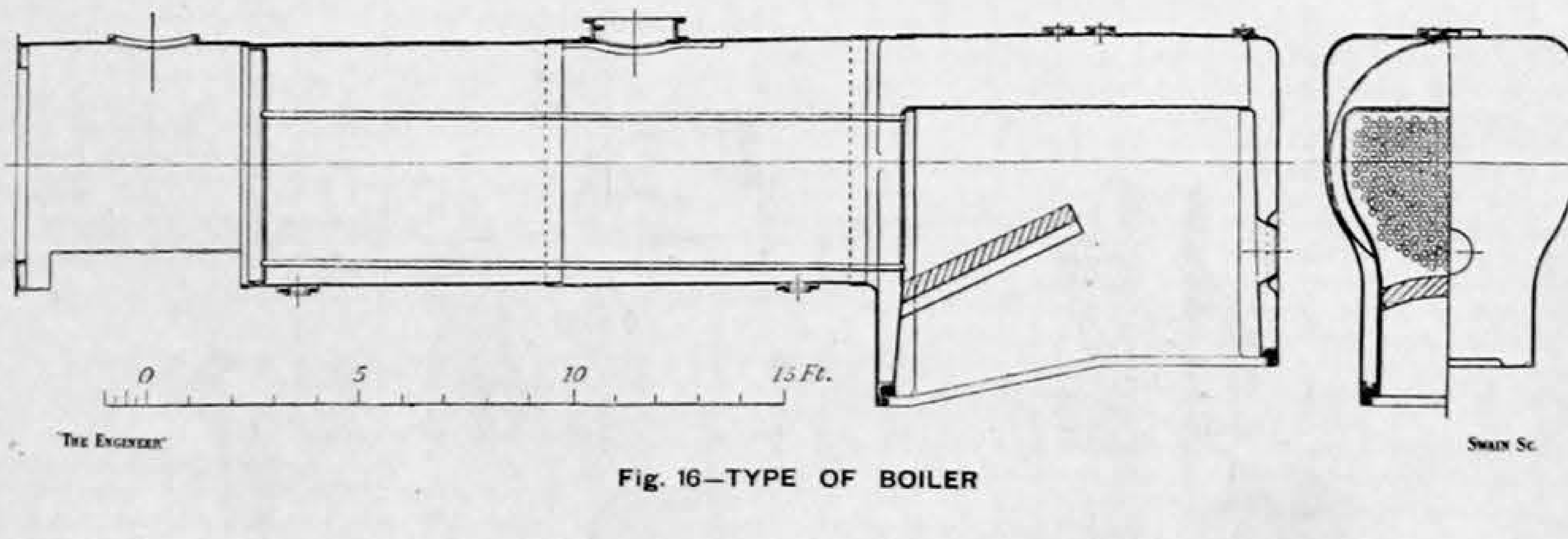


Fig. 16—TYPE OF BOILER

Aspinall's six-wheeled coupled outside-cylinder shunting tank engines. (Built October, 1891.)—These engines are employed for shunting purposes in the various goods yards, and for hauling the traffic up the stiff incline from the Manchester Ship Canal Dock—Fig. 23. They are fitted with outside cylinders, and Richardson's balanced valves placed on the top. The motion is a combination of the "Allan" type, with a rocking shaft. In order to negotiate sharp curves, the weight is concentrated on a short wheel base. Twenty of this type have been built, and haul loads of 1000 tons on the level.

Aspinall's converted tank engines for shunting. (May, 1893.)—Prior to the construction of locomotives at Horwich, the stock for goods service comprised a large number of 4ft. 6in. tender engines and a variety of designs of out-of-date tank engines. To bring the shunting stock up to date, and meet the heavy demand for this class of work, Mr. Aspinall decided gradually to convert the 4ft. 6in. tender engines into saddle tanks, cutting up the obsolete types, and using the tenders for new stock. The conversion consisted of placing a saddle tank on the boiler, and adding a short length to the frames to carry a bunker—Fig. 35. The cylinders are inside, with valves between, actuated by Stephenson's gear. The tank capacity is 1000 gallons, and the bunker holds two tons of coal. Two hundred and thirty of these engines are in service, and have proved exceedingly useful.

Aspinall's ten-wheeled bogie passenger engine, "Atlantic" type. (Built March, 1899.)—To meet the persistent demands of the traffic department for heavier trains, these engines were next designed—Fig. 29; a sectional elevation is also shown on Fig. 35A (post). At the time of construction they were the largest inside-cylinder engines of this type in the country. The cylinders were of similar design to those of the eight-wheeled passenger, radial tanks, and goods, but were of larger dimensions, steam-jacketed,* and had valves of the Richardson type, exhausting through the back. Twenty were first built, one of which was fitted with a superheater of Mr. Aspinall's design. The tenders, which are larger than those previously constructed, carry five tons of coal and 2290 gallons of water. A further twenty followed, not fitted with jacketed cylinders, five of which had superheaters, similar to the one previously built. The trains hauled by these engines are 375 tons, being the heaviest and fastest on the line.

Aspinall's eight-wheeled coupled coal engines. (Built April, 1900.)—The "Atlantic" type of engine was followed by the eight-wheeled coal engine, with Belpaire fire-box, specially designed to haul the heaviest mineral and goods train—Fig. 31. The cylinders, 20in. diameter, placed inside the frames, were the largest yet employed by this company. The valves were of the Richardson type, placed on the top, and exhausted through the back. The employment of large cylinders and small driving wheels renders these engines extremely powerful for heavy haulage. They are fitted with large tenders carried on four pairs of fixed wheels, with a capacity of 3600 gallons of water and five tons of coal. One hundred and eight of this type are in use, and a further twenty-one have been constructed, but with corrugated flue boilers, March, 1903—Figs. 32 and 14. Originally the tube plate of the corrugated steel flue was ⅞in. thick, and steel tubes were employed, but this combination was unsuccessful, owing to frequent tube leakage. The tube plate was then taken out, and replaced by another ⅝in. thick, with slightly better results. Steel tubes with copper ends in combination with the ⅝in. plate were next employed, and although improvement was effected, the leakage was not entirely stopped. The thin plates were then replaced by copper tube plates 1in. thick, and the trouble through leaky tubes has disappeared. After 5½ years' service, however, many are now developing cracks in the upper and side portions of the tube plate near the flange. It was anticipated that the fire-box crown, being subjected to the highest temperature, would be the point at which drooping would first occur, but in some cases, contrary to expectations, there was no droop; but the crown actually moved upwards and flat places also appeared in other parts, notably in positions from 12in. to 18in. on either side of the centre line. Later measurements showed that there was a tendency for the box to assume a more or less oval form. It was calculated that a deviation of 1½in. from the circle could be allowed as a safe maximum; the defective part is forced back to its original form by a 200-ton hydraulic jack. The first box attained a mileage of 43,000 before this became requisite, and it was again jacked after a further 19,500 miles. The second box covered 29,000 miles in its first period. Up to the present fifteen fire-boxes have been treated in this manner, with an average mileage of 61,700, and experience with these boxes indicates that the mileage becomes less each time jacking is resorted to. In this deflection from the circular form it has been repeatedly noticed that the movement when once started is fairly rapid up to about 1in., after which it becomes slower. The depressions in the crown are generally most pronounced over the fire-bridge, while the tendency of the box to assume an oval form is most noticeable about half-way between the fire-bridge and the fire-hole door. After the first jacking it was noticed that the weld which was placed at an angle of 45 deg. on bottom of right-hand side, had just become visible, but subsequent service did not affect it. An experiment has been made to prevent this deformation by direct staying of the flue to the outer shell, but with little success. The most recent examinations of this type of flue show that comparatively little wasting occurs on the sides and crown, but it is pronounced round the ash-hopper. This wasting has reduced the plate thickness in some cases $\frac{3}{16}$in., the original thickness being ⅝in. Some grooving has been observed at the junction of the tube-plate and flue on the fire side. The usual pitting is encountered on the box and shell. The circulation in this type of boiler is poor, and compares unfavourably with the stayed fire-box boiler in this respect. Trouble has been experienced with priming, especially when shunting. Several appliances have been tried to obviate this, such as increasing the size of the dome, baffle-plates across the boiler near the base of the dome, perforated plates in the dome, &c., but none of these removed the evil. Satisfactory results, however, have been obtained by connecting the safety-valve manhole to the dome with an anti-priming pipe placed outside the boiler. An arrangement is also under trial known as the Ross-Hotchkiss scum collector and circulator. Both the Belpaire and corrugated types are hauling trains up to 1000 tons.

Figures.	Boiler. Diam.	Boiler. Length.	Boiler. Pressure.	Firebox Shell. Long.	Firebox Shell. Wide.	Copperbox. Long.	Copperbox. High.	Tubes. Number.	Tubes. Out. Dia.	Heating Surface. Tubes.	Heating Surface. Firebox.	Firegrate.
	ft. ins.	ft. ins.	lbs.	ft. ins.	ft. ins.	ft. ins.	ft. ins.	–	ins.	super. feet.		feet.
12	4-2	10-7½	180	6-0	4-1	5-4⅞	5-10	220	1¾	1108·73	107·68	18¾
13	4-6	10-9⅞	180	6-4	4-1	5-6⅞	F 5-11¼ B 4-8¼	220	1¾	1086	107	18¾
14	5-5½	12-3	180	Shell 6-8⅞ dia. Flue 8-6 long. dia. over corrugations 5-1⅛.				289	2	1775	125	26
15	4-10	15-0	180	8-1	4-1	7-5⅞	6-11¼	225	2	1767	161	23
16	5-5½	15-0	180	9-6	4-1	8-7¼	F 7-0 B 6-1	295	2	2317	190	27

DETAILS OF BOILERS

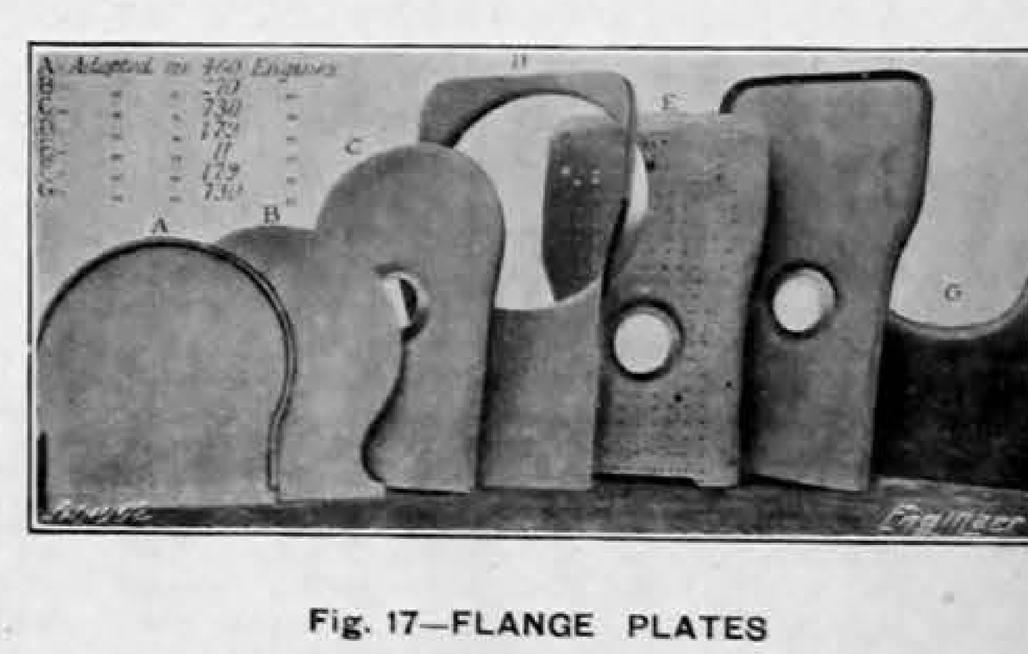


Fig. 17—FLANGE PLATES

* "Proceedings," Inst. Mech. E., 1896, Part 4, page 466.

LOCOMOTIVES OF THE LANCASHIRE AND YORKSHIRE RAILWAY

(For description see page 119)

Fig. 18. Eight Wheeled Radial Tank Engine

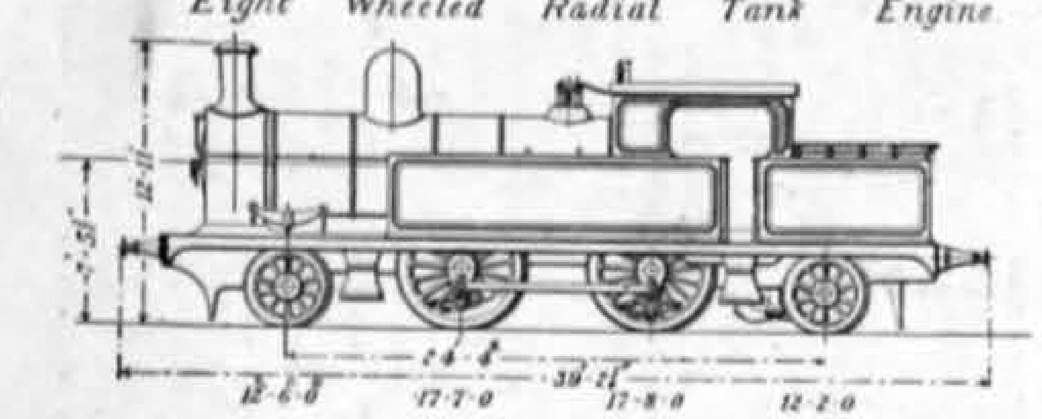


Fig. 22. Ten Wheeled Banking Engine

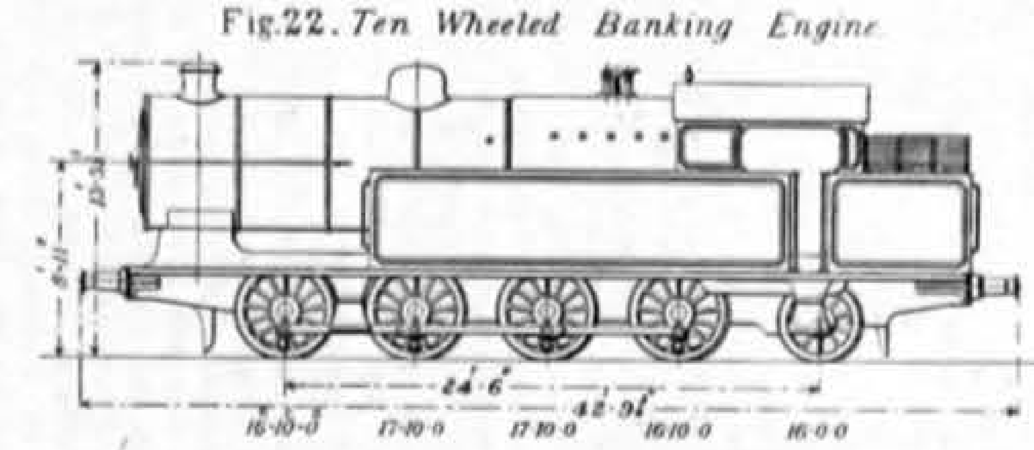


Fig. 27. Eight Wheeled Passenger Engine.

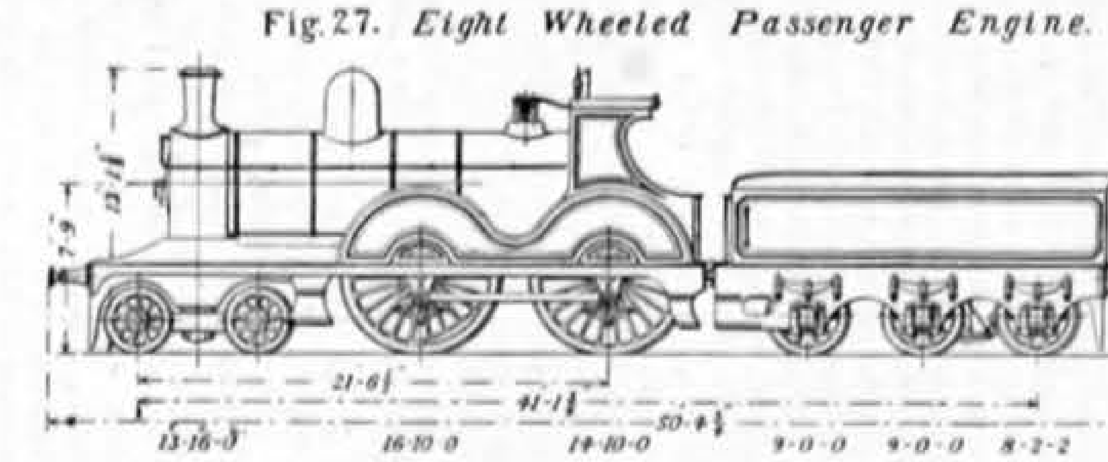


Fig. 31. Eight Wheeled Coal Engine

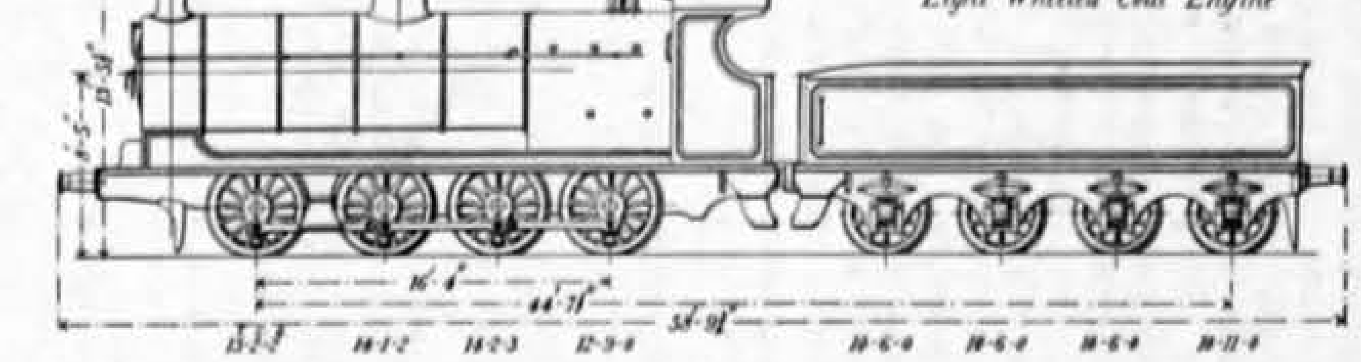


Fig. 19 Eight Wheeled Radial Tank Engine with "Belpaire" Firebox

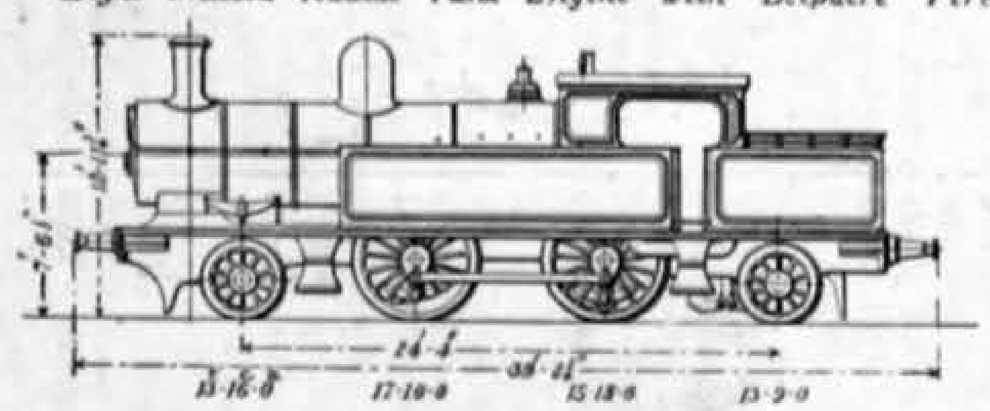
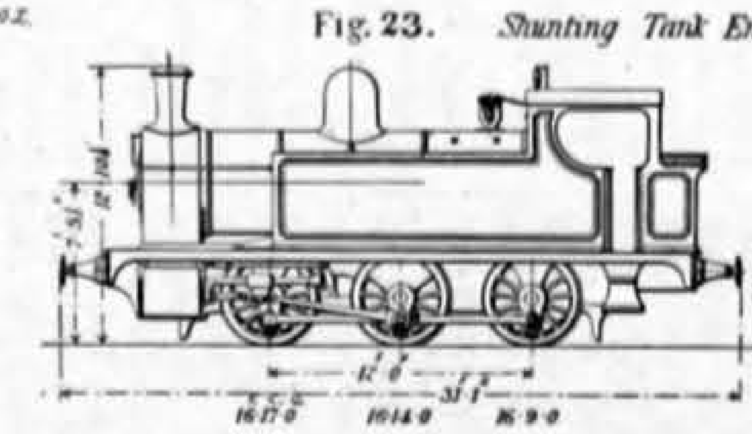


Fig. 23. Shunting Tank Engines Fig. 24



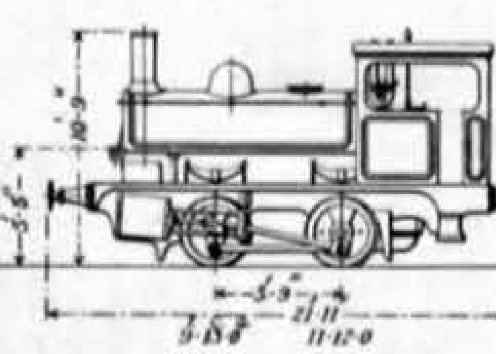


Fig. 28. Eight Wheeled Passenger Engine with Superheater.

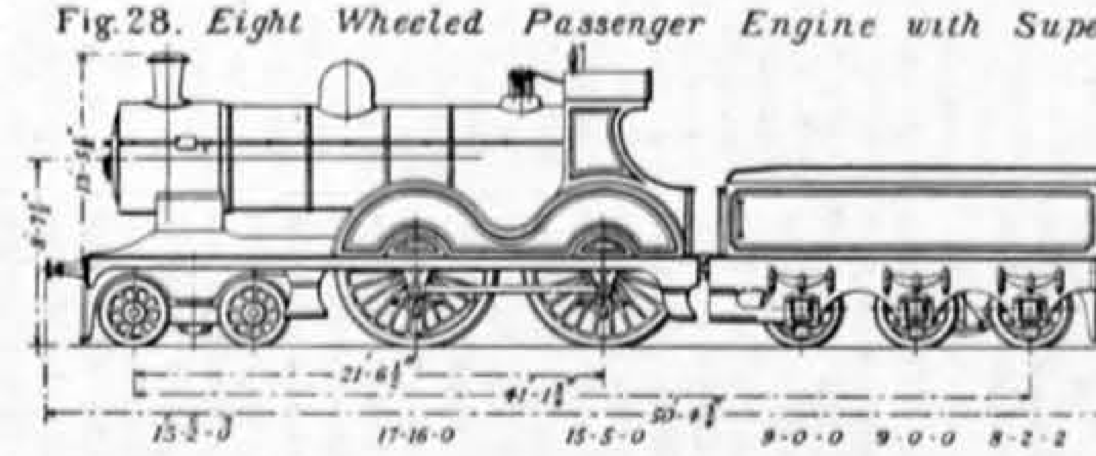


Fig. 32. Eight Wheeled Coal Engine with Corrugated Steel Firebox

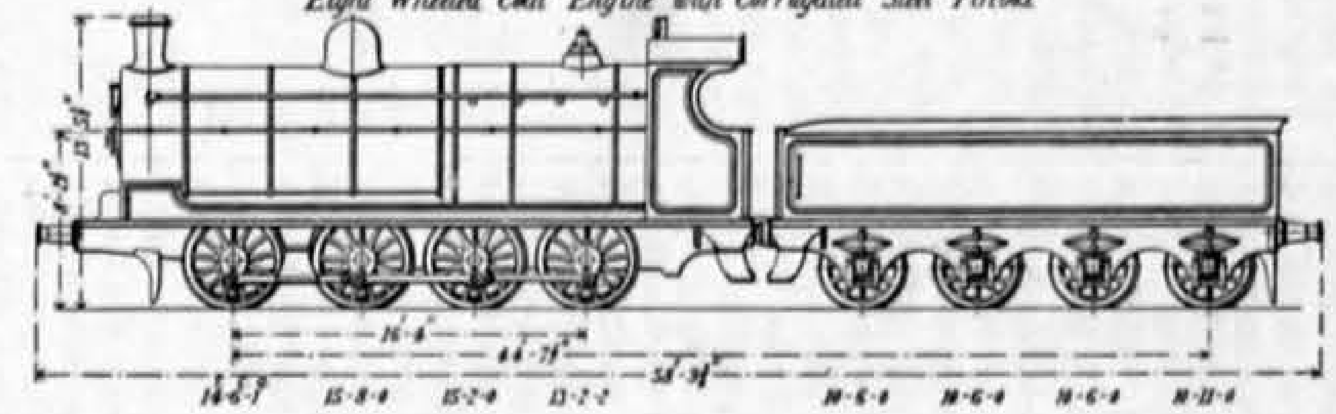


Fig. 20 Eight Wheeled Radial Tank Engine with Thermal Storage System.

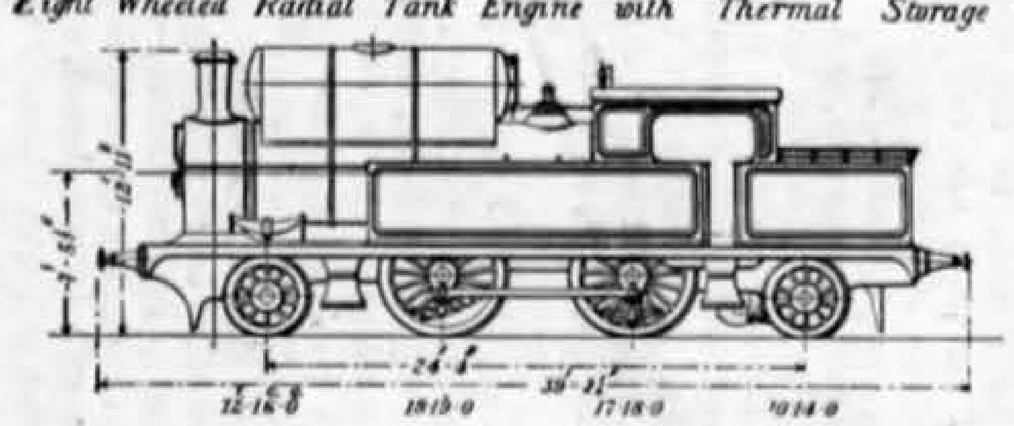


Fig. 25 Six Wheeled Goods Engine

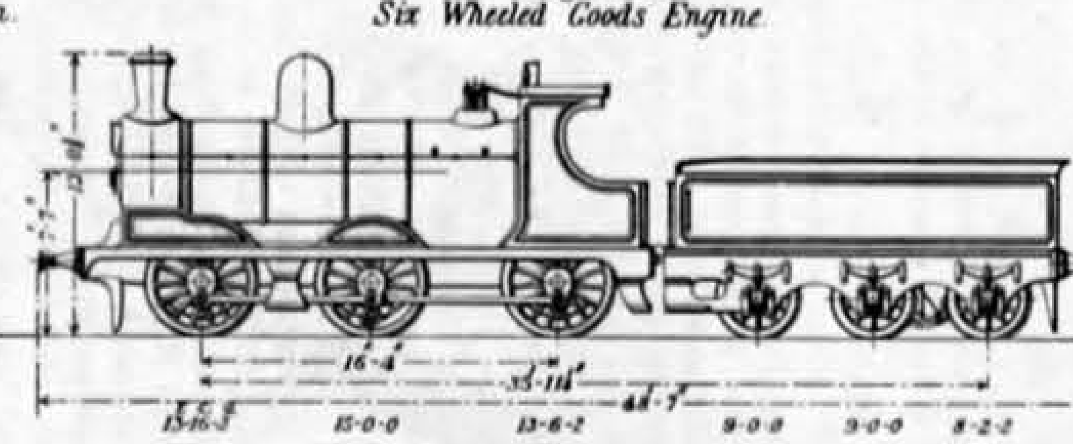


Fig. 29. Ten Wheeled Passenger Engine

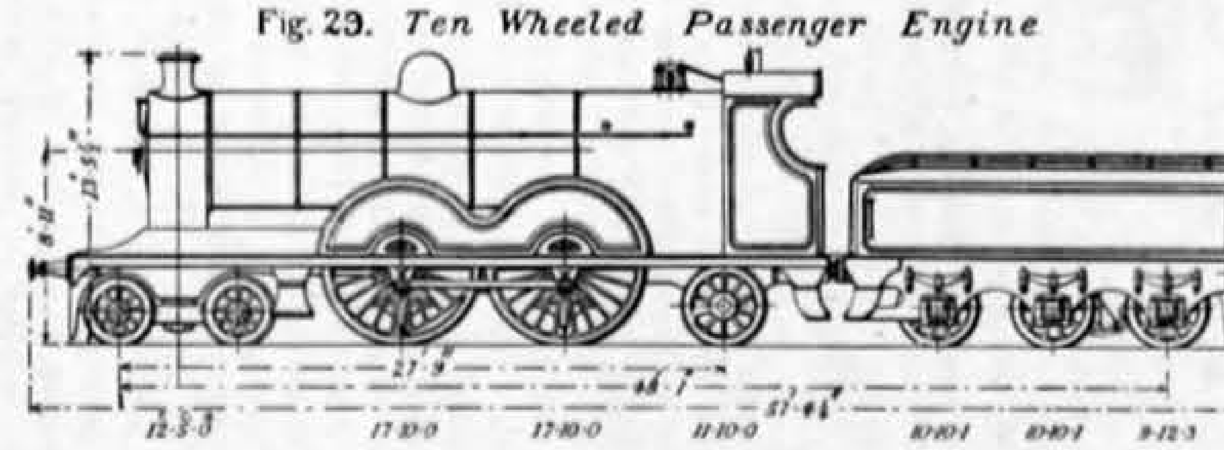


Fig. 33 Eight Wheeled Compound Coal Engine.

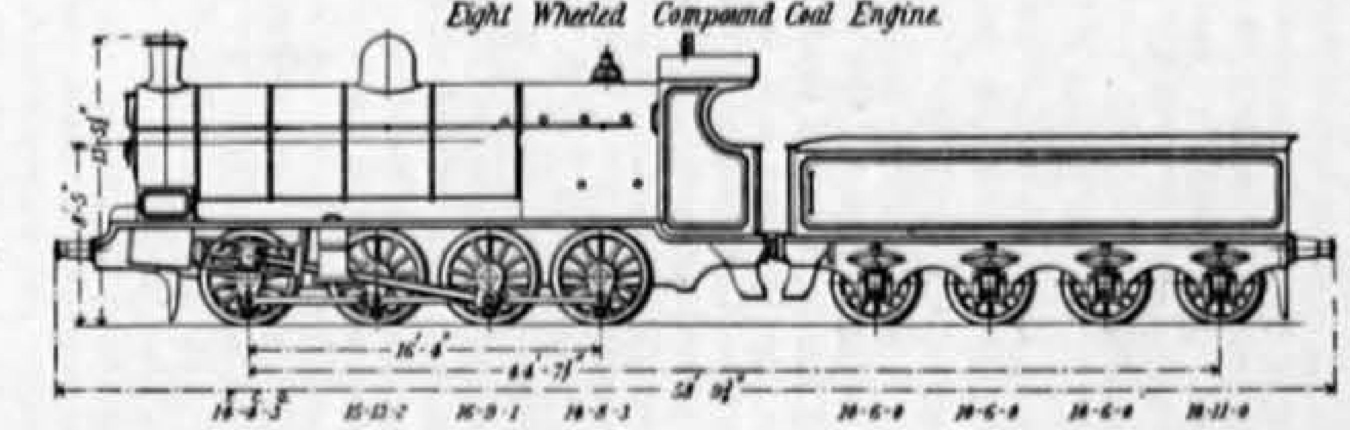


Fig. 21. Ten Wheeled Radial Tank Engine

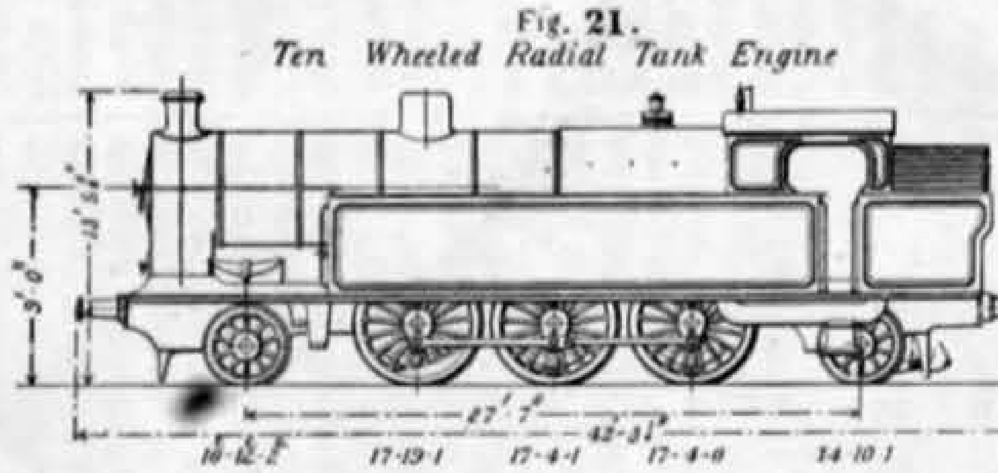


Fig 26 Six Wheeled Goods Engine with Superheater

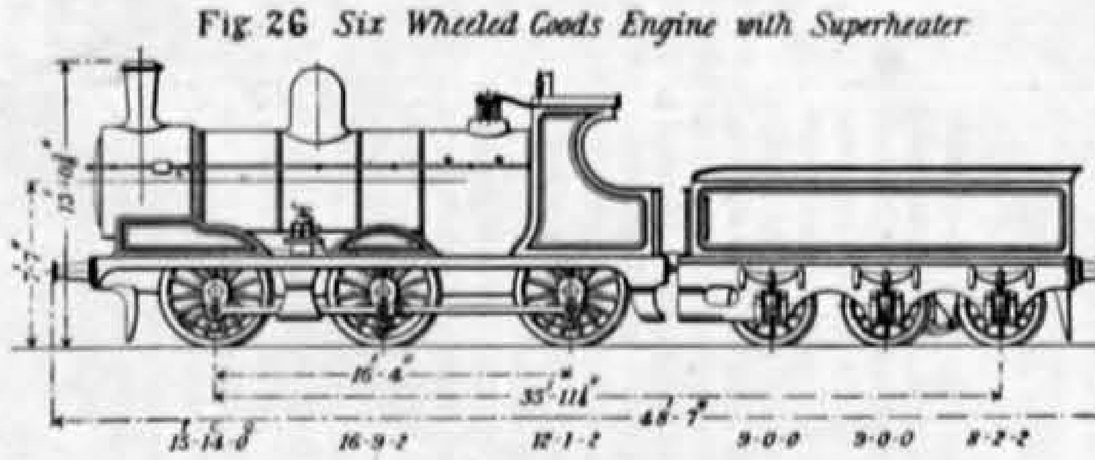


Fig 30 Four Cylinder Ten Wheeled Passenger and Fast Goods Engine.

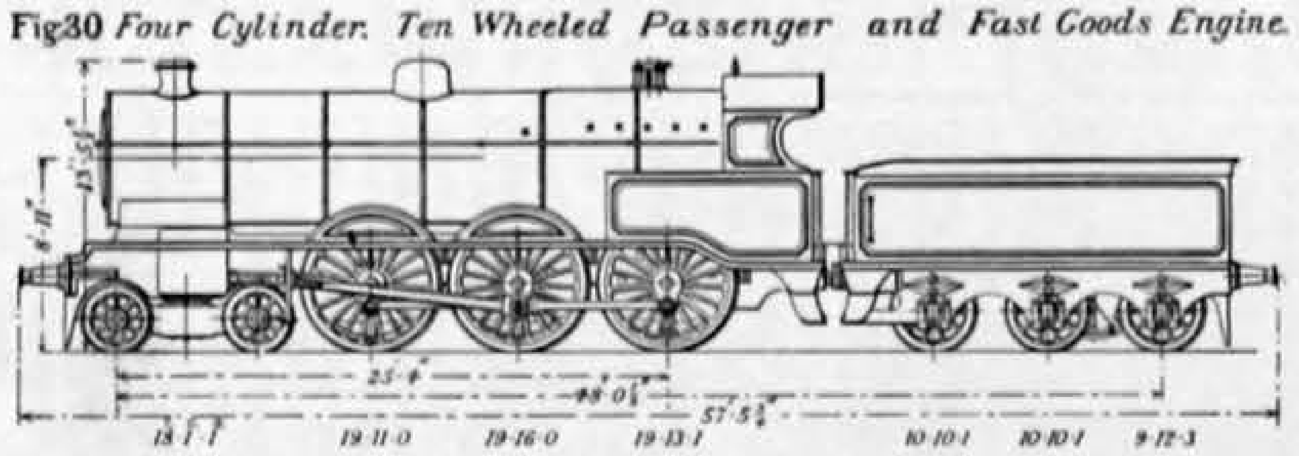
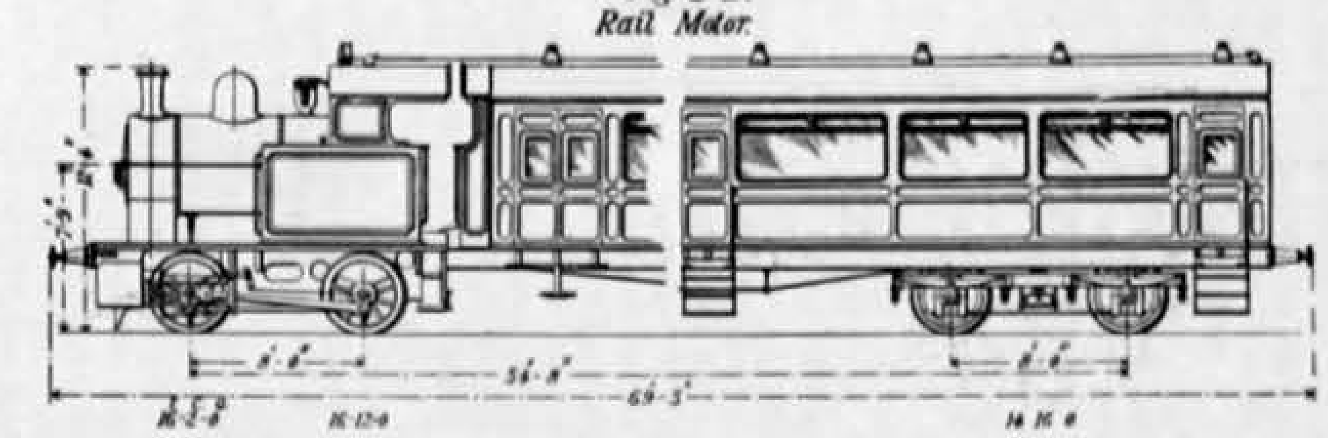


Fig 34. Rail Motor.



Figures	Cyl'rs Diam.	Cyl'rs Stroke	Wheels Radial	Wheels Coupled	Boiler Diam	Boiler Length	Firebox Shell Long	Firebox Shell Wide	Copperbox Long	Copperbox High	Tubes Number	Tubes Out Dia	Heating Surface Tubes	Heating Surface Firebox	Firegrate	Tank
	inches		ft ins	ft ins	ft ins	ft ins	ft ins	ft in	ft ins	ft ins	-	ins	super	feet	feet	gal's
18	18	26	3 7½	5 8	4 - 2	10 - 7½	6 - 0	4 1	5 - 4½	5 - 10	220	1¾	1108·73	107·68	18¾	1540
19	18	26	3 - 7½	5 - 8	4 - 6	10 - 9½	6 - 4	4 - 1	5 - 6½	F 5-11¾ B 4-4¾	220	1¾	1036	107	18¾	1540
20	18	26	3 - 7½	5 - 8	4 - 2	10 - 7½	6 - 0	4 - 1	5 - 4½	5 - 10	220	1¾	1108·73	107·68	18¾	1540
21	19	26	3 - 7½	5 - 8	4 - 10	15 - 0	8 - 1	4 - 1	7 5½	6 - 3½	239	2	1877	161·64	26·05	2000

Figures	Cyl'rs Diam.	Cyl'rs Stroke	Wheels Coupled	Wheels Radial	Boiler Diam.	Boiler Length	Firebox Shell Long	Firebox Shell Wide	Copperbox Long	Copperbox High	Tubes Number	Tubes Out Dia	Heating Surface Tubes	Heating Surface Firebox	Firegrate	Tank
	inches		ft ins	ft ins	ft ins	ft ins	ft ins	ft in	ft ins	ft ins	-	ins.	super	feet	feet	gal's
22	21½	26	4 - 6	3 - 7½	5 - 8½	13 - 0	8 - 10	4 - 1	7 - 1⅜	7 - 0	295	2	2008	190	25·6	2000
23	17	24	4 - 6	-	4 - 2	10 - 4½	5 - 6	4 - 1	4 - 6½	4 - 10½	220	1¾	1081·5	85·9	17	980
24	13	18	3 - 0½	-	3 - 0	8 - 10	2 - 10	3 - 9	2 - 3½	4 - 3½	104	1¾	432·75	43	7·2	450
25	18	26	5 - 1	-	4 - 2	10 - 4½	6 - 0	4 - 1	5 - 4½	5 - 10	220	1¾	1102·6	107·68	18¾	1800
26	20	26	5 - 1	-	4 - 2	10 - 4½	6 - 0	4 - 1	5 - 4½	5 - 10	see description					1800

Figures	Cyl'rs Diam.	Cyl'rs Stroke	Wheels Bogie	Wheels Coupled	Wheels Trailing	Boiler Diam.	Boiler Length	Firebox Shell Long	Firebox Shell Wide	Copperbox Long	Copperbox High	Tubes Number	Tubes Out Dia	Heating Surface Tubes	Heating Surface Firebox	Firegrate	Tank
	inches		ft ins	ft ins	ft ins	ft ins	ft ins	ft ins	ft in	ft ins	ft ins	--	ins	super	feet	feet	gal's
27	18	26	3 - 0½	7 - 3	-	4 - 2	10 - 7½	6 - 0	4 - 1	5 - 4½	5 - 10	220	1¾	1108·73	107·68	18¾	1800
28	20	26	3 - 0½	7 - 3	-	4 - 2	10 - 7½	6 - 0	4 - 1	5 - 4½	5 - 10	see description.					1800
29	19	26	3 - 0½	7 - 3	3 - 7½	4 - 10	15 - 0	8 - 1	4 - 1	7 - 6½	6 - 4½	225	2	1767	161	23	2290
30	16	26	3 - 0½	6 - 3	[illegible]	5 - 8½	15 - 0	9 - 6	4 - 1	8 - 7⅛	F 7-0 B 6-1	295	2	2317·0	190	27	2480

Figures	Cylinders Diam.	Cylinders Stroke	Wheels	Boiler Diam	Boiler Length	Firebox Shell Long	Firebox Shell Wide	Copperbox Long	Copperbox High	Tubes Number	Tubes Out Dia	Heating Surface Tubes	Heating Surface Firebox	Firegrate	Tank
	inches		ft ins	ft ins	ft ins	ft ins	ft ins	ft in	ft ins	-	ins	super	feet	feet	gal's
31	20	26	4 - 6	4 - 10	15 - 0	8 - 1	4 - 1	7 - 2½	6 - 3½	225	2	1767	147	23·65	3600
32	20	26	4 - 6	5 - 5½	17 - 3	Shell 6-0½ dia. Flue 9-6 long dia. over corrugations 2-11				280	2	1775	125	26	3600
33	15½ & 22	26	4 - 6	4 - 10	15 - 0	8 - 1	4 - 1	7 - 2½	6 - 3½	225	2	1767	147	23·65	3600
34	12	16	3 - 7½	4 - 3	5 - 6	3 - 4	4 - 1	2 - 5½	4 - 3½	199	1¾	455	54	9·4	550
35	17½	26	4 - 6	4 - 2	10 - 3	6 - 0	4 - 1	5 - 4½	F 4-11½ B 3-5	194	1¾	945	97	19½	932

"THE ENGINEER" SWAIN Sc

Hoy's ten-wheeled radial tank engines. (Built October, 1903.)—The next design was a ten-wheeled radial tank engine, built for the Manchester and Oldham branch service—Fig. 21. The gradients on this section are as severe as 1 in 41, eight stations occurring in 7½ miles. Loads of 200 tons have to be hauled at an average speed of 26 miles per hour, including stops, and with a restricted time allowance an engine possessing rapid acceleration was necessary. To obtain sufficient adhesion six wheels coupled were employed, with a radial box at each end. The cylinders, which are 19in. diameter, are similar to those of the goods and passenger engines previously described. Water is carried in side and back tanks of 2000 gallons capacity, and the double scoop apparatus, similar to the eight-wheeled tanks, is used. The coal capacity is 3¾ tons.

Hughes' eight-wheeled radial tank engines with Belpaire fire-boxes. (Built April, 1905).—These engines are similar to the previous eight-wheeled tanks, except that the fire-box is of the Belpaire pattern, and the boiler has 20 per cent. more water and 40 per cent. more steam space than the ordinary round top type—Fig. 19—this addition being obtained without altering any other portion of the original design. These engines are employed on the same work as the other eight-wheeled tanks, and twenty are in service.

Thermal storage tanks. (June, 1902).—Six radial tanks of the round top fire-box type have been equipped with the Druitt-Halpin thermal storage tank—Fig. 20. This arrangement consists of a cylindrical tank mounted above the boiler, and connected thereto by a saddle-plate—Fig. 37 (post)—and is so well known that a further description is unnecessary. Where stopping places are frequent on rising gradients there is distinct economy. Certain tests were carried out between Salford and Accrington, resulting in an actual saving of one ton of water, and under similar conditions elsewhere the saving was 12 per cent. When, however, these engines have to take their turn on other sections of the line which are not so favourable the all round economy is brought down to 4 per cent.

Hughes' steam rail motor cars. (Built May, 1906).—Thirteen steam rail motor cars have been built—Fig. 34. The engines have outside cylinders, 12in. by 16in. stroke, and the valves are operated by the Walschaert gear. A locomotive type boiler is fitted, similar in design to Fig. 18, which allows the employment of standard flanged plates and fittings, thereby reducing the cost of manufacture. The adoption of a comparatively large boiler gives additional

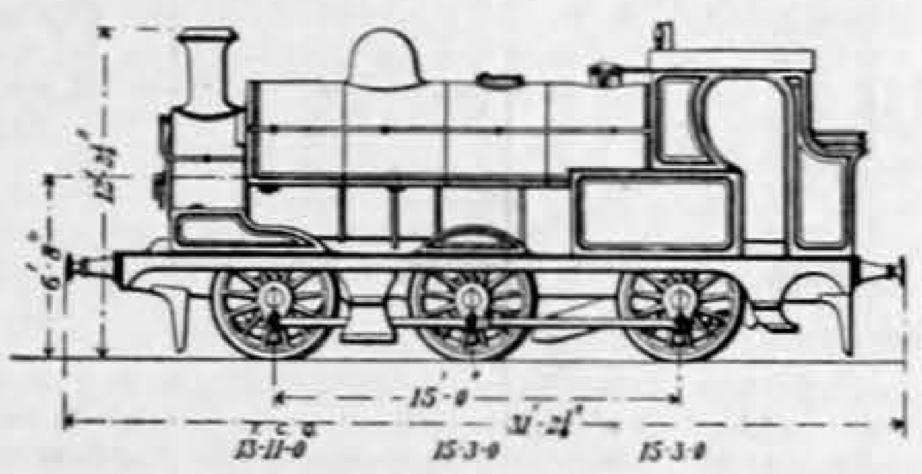


Fig. 35—CONVERTED TANK ENGINE

heating surface, and provides a good margin for starting purposes. The car body is 47ft. long, and divided into three sections, namely, a luggage compartment with a capacity of 340 cubic feet, third-class accommodation for 56 passengers, and a driver's compartment. The car is steam heated, and lighted by incandescent oil-gas lamps. A feature in the design is the collapsible steps at each doorway, which can be raised or lowered from the trailing end so as to form a staircase from the car floor to the rail level, to enable passengers to board or leave at the "halts." The ease of attaching or detaching the engine from the car is another feature, thirty minutes being ample time for this work. The car can be operated from either end, and electric bell communication is also provided for signalling purposes between the driver and fireman when propelling. These cars run on gradients of 1 in 40 and 1 in 50, and attain an average speed of 35 miles per hour, with an annual average mileage of 34,000.

Hughes' compound coal engine. (Built April, 1907).—Following the rail motors, ten compound coal engines were constructed—Fig. 33. This step was taken after some exhaustive tests with an engine which the author had converted into a compound. This subject will be dealt with in a future paper at an early date.

Schmidt's superheater.—In November, 1906, two standard goods engines were fitted with Schmidt's superheating arrangement—Fig. 26. Schmidt's experience showed the possibility of increased piston area, and so the 18in. cylinders were replaced by cylinders 20in. diameter; the maximum steam cut-off at the same time was reduced to 70 per cent. With superheating, a higher initial pressure is maintained in the cylinder, and therefore a greater range of expansion is possible, whilst condensation is less. The additional weight, by reason of fitting this appliance, is about two tons, but the tractive force is increased in a greater ratio than the adhesion. Five passenger engines and twenty new standard goods engines, with this arrangement, have been built, or are under construction, and the actual number in service up to date is sixteen. The subject will be dealt with in a future paper at an early date.

Hughes' banking engines. (Built March, 1908).—For heavy banking service and coal-shunting in the neighbourhood of Fazakerley, Liverpool, and Accrington, the author has put into service five very powerful engines—Fig. 22. They are equipped with the largest diameter of cylinders yet employed in a simple engine in this country, and, with their comparatively small wheels, possess a high tractive effort—an essential quality for shunting. In this design, owing to permanent-way considerations, it was necessary slightly to increase the fixed wheel base beyond that of the six-wheeled goods and eight-wheeled coal engines. For ease in passing round curves the flanges of the two middle pairs of driving wheels are omitted and the tires made wider. Water is carried in side and back tanks of 2000 gallons capacity. Steam and vacuum brakes are provided.

(*To be continued*).

AMERICAN ENGINEERING NEWS.

Waterworks and fire protection.—At the annual meeting of the American Waterworks Association, Mr. H. M. Wilson presented a paper on "Fire Wastes," in which he showed that the total cost of or loss in fires in the United States during the year 1907 amounted to £91,300,000, while the actual fire loss due to the buildings and their contents being destroyed was £43,000,000, or a per capita loss of 10s. for the entire country. He pointed out the significance of these figures in view of the fact that the average for the six leading countries of Europe was a loss of only 1s. 4d. per capita. The insurance loss for the year amounted to £29,000,000. The cost of fire department maintenance—including interest on capital—amounted to £8,800 000, while that of private fire protection was £3,600,000. Of the £43,000,000 due to the burning of buildings and their contents, £13,700,000 was chargeable to brick and stone buildings, and £29,300,000 to wooden buildings. The total cost of the waterworks systems of the United States amounts to some £225,849,500. Of this total, £176,715 000 is chargeable to domestic service and £49,134,500 is chargeable to fire service. Thus, only 22 per cent. of the total cost of waterworks systems is due to the additional supplies necessary for protection against fires. In individual cities, this proportion of fire protection cost to total cost of waterworks ranges from zero up to 60 per cent. Of the total amount given above, £49,134,500, the water supply cost represents £13,300,000; the distributing system, £25,450,000; hydrants, £6,000,000; and separate high-pressure fire service, £4,440,000. The cost of waterworks ranges from £4 15s. 6d. per capita in towns of 5000 to 30,000 inhabitants, to £5 16s. 10d. in those of 30,000 to 100,000, and £6 11s. 4d. per capita in cities of over 100,000.

Factory stock room methods.—To reduce the work of handling stock when taking an inventory, the Ryerson Company has an extra vertical row of empty bins at the end of each stack of bins. Thus, if there are fifteen bins in each horizontal row, the first one will be empty and the others numbered 1 to 14. In taking stock the contents of No. 1 are counted and placed directly in the adjacent empty bin, which is then marked No. 1. In the same way the contents of No. 2 are transferred to form No. 1, which is re-numbered as No. 2, and so on until No. 13 becomes No. 14, and the end—or fifteenth—bin is empty. At the next stock-taking, No. 14 is taken first, and the contents placed in the adjacent empty bin, which is then numbered No. 14, and so on down the line. The Pierce Automobile Company uses rows of sheet steel boxes or drawers in horizontal and vertical rows for storing small articles. A boy makes a daily round of the stacks, and wherever he finds the supply low he turns on end the stock card, which is set in a frame on the box and indicates the contents. These upright cards attract the attention of the stock clerk, who makes out the necessary order for replenishing the supply; he then replaces the card, but with its reverse side outward, indicating that the supply has been ordered. For emery wheels and polishing wheels, which are of odd sizes, and for other odd shaped articles, the United Shoe Machinery Company uses long pegs of iron rods, each having an iron lug cast on one end. A rack of horizontal angle irons is placed against the wall, and the rods are set in any desired part of the rack by means of the lugs, which form attachment lugs. Thus the spacing or position of the rods is varied to suit the size or shape of the articles strung upon them.

Machines for loading railway wagons with coal.—In certain parts of the United States coal is shipped very largely in covered wagons or "box cars," partly to reduce loss by theft and partly to utilise the ordinary goods wagons. As these wagons are of 30 to 40 tons capacity and about 30ft. long, with a door in the middle of each side, special means are required to give them full loads promptly. Special portable conveyors have been adapted to this work. Some of these have fast-running belts, the belt being carried on a frame which is inserted in the wagon and turned parallel with its length. The coal delivered to this frame or belt, or inclined shoot, is thrown from the belt to the end of the wagon. This method is liable to result in considerable breakage with certain kinds of coal. Another form of machine has a trough-shaped hopper, which travels to and fro inside the wagon, and has a rocking motion which tilts the contents out at each end of the travel, assisted by a scraper which passes through the hopper before the motion is reversed. At the middle of its travel, when opposite the door of the wagon, the hopper receives its load from a shoot. The hopper is mounted on the end of an arm which is inserted through the door, the hopper being pivoted so as to be parallel with the frame during the placing or removal of the frame. When inside the wagon the hopper or trough is placed parallel with the rails. The frame is pivoted to a steel truck or lorry, which carries the driving machinery and travels on a line of rails parallel with the wagon loading siding. A 75 horse-power electric motor is used, running at 450 revolutions, and using current at 220 volts. Two wires and a double trolley are used, one for the supply and the other for the return current. The last few tons are shot in direct from the shoot. The machine can load from 40 to 50 wagons in ten hours.

A steel bowstring arch bridge.—At Philadelphia, a steel bridge of novel design is being built to carry a street across a railway at a point where there are some sixteen lines of rail, and no intermediate piers or columns could be used. The rails are about 20ft. below the level of the street. The bridge has two steel arch ribs of box section, 15in. wide, 16in. deep at the crown, and 10½ft. deep at the inclined springing lines on the abutments, the springing being just below the street level. The clear span between the faces of the springings is 250ft., and the rise of the arch is 54½ft. above this level. The height from the roadway to the top of the arch is 46ft., and the roadway has a camber of 3ft. in 125ft., with a radius of 2000ft. at the middle of the span and gradients of 1 in 33 at the ends. The arches are 37½ft. apart, and the floor girders carry outside footpaths, the total width being 57ft. A peculiar feature is that the hollow arch ribs are filled with concrete, made with ¾in. stone, and very wet. This is deposited through holes in the top cover plate and thoroughly rammed. The filling is carried on from both sides simultaneously. The arches were erected on staging and bolted at three splices, which were not riveted until the centers had been struck. The cross girders for the floor are suspended from the arch by hangers made of 15in. steel joists, the upper end of the joist lying inside the arch rib, with its flanges riveted to the web plates. The bottom cover plates of the ribs are cut to fit snugly between the hangers. Between the cross girders are 15in. rolled joists forming longitudinal bearers 17ft. 4in. long. The cross girders are encased in concrete, and concrete jack arches are built between the longitudinals, being so placed as to completely encase the steel and protect it from smoke and gases from the engines. The roadway is paved with asphalt. The bridge is designed for a distributed load of 100 lb. per square foot, with a concentrated load of 40 tons on a four-wheeled tram car on the roadway, and 110 lb. per square foot on the footpath.

Road improvement experiments.—Much experimental work is being done in the United States to improve the public roads of two different classes:—First, the roads of moderate and heavy traffic, especially near cities and towns; second, the roads in thinly populated country districts. Many of the experiments are in relation to utilising local materials, where ordinary road-making materials are not easily available. In the neighbourhood of some large sugar refineries a by-product —which is almost a waste product—is "blackstrap," a heavy treacle. It is extremely dense and sticky, and when mixed with quicklime sets into a heavy and sticky cement. This being soluble, the addition of heavy oil serves to make it permanent and waterproof. About 300 lb. of lime are slaked with 100 gallons of water and 90 gallons of treacle residuum added and well mixed; to this are added 50 gallons of asphaltic oil. While the mixture is hot, road metal in graded sizes is added and thoroughly mixed. When rolled upon the road surface it produces a firm and resilient paving. Another experiment consists in mixing oil or asphalt compositions with the natural earth, whether sandy or clayey. The road surface is alternately ploughed—or harrowed—and sprinkled, and finally rolled. With sandy soil the rolling is best done by a roller having its face formed by a series of mushroom-shaped lugs or projections, which thus pack the material by ramming instead of by dead pressure. In still another case, in sandy districts, where the sandy road material is blown away by constant winds, a bed of heavy clay is laid upon the sandy road and well packed. This is watered, harrowed, covered with sand, and rolled until a thick and dense road covering is formed.

MIDLAND INSTITUTE OF ENGINEERS.—The annual meeting of the Midland Institute of Mining, Civil, and Mechanical Engineers was held at Sheffield on the 22nd inst., Mr. M. H. Habershon presiding. The annual report notified a membership of 365, as compared with 363 last year. The report dealt with various aspects of the work of the Institute during the year, and, referring to the appointment of Professor C. T. O'Shea as hon. secretary of the Institution of Mining Engineers, in succession to the late Mr. Walton Brown, said that Mr. O'Shea had asked to be allowed to resign the secretaryship of the Midland Institute in consequence of the extra work his new appointment entailed. The Council had accepted his resignation, having taken the view that what was undoubtedly an immediate loss to that Institute was for the ultimate benefit of the Institution of Mining Engineers. Officers for the ensuing year were elected, and subsequently Mr. James Elce Silverwood, read a paper on "Some Notes on the Working and Testing of Locked-coil Winding Ropes." An interesting discussion followed.

THE THWAITE FUND.—The B. H. Thwaite fund has received from Mr. Carnegie a cheque for £500. The conditions which were attached to Mr. Carnegie's offer—namely, that a further £500 should be forthcoming from subscriptions from those who recognised the value of the services rendered to certain departments of science and industry by the late Mr. Thwaite—were not exactly complied with, as the subscriptions did not reach a quite equal sum; but Mr. Carnegie has not allowed this to stand in the way. He was doubtless influenced in his decision by the successful efforts of the committee with regard to Mr. Thwaite's son, aged nine, who has been elected to the Yorkshire Society School. We understand that arrangements are also in progress for placing Mr. Thwaite's daughter in a school. The Committee are desirous of expressing, through our pages, their gratitude to Mr. Carnegie for his generosity and kind consideration, to all who by their subscriptions have helped to make up the required sum, and to those who have so substantially assisted by placing Mr. Thwaite's son in the above school. In the last-named connection, special thanks are due to Mr. George Mellor, the secretary of the Association of Yorkshiremen in London, of which association the late Mr. Thwaite was a founder.

REPORT ON THE IRON ORES OF NOVA SCOTIA.—The Mines Branch of the Department of Mines, Ottawa, which was organised for the purpose of devoting special attention to the economic features of Canada's mineral resources, has just issued a report on the iron deposits of Nova Scotia, prepared by Dr. J. E. Woodman, until recently Professor of Geology at Dalhousie University, Halifax. This report, which covers the more important iron deposits of the province, consists of 222 pages of text, 63 illustrative photographs, diagrams and maps, and an index. The scope and economic importance of the work may be judged from the instructions given to the author, who was requested to give special attention to:—(1) Localities of iron ore deposits so far discovered, and names and addresses of owners; (2) history of development of mines and companies (if any); (3) geological description; (4) analyses of ores; (5) in cases of mines which have been worked, output and statistics; (6) transportation facilities; (7) limestone in neighbourhood of deposits; (8) the general character of the forest in the neighbourhood, *i.e.*, whether the supply is sufficient for mining purposes and for the production of charcoal in the event of the introduction of electric smelting; and (9) maps of mines (and drill holes, if any). The report itself is divided into two main parts:—Part I. deals with the geographic relations of the deposits, their mineralogy and geology, and questions relating to mining policy, bounties and mining laws. Part II. is entitled "Details of Iron Districts," and covers more particularly the ores of the Clementsport basin, the Nictaux-Torbrook field, the deposits of Hants and Colchester counties, the ores of the Western Cobequid mountains and of Arisaig, and the ores of Cape Breton, and is replete with analyses of ores, records of bore-holes and geological sections, and other statistical data. A second volume covering iron ore deposits, not referred to in Volume I., and devoting special attention to limestones of value for metallurgical purposes, will shortly be issued. Copies of the report may be obtained on application to Dr. Haanel, Director of Mines, Ottawa.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—The detailed official programme of the summer meeting of the North-East Coast Institution of Engineers and Shipbuilders, to be held jointly with the Scottish Institution of Engineers and Shipbuilders in Glasgow on the 4th, 5th and 6th August, has now been issued. The representatives from both bodies will meet on Wednesday, August 4th, at 10 a.m., at the fine new home of the Scottish Institution in Elmbank-crescent, when an address of welcome will be given by Mr. John Ward, the President of the Scottish Institution, which will be responded to by Mr. Summers Hunter, President of the North-East Coast Institution. The forenoons of both Wednesday and Thursday will be devoted to the reading and discussion of papers. These will be as follows:—"A Slight Sketch on the History of Propellants," by Sir Andrew Noble, Bart., K.C.B., F.R.S., D.Sc.; "Notes on the Trials and Performances of the s.s. Otaki, fitted with a Combination of Reciprocating and Turbine Machinery," by Engineer-Commander W. McK. Wisnom, R.N.; "Sixty Years of Merchant Shipbuilding on the North-East Coast," by Dr. G. B. Hunter and by Mr. E. W. DeRusett, M.I.N.A.; "Fifty Years of Warship Building on the Clyde," by Professor J. H. Biles, LL.D. The afternoon of Wednesday will be devoted to alternative visits to works in the Motherwell, Johnstone, and Renfrew districts. At Motherwell a visit will be paid to the Dalzell Steel and Ironworks (David Colville and Co., Limited), the Brandon Bridge Building Company, Limited, and the steel roof and bridge-building works of Messrs. Alex. Findlay and Co., Limited. At Johnstone a visit will be paid to the machine tool-making works of John Lang and Sons and Messrs. Thos. Shanks and Co. At Renfrew the works of Messrs. Babcock and Wilcox, Limited, engineers and boiler-makers, will be visited. The afternoon of Thursday will be devoted to alternative visits to the Albion Motor Car Company, Limited, and the shipbuilding and engineering works of Yarrow and Co., Limited, at Scotstoun, to the dredger-building works of Messrs. Wm. Simons and Co., Limited, Renfrew, or to the Steel Company of Scotland's works at Blochairn, and the works of Sir Wm. Arrol and Co., Limited, engineers and bridge builders, Dalmarnock. In addition about twenty other works will be open to visitors.

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

(*From our own Correspondent.*)

War in Galvanised Sheet Trade.

THE war in the galvanised sheet trade was confirmed in every detail to-day. It is stated that the members of the late organisation have in set purpose declared war to the knife against the newer firms, which, by refusing to join the late Association, brought about the downfall of that body, and that they have determined to try either to drive these newer firms out of the trade, or force them to reconsider their decision to remain outside any association. With this express object, selling prices, it was declared this afternoon, are to be sacrificed in an utterly reckless manner, and the conduct of business below cost is to be the rule of the trade. The ruin which this reckless state of things must of necessity bring about is almost shameful to contemplate, and the money which must be lost in the course of the fight is certain to be very large. Names were freely canvassed to-day respecting which makers in the galvanised sheet trade are supposed to be in the best—*i.e.*, the strongest—position to emerge sound out of the fierce racket, and which must succumb, but beyond the general fact that makers situated near the ports will, owing to their situation, stand a much better chance of surviving than those inland, such as the Staffordshire and Midland makers in particular, nothing definite could be declared. The position which has been sprung upon the industry is certainly one for extreme regret, and of grave trade moment. Selling prices to-day for 24 w.g. f.o.b. Liverpool or equal were £10 to £10 10s. and £10 15s. per ton, compared with £12 10s., which was the ruling quotation before the break up of the Association. The spelter market partakes of the disorganisation of the sheet branch, and virgin spelter is quoted £12 15s. at Birmingham, and hard at £18 10s.

Closing Ironworks.

The immediate result upon the black iron trade of the war which has been declared in galvanised sheets is disastrous. One large firm in the Wolverhampton district owning four sheet mills has given notice to its men of its intention immediately to close down the works until such time as better trade arrives, and more remunerative prices can be got. This is a very serious state of things, and it is feared that some other ironworks may follow the example. Owing to the unsatisfactory state of trade and the exceedingly low prices prevailing, certain of the common bar ironworks have been closing down some of their mills for some time past, and now it seems the black sheet makers are to do the same. Black sheets have fallen 2s. 6d. to 5s. per ton the last fortnight, and prices are now:—20 w.g. sheets, £7 to £7 2s. 6d., 24 w.g., £7 2s. 6d., and 27 and 28 w.g., £7 15s. to £7 17s. 6d. per ton. Common bars for nut and bolt and fencing purposes are down to £5 12s. 6d. per ton, and merchant bars are as low as £5 17s. 6d. North Staffordshire "crown" bars are £6 10s. at the ports.

Raw Iron Trade.

The price of pig iron is said to be out of proportion to the selling values of finished material, but makers will not listen to consumers' demands for any sensible reduction in prices. The improvement on the Cleveland market, with an advance in the value of No. 3 iron of 1s. 1d. on the week, adds to the strength of the local makers' position. Prices are quoted:—Forge pig iron: Staffordshire common, 46s.; part-mine, 48s. to 49s. 6d.; best all-mine, 80s. to 81s.; cold blast, 110s.: Northamptonshire, 46s. to 47s.; Derbyshire, 47s. 6d. to 48s. 6d.; North Staffordshire, 49s. to 50s.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

MANCHESTER, Thursday.

Better Undercurrent in Pig Iron.

IT is pleasing to note that there are now improved prospects in pig iron. Merchants are sending out a fair number of inquiries for decent quantities, and, notwithstanding bad trade, consumers are at last compelled to cover their requirements. There is also some anxiety to buy for forward delivery, but this makers in most cases will not hear of. Indeed, one well-known Scotch firm has withdrawn quotations for a time owing to the critical position in the coal trade, while others will not quote for delivery within the next three months. No doubt much of this is caused by buying on speculative account, coupled with strong American advices. English brands are firmly held for full rates, and Middlesbrough and Scotch are 6d. to 1s. better on the week, according to circumstances. On the month, Staffordshire and Derbyshire are practically unchanged, and Lincolnshire 6d. better. Gartsherrie has shown the highest figure, 1s. to 1s. 3d.; Eglinton and Dalmellington, 9d. to 1s.; and Glengarnock, 6d. per ton. Hematite is about 6d. per ton better, but the close is dull. Forge iron was in better inquiry, but remains weak on spot.

Finished Iron and Steel.

Shows little change. There is still a scarcity of foreign billets, which now pretty well approximate to English in price.

Copper.

Manufactured rallied somewhat in the concluding week of this month, but while tubes were ⅛d. per lb. higher, sheets were £2 per ton lower. Tough ingot was rather easier.

Lead.

Values gradually dropped, and sheets are 10s. per ton lower, and the feeling easier.

Tin.

English ingots have been variable, but close about 20s. per ton better on the month.

Quotations.

Pig iron: Lincolnshire No. 3 foundry, 52s. to 52s. 6d.; Staffordshire, 51s. to 51s. 6d.; Derbyshire, 52s. 6d. to 53s.; Middlesbrough, open brands, 57s. 10d. to 58s. 1d. Scotch: Gartsherrie, 59s. 3d.; Glengarnock, 58s.; Eglinton, 57s. 6d.; Dalmellington, 57s. 6d., delivered Manchester; West Coast hematite, 58s. 6d.; East Coast ditto, 56s., both f.o.t. Delivered Heysham: Gartsherrie, 57s. 3d.; Glengarnock, 56s.; Eglinton, 55s. 6d.; Dalmellington, 55s. 6d. Delivered Preston: Gartsherrie, 58s. 3d.; Glengarnock, 57s.; Eglinton, 56s. 6d.; Dalmellington, 56s. 6d. Finished iron: Bars, £6 10s.; hoops, £7 12s. 6d.; sheets, £7 15s. to £8. Steel: Bars, £6 5s.; Lancashire hoops, £7 5s.; Staffordshire ditto, £6 17s. 6d. to £7; sheets, £7 17s. 6d. to £8; boiler plates, £7 2s. 6d.; plates for tank, girder, and bridge work, £6 to £6 5s.; English billets, £4 10s. to £4 12s. 6d.; foreign ditto, £4 7s. 6d. to £4 10s.; cold-drawn steel, £9 5s. to £9 10s. Copper: Sheets, £71; tough ingot, £62 to £62 10s.; best selected, £62 to £62 10s. per ton; copper tubes, 8½d.; brass tubes, 6¼d.; condenser, 7⅞d.; rolled brass, 6¼d.; brass wire, 6½d.; brass turning rods, 6½d.; yellow metal, 6¼d. per lb. Sheet lead, £17 5s. per ton. English tin ingots, £131 10s. per ton.

The Lancashire Coal Trade.

The attendance on the Coal Exchange was rather under the average, but there was more business being done. The Eight Hours Act, with one or two slight exceptions, does not appear to have caused much trouble. Still, there was a marked disposition on the part of buyers to cover forward, especially in house coal. In shipping and bunkering coal the tone was also decidedly better. The market closed with an upward tendency, although no change was made in official quotations.

BARROW-IN-FURNESS, Thursday.

Hematites.

The tone of the hematite iron trade has not improved. The demand is confined to a much smaller business than has been the fact of late, and makers, generally speaking, are not holding as many orders as for some time past. Consequently there is an increase of stocks in makers' yards, and the prospect of a further increase in warrant stores. The iron held in the latter is the same as last week, 13,377 tons, which is, of course, only looked upon as a comparatively small bulk of metal. There are still 26 furnaces in blast, and it is not proposed at the moment to put any of these out of blast, as the general feeling is that the present period of depression will only be of brief duration. Prices are still easy at 58s. net f.o.b. for mixed Bessemer numbers, and 56s. 6d. for warrant iron net cash sellers, 56s. buyers, special hematites are at 60s. to 61s. 6d., and are in fairly good demand; indeed, although the general trade is quiet, the special trade is reasonably supplied with orders. There are good prospects for this particular business, as by the means of specifying exactly the analysis of metal a consumer wants half his battle is fought in the special manufactures which require this high grade metal as the basis of their operations. The sale of spiegeleisen is not large, and most of it is used in the district, but a portion of it is being utilised on foreign account. Ferro-manganese is making a market for itself, and there is no question that this material will be in very strong demand when there is a general improvement in trade. Charcoal iron is selling fairly well, and there is much activity in the district in the manufacture of charcoal required in the smelting operations. Scrap iron is in good demand, and some large parcels have recently been sold. Iron ore is in small request, and the mines are being but indifferently worked, except those at Hodbarrow and Ronhead, where there is a good output of iron ore, which, of course, is of the best quality, and realises 17s. per ton net at mines, while medium sorts are at 13s. 6d. and ordinary at 11s. per ton. Cargoes of foreign ores have not been largely imported of late.

Steel.

There is no improvement to report in the steel trade. The mills are not fully employed, even in the Bessemer department. The demand for rails is not large enough to keep all the mills in the district employed, and considerable foreign competition has now to be faced. Merchant steel is in quiet demand. Shipbuilding classes of steel are in poor request, although some good local orders are expected.

Shipbuilding and Engineering.

The only news in the shipbuilding trade this week is the receipt of an order by Vickers, Sons and Maxim for the construction of a floating dock to raise one of the Dreadnoughts. No information is to hand as to the size of this dock, but as it has to lift about 23,000 tons, it may be judged to be of considerable dimensions. Other docks of this class have to be built for the Admiralty. Orders have been received for a large number of gun mountings, and this department of local industry will soon be very briskly employed.

Shipping and Coal.

The shipping figures this week are not to hand, but it is known that the exports of iron and steel are low. Coal and coke quiet, but prices, in view of the crisis, are high.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

Steam Coal Active.

STEAM coal is at present much in demand for shipment, at prices reaching up to 9s. 6d. per ton. Heavy tonnages are leaving the South Yorkshire districts for the East Coast more especially, and also for the West. All kinds of steam fuel are selling freely, steam nuts and seconds hards being inclined to move with almost equal freedom to best hards, at corresponding rates. The latest available official return of exports of coal from Hull—that for the week ending 20th July—shows the total to have been 106,241 tons, as compared with 84,979 tons for the corresponding period of last year. Cronstadt was the principal market, taking 19,690 tons, Alexandria second with 9831 tons, and Rotterdam third with 9271 tons.

House, Gas, and Small Coal.

House coal keeps in fair demand, owing largely to householders putting in their winter supplies. London merchants maintain their requirements, which are stated to be rather larger than usual at this period of the year. Country merchants are also reported to be ordering somewhat more freely, especially from the Eastern Counties. Secondary qualities do not sell so actively as the superior grades. Best Barnsley continues at 11s. 6d. to 13s. per ton at pit; secondary descriptions, from 10s. to 11s. per ton at pit. Gas coal is in moderate demand, a considerable tonnage being despatched on account of contracts. Slacks are in good request, extra supplies being taken in several instances for stock at works and mills. For qualities used in Lancashire cotton and Yorkshire woollen districts the prices are maintained at 4s. 6d. to 5s. 6d. per ton.

Coke.

A fair demand continues in the coke market at recent prices, and is showing no tendency to decline. Best washed coke, 10s. 6d. to 11s. per ton; unwashed, 10s. to 10s. 6d. per ton. Coking smalls are in good request, and somewhat scarce, the firmer tone noted last week being still evident.

The Iron Market.

Official prices of hematites still continue as during the past few weeks. A brisk demand arose for East Coast iron a few days ago for shipment, but not sufficient to affect prices permanently. Generally the demand for East or West Coast is much below the output, and iron is being daily put into stock. Hopes are still entertained of better times, and this, with the low Bank rate, keeps up the make and price. The Lincolnshire Ironmasters' Association met last Friday, but made no alteration in prices—neither buyers nor sellers seem to be pushing business. Most of the pig iron producers are fairly well sold until after the holiday season, when they expect trade will improve. Quotations:—Hematites: West Coast, 68s. to 69s. per ton; East Coast, 64s. to 65s. per ton; both less 2½ per cent. delivered in Sheffield and Rotherham; Lincolnshire, No. 3 foundry, 50s. per ton; No. 4 foundry, 49s. per ton; No. 4 forge, 49s. per ton; No. 5 forge, mottled and white, 49s. per ton; basic, 50s. 6d. per ton; Derbyshire, No. 3 foundry, 49s. 6d. to 50s. per ton; No. 4 forge, 48s. 6d. to 49s. per ton. Both Lincolnshire and Derbyshire irons net delivered in Sheffield and Rotherham.

Bars, Hoops, and Sheets.

The finished iron trade of the district is very much in want of work, the employment afforded being little more than half time in several directions. Quotations unaltered, viz.:—Bars, £6 10s. per ton; hoops, £7 10s. per ton; sheets, £8 10s. per ton.

The Heavy Trades—Armour Orders.

The statement that the Government had decided to carry out their contingent programme of four additional Dreadnoughts was most acceptable. The Government have given out the orders for armour for two ships, and distributed them fairly equally amongst the five armour-making firms of the country. The total weight is from 6000 to 7000 tons. This will follow on very conveniently the work just being completed, and is very welcome all round. In other departments of the heavy industries we do not hear of much change. Orders for railway material are very small and engineering requirements languid. No firms are fully employed, the majority probably only about half on these classes of work. In marine work there is nothing new except for special lines, and limited to few firms.

The Lighter Trades.

Several of the lighter departments are moderately employed on foreign account, more especially in tool steel, circular saws, and various kinds of tools. Russia and Italy are reported to be ordering pretty freely in several lines. There is said to be rather less being done in high-speed steel.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Cleveland Pig Iron.

SELLERS of Cleveland iron have not done so well this week as they did last, though on Monday they booked very good orders, and this has placed them in a rather satisfactory position, so that for the present they have no need to press iron upon the market. On Tuesday, however, the active buying ceased, and prices have since fallen away a few pence. The upward movement resulted in the price of Cleveland pig iron being raised 1s. 3d. per ton, 49s. 3d. per ton for No. 3 being touched on Monday, but since then 3d. of this has been lost, while the Cleveland warrant price has dropped 4d. Consumers bought rather freely last week, and there was considerable animation in the warrant market, the stocks of users having been allowed to get small, and the need to have them replenished became rather pressing. This week since Monday a quieter state of things has been reported, and one reason for the reaction is said to be the more rapid increase in the stock of Cleveland pig iron in Connal's store, and another reason was that speculators in warrants were endeavouring to take profits, and thus were offering them more freely. Then tin and copper prices are somewhat easier. No. 3 Cleveland G.M.B. pig iron on Wednesday was quoted at 49s.; No. 1 at 51s. 6d.; No. 4 foundry at 48s.; No. 4 forge at 47s. 9d.; and mottled and white at 47s. 3d., all for early f.o.b. delivery. The prices for forward delivery were practically nominal, buyers holding back.

Hematite Pig Iron.

Makers of East Coast hematite pig iron at last are able to give somewhat more cheerful reports about their business, and it is now hoped by them that the worst of the depression is over, so far as they are concerned, for there appears some improvement in the shipbuilding industry, on which local hematite pig iron producers largely depend. Consumers have been buying more freely during the last few days, and sellers have seen their way to advance quotations for mixed numbers to 55s. per ton for early delivery, which is a rise of 3d. per ton this week, and the higher price can be more readily realised now than was the 54s. 9d. asked last week. Makers of East Coast hematite pig iron have had a very unsatisfactory experience during the last two years, and the directors of the Normanby Ironworks Company, Limited, Middlesbrough, in their annual report, state that at no time during the past twelve months has it been possible to sell hematite iron and purchase the ironmaking materials so as to leave a reasonable margin of profit. They have only kept two furnaces in operation out of their four built, and nevertheless it has, at times, been difficult to dispose of even the reduced make and keep down the stocks of pig iron. This company makes exclusively hematite pig iron. This experience is more or less general among those who produce this class of pig iron for the market. Cheaper ore cannot be reported, for 16s. 3d. per ton c.i.f. Tees is firmly adhered to, nor is any relief obtainable in the price to be paid for coke, the figure for furnace coke being maintained at 15s. 6d. per ton delivered equal to Middlesbrough, and some sellers hold out for 15s. 9d.

Stock and Shipments of Pig Iron.

It must be conceded that the figures with respect to the stock and shipments of pig iron are most disappointing. They were bad enough in June, but are much worse this month, more especially the stock returns. Last week alone nearly 8000 tons were added to Connal's stock of Cleveland pig iron, and for the first time since July, 1907, that stock, which was under 48,000 tons a year ago, has overtopped a quarter of a million tons. It has a weakening effect to find that iron is going into the public store from furnaces which have not heretofore had any of their iron lodged with Connal's. The quantity of Cleveland pig iron in Connal's store on the 28th was 258,353 tons—an increase of 20,471 tons for the month—a more rapid increase than has been known since 1905. The stock consisted of 252,718 tons of No. 3, 4734 tons of No. 4 foundry, and 901 tons of other iron undeliverable as standard. Shipments are poor this month; they were not good in June, but are much worse this month, only 83,946 tons having been despatched up to the 28th, as compared with 96,546 tons last month; 97,881 tons in July, 1908; and 129,268 tons in July, 1907, all to 28th.

Realised Prices of Manufactured Iron.

It has been this week notified to the Board of Conciliation and Arbitration for the Manufactured Iron Trade of the North of England that the average net price realised by the manufacturers of the district for the finished iron despatched from their works during May and June was £6 6s. 7.16d. per ton, which was 1s. 2.26d. per ton below the average for March and April, and in accordance with the sliding scale arrangement, the rate for puddling in the North-East of England will be reduced 3d. per ton, viz., to 8s. 3d. per ton, while other forge and mill wages will be reduced 2½ per cent. from Monday next. The following were the average prices realised for the different descriptions of finished iron, and the increase or decrease on the figures for the March-April rates:—Rails, £5 12s. 2.65d. per ton, decrease 16s. 2.47d.; plates, £5 18s. 6.35d., decrease 2s. 9.06d.; bars, £6 7s. 7.8d., increase 2.25d.; and angles, £6 14s. 8.45d., decrease 3s. 7.66d. The fall in realised prices during the first half of the year was 6s. 10½d. per ton, and over the last twelve months 7s. 3.45d.; while from the highest average of the late "boom" the decrease has been 20s. 1.94d. The rate for puddling has fallen 1s. per ton, and other mill and forge wages 10 per cent. The price now reported for all kinds—£6 6s. 7.16d.—is the worst that has been announced since November-December, 1905. The deliveries of the last two months were the smallest ever reported—they were at the rate of only 30,000 tons per annum, whereas as much as 657,000 tons were turned out at one time in a year.

Manufactured Iron and Steel.

On the whole more sanguine reports are given with respect to business in the finished iron and steel trades, and increased business is being done in several branches, more particularly in rails, sheets, and plates, the better demand for the last being due to the improvement which is at last being experienced in shipbuilding. Messrs. Bolckow, Vaughan and Co. have secured the order for 25,000 tons of steel rails for the Transvaal Government Railways, also one for 12,000 tons for the Australian Railways. On the other hand, one of the other railmaking concerns, owing to shortness of specifications, cannot keep its works fully going. At Messrs. Bolckow, Vaughan and Co.'s Eston

Steelworks the wages of the men, which are regulated by a sliding scale based upon the prices which the firm realises for steel rails, have been raised 4 per cent. for the next two months. No changes have been made in the quotations for manufactured iron and steel during this week. The Darlington Forge Company has this week sent to Belfast two of the largest boss brackets ever forged. They weigh nearly 40 tons each, and are for the new White Star liners now being built there.

Shipbuilding and Engineering.

Some improvement in shipbuilding in this district can now fairly be reported, a number of orders for new vessels having been secured, and the outlook is certainly more favourable. The list of "laid up" vessels is being shortened, and on the Tyne the number is under fifty, or nearly a third of what it was at the commencement of the year, while rates of freight are showing a slight improvement. The directors of the West Hartlepool Steam Navigation Company say that they believe the worst of the depression has been experienced, and the current voyages of their steamers are more satisfactory. Profitable business is likely to be done in the autumn.

Cleveland Ironstone Miners' Wages.

A fortnight ago the Cleveland Mineowners' Association claimed a reduction of 2½ per cent. in miners' wages. This they regarded as due owing to the fall in the price of pig iron shown by the last ascertainment. A deputation of the men on Wednesday asked the owners if they could not forego a reduction on this occasion. The owners were unable to acquiesce in the suggestion, but expressed a willingness to settle at 1¼ per cent. reduction. This proposal will be placed before the district.

Coal and Coke.

The coal trade in Northumberland and Durham continues to show much activity; indeed, the collieries experience some difficulty in satisfying the demand for coal for early delivery. The rates for forward execution are not so brisk as they were, because the consumers expect prices will ease if there is an amicable settlement of the dispute in the Scotch coal trade. Quotations are now comparatively high, best steams at 12s. 6d. to 13s.; steam, smalls, 5s. 6d. to 6s. 6d.; best gas coals at 11s.; gas, seconds, 10s.; and bunkers and coking coal 9s. 6d. to 10s. 3d. Coke is very firm in price, and in good request; furnace coke is realising 15s. 6d. to 15s. 9d. per ton delivered at Middlesbrough.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

The Crisis in the Coal Trade.

THERE was a general impression in trade circles early in the week that a settlement might be reached by the conference that took place in Glasgow on Tuesday between representatives of coalmasters and miners to deal with the wages dispute. It was understood that the employers were not unwilling that the 6s. minimum wage should be obtained by the miners, provided that they—the employers—could be saved from loss by a readjustment of the sliding scale. The conference lasted over three hours, and failed to arrive at an arrangement, it being understood that its proceedings would be reported to an adjourned meeting to be held at the Board of Trade offices in London on Thursday. Hardly any information regarding what occurred at Tuesday's meeting was allowed to leak out, but it became known that the representatives of the men took up an uncompromising position, fortified as they were by the very large majority by which the Scottish miners have voted in favour of a general strike. Of the 80,000 miners, no less than 68,275 took part in the vote, and 63,083 voted in favour of a strike, and 5192 against. This result, together with reports as to the balloting in England, seems to have encouraged the miners' leaders to assume very high ground, and the outlook at the moment is not reassuring.

The Pig Iron Market.

At the end of last and beginning of the present week there was a more hopeful feeling in the warrant market, and a fair business took place, with a gradual improvement in prices. This feeling has not been maintained, the result of the conference on the mining dispute having had an unfavourable effect on the market. Business has been done in Cleveland warrants from 48s. 5½d. to 49s 2d. cash, 48s. 9½d. to 49s. 5d. one month, and 49s. 2½d. to • 10d. three months. Transactions were also noted at 49s. and 1½d. for delivery in seven days, 49s. 2d. seventeen days, and 4!. 1d. for September 2nd.

Scotch Makers' Iron.

Deliveries and shipments of pig iron in the last few weeks showed a tendency to increase, this being due not so much to any real improvement in trade as to a desire on the part of consumers to be supplied with raw iron in case of a rise in price. There was, of course, the probability of a proportion of the furnaces being put out of blast in the event of a general strike of colliers, and a scarcity of fuel might reduce the output of iron. The demand for pig iron fell away considerably, however, in the course of the past week, so that the market was flat; but it is quite likely that a strike of miners might help somewhat to raise prices by reducing output and stocks. Ten furnaces have been stopped, but it has been quite usual to reduce the production during the summer trade holidays. There are now 72 furnaces in blast in Scotland, compared with 82 in the preceding week, and 69 at this time last year. Should the mining trouble be prolonged, it is not unlikely that the pig iron output may be further curtailed. Some brands of pig iron are lower this week. Monkland, No. 1, is quoted f.o.s. at Glasgow, 55s.; No. 3, 53s.; Carnbroe, No. 1, 58s. 6d.; No. 3, 53s. 6d.; Clyde, No. 1, 59s. 6d.; No. 3, 53s. 6d.; Gartsherrie, No. 1, 60s.; No. 3, 54s.; Calder, No. 1, 60s.; No. 3, 55s.; Summerlee, No. 1, 60s. 6d.; No. 3, 55s. 6d.; Langloan, No. 1, 61s.; No. 3, 56s.; Coltness, No. 1, 88s.; No. 3, 56s.; Glengarnock, at Ardrossan No. 1, 62s.; No. 3, 57s.; Eglinton, at Ardrossan or Troon, No. 1, 55s.; No. 3, 53s.; Dalmellington, at Ayr, No. 1, 58s.; No. 3, 53s.; Shotts, at Leith, No. 1, 60s.; No. 3, 55s.; Carron, at Grangemouth, No. 1, 63s.; No. 3, 56s. per ton.

The Hematite Trade.

The market for hematite has this week been very dull. Consumption in the West of Scotland has been at a standstill, with some doubt as to when it might be fully resumed. Cleveland warrants have been on offer at 56s. 6d. without purchasers, and Scotch hematite is also comparatively neglected, the nominal price being 57s. for delivery at the West of Scotland steelworks.

Shipments of Pig Iron.

The shipments of pig iron from Scottish ports in the past week amounted to 5968 tons, against 3846 in the corresponding week of 1908. Of the total, there was despatched to Italy 2052 tons, Belgium 120, Canada 400, India 60, France 25, Germany 41, Holland 60, China and Japan 110, other countries 225, the coastwise shipments being 2875 tons, compared with 2113 in the corresponding week. The arrivals at Grangemouth of pig iron from Cleveland and district were 7090 tons, showing an increase of 3137 tons over the corresponding week's imports last year.

Finished Iron and Steel.

Only a partial start was made this week after the holidays at the finished iron and steel works. The orders coming to hand have been unsatisfactory, both as regards malleable iron and steel. For shipbuilding material the new orders are small, but if a strike of miners were averted, it is believed they would soon become more important, as it is understood the prices are now low enough to induce business.

The Coal Trade.

Business is disorganised in the Scottish coal markets by the labour dispute, and the tension pending the final result of the conferences between representatives of employers and workmen has been so great that scarcely any business could be attempted, except for prompt delivery. The demand for manufacturing purposes has been reduced by the holidays, and from the same cause shipments have decreased to little over one-half what they were in the preceding week. Prices cannot be given at the moment with anything like accuracy.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Last Week's Coal Trade.

IN some respects business last week was of a disappointing character. Usually before holiday there is a more vigorous tone, with a tendency to stronger prices, but last week, what with absenteeism on the part of colliers, many of whom are engaged in harvest work, supplies were scanty, and yet quite sufficient to meet the demand, so that prices remained but slightly affected. Newport totals were good, considering, the total being 90,525 tons, of which nearly 77,000 tons went to foreign destinations. Swansea total was only 62,000 tons, and in all there was a decrease in the export and import trade of the port of 6000 tons. Port Talbot showed an improved total. Occasionally during the week Cardiff showed an improvement, and the foreign shipments were large, but on the whole there was a falling off. Among the larger shipments, Port Said, Cronstadt, Montevideo, and Alexandria figured well. Steam coal was brisk; dry coals in demand. Supplies of steam and semi-bituminous remain in the ascendant. No. 3 Rhondda continues with an upward tendency. Best bunker prices firm; other kinds unsteady. No improvement in house coal, which remains, both in volume and in price, below the expectation of coalowners—in fact, the season so far has failed to bring this class of coal up to summer bulk and values.

Present State of Coal Trade.

The severe weather has told seriously against the coal trade, and even best and seconds steam coal have been in poor demand. Drys and Monmouthshire are in a similar position. The outlook is bad. The situation, authorities say, can only be saved by the successful issue of Mr. Churchill's intervention. At Cardiff, mid-week, prospects were stated to be gloomy, even by authorities who have hitherto been hopeful. Latest prices:—Best large steam, 16s. 9d. to 17s; best seconds, 15s. 9d. to 16s.; ordinary seconds, 14s. 6d. to 15s.; best drys, 15s. 6d. to 16s.; ordinary drys, 13s 6d. to 14s. 3d.; best washed nuts, 13s. 9d. to 14s. 9d.; seconds, 12s. 9d. to 13s. 3d.; best washed peas, 12s. 6d. to 12s. 9d.; seconds, 10s. 9d. to 11s. 9d.; very best smalls, 9s. 3d. to 9s. 9d.; best ordinaries, 7s. 3d. to 7s. 9d.; inferior sorts, 6s. 6d. to 7s.; best Monmouthshire black vein, 15s. 6d. to 15s. 9d.; ordinary Western Valleys, 14s. 6d. to 14s. 9d.; best Eastern Valleys, 13s. 9d. to 14s. 3d.; seconds, 12s. 9d. to 13s. Bituminous coal: Very best households, 15s. 6d. to 15s. 9d.; best ordinaries, 14s. 6d. to 15s. 6d.; No. 3 Rhondda, large 17s. to 17s. 6d.; brush, 13s. 6d. to 13s. 9d.; smalls, 10s. to 10s. 3d.; No. 2 Rhondda, 12s. 9d. to 13s.; through, 10s. to 10s. 6d.; smalls, 8s. 9d. to 9s. Patent fuel, 15s. to 15s. 6d. Coke: Furnace, 17s. to 17s. 9d.; foundry, 18s. 6d. to 21s. 6d.; special foundry, 24s. 6d. to 27s. 6d. Pitwood, ex-ship, 21s. to 22s.

Newport Coal.

This district continues to enjoy a greater degree of favour than has been obtained by Cardiff of late. There was a difficulty in getting supplies for this side of the holidays, and sellers were firmer in their quotations. Best black vein in good demand. Best black vein, 15s. 3d. to 15s 6d.; ordinary Western Valleys, 14s. 3d. to 14s. 6d.; best Eastern Valleys, 13s. 6d. to 14s.; other sorts, 12s. 6d. to 12s. 9d.; best smalls, 8s. to 8s. 6d.; seconds, 7s. 3d. to 7s. 9d.; inferiors, 6s. 9d. to 7s. Bituminous coal: Best house coal, 15s. to 15s. 3d; seconds, 14s. to 14s. 3d. Patent fuel, 14s. 6d. to 15s. Coke: Foundry, 18s. to 19s.; furnace, 16s. to 16s. 6d. Pitwood, 21s. 6d. to 22s.

Swansea Coal.

Trade showing a slight improvement and demand improving, but, as at all parts, the weather has been and continues very adverse, and strike foreshadowings are prominent. Latest prices:—Best malting, hand picked, 23s. to 24s. net; second malting, 21s. to 22s. net; big vein, 18s. to 19s. 6d., less 2½; red vein, 12s. to 12s. 6d., less 2½; machine-made cobbles, 23s. to 23s. 6d. net; Paris nuts, 23s. 6d. to 24s. 6d. net; French nuts, 23s. 6d. to 24s. 6d. net; German nuts, 23s. to 23s. 6d. net; beans, 17s. to 17s. 6d. net; machine-made large peas, 10s. 6d. to 11s. 6d. net; fine peas, 10s. to 11s. 6d. net.; rubbly culm, 5s. to 5s. 3d., less 2½; duff, 3s. to 3s. 3d. Other coal: Steam, best large, 15s. 6d. to 16s., less 2½; seconds, 13s. 6d. to 14s. 6d., less 2½; bunkers, 10s. to 10s. 9d., less 2½; small, 8s. to 9s., less 2½. Bituminous coal: No. 3 Rhondda, 17s. 6d. to 18s. 6d., less 2½; through, 14s. 6d. to 15s., less 2½; small, 9s. 9d. to 10s., less 2½. Patent fuel, 13s. to 13s. 6d., less 2½.

Amalgamated Society of Engineers.

Mr. C. A. Adams has been selected for the vacant position of Organising Secretary for the West of England and South Wales.

Miners' Refusal to Work Extra Hours.

The refusal of miners to work the extra hours authorised by the Coal Mines Regulation Act is to be associated with police proceedings. Early in August a summons is returnable in connection with the Porth case at Ystrad, Insoles Company claiming for damages. This is to be a test case.

Mabon and the Coal Trade Crisis.

Mabon's opinion is that the Scotch coalowners will not persist in forcing a reduction. In closing my despatch the question is left in great uncertainty. The outside opinion is that to strike will be suicidal, but, unfortunately, the colliers appear to be banded together to bring about a crisis. North and South Wales colliers support the Scotch in advocating a strike.

Iron and Steel.

There was only half a week's work last week. The Big Mill at Dowlais was busy up to Thursday, but in the finished steel departments very little was done, and the situation generally may be regarded as unimproved. In the Llanelly and Swansea districts the condition of things is better. The local market in Llanelly is doing well with steel bars. At Swansea all the steel smelting works are brisk. Cargoes of steel have been coming in freely; 1720 tons from Bruges, 1112 from Antwerp, old rails and scrap iron from Southampton. Swansea imported 3540 tons pig iron, 1290 tons scrap steel, 4087 tons iron ore. The iron cargoes have been large and varied, including a quantity from Belfast. Quotations remain much about the same:—Steel bars: Siemens £4 8s. 9d. to £4 10s.; Bessemer the same. Hematite pig: Mixed numbers, 50s. 3d. cash and month; Middlesbrough, 49s. cash; 49s. 3d. month. Scotch, 55s. cash and month. Welsh hematite, 60s. to 61s. East Coast hematite, 59s. 6d. c.i.f. Rubio, 15s. 6d. to 15s. 9d.-16s.

Tin-plate.

The harbour returns for last week were as follows:—Received from works, 101,241 boxes; shipped during the week, 81,129 boxes; stocks remaining at docks, 219,728 boxes. Latest prices:—Siemens and Bessemer, 11s. 10½d.; C.A. roofing sheets, £8 5s. to £8 7s. 6d.; big sheets for galvanising, £8 7s. 6d. to £8 10s. per ton; finished black plates, £9 5s.; galvanised sheets, 24 g., £10 10s. to £11 nominal per ton; ternes, 21s. 6d. Norway is importing largely of terne plates.

Other Quotations.

Block tin, £132 12s. 6d. cash, £134 three months; copper, £58 13s. 9d., three months £59 8s. 9d.; lead, £13; spelter, £22; silver, 1s. 11⅛d. Tin-plate works all fully occupied; spelter refineries busy, and produce of copper works a good average. Foundries and engineering works busy, and ample orders in hand generally that will necessitate full time for some time to come. At Llanelly extensions are well in hand. The break up of the galvanising combination is noted with interest, and its effect on local works is being noted carefully.

CATALOGUES.

GILBERT LITTLE AND CO., Limited, Horton Works, Bradford.—This company has forwarded us a concise little pamphlet having reference to belt conveyors for various classes of service.

THE TUDOR ACCUMULATOR COMPANY, 119, Victoria-street, Westminster, S.W.—This is a list giving prices of battery installations working at 25 and 50 volts, and suitable for metallic filament lamps.

ROPEWAYS, Limited, Eldon-street, South-place, E.C.—This is an excellently got up catalogue dealing with ropeways. It contains many illustrations, showing the company's ropeways in various kinds of industrial service.

THE GLOBE PNEUMATIC ENGINEERING COMPANY, Limited, 150, Queen Victoria-street, London.—A well got up illustrated catalogue of pneumatic tools and appliances has reached us. Also an interesting and useful little booklet dealing with the care of pneumatic tools.

THE LONDON ELECTRIC FIRM, George-street, Croydon.—Catalogue No. 125 has reached us. It deals with arc lamp lowering gear and self-sustaining winches, and many other fittings and accessories connected with arc lamps, such as guide pulleys, flexible wire rope, span wire lowering gear, contact devices, and so forth.

WILLANS AND ROBINSON, Limited, Victoria Works, Rugby.—From this company we have received an excellently got up pamphlet dealing with steam turbines. It contains a considerable amount of descriptive matter, also illustrations showing turbines erected in various power stations, parts of steam turbines, the company's system of blading, &c.

J. DAMPNEY AND CO., Limited, Bute Docks, Cardiff.—This is a little booklet dealing with Dampney's "Apexior" compound for coating the internal surfaces of steam boilers to prevent the deposit of hard scale and pitting, also for coating the external surface of steam boilers and steam pipes before clothing, as a protection from corrosion, and for various other purposes.

NEWALL'S INSULATION COMPANY, Limited, Scottish Provident-buildings, Mosley-street, Newcastle-on-Tyne.—A well got up pamphlet has reached us which has reference to Newall's magnesia covering for steam pipes, boilers, &c. Among the illustrations which the pamphlet contains there is one showing a large turbine lagged with the company's magnesia slabs.

CALLENDER'S CABLE AND CONSTRUCTION COMPANY, Limited, Hamilton House, Victoria Embankment, London, E.C.—The 1909 edition of this company's catalogue has reached us. It has been got up in the usual excellent style and the cable code at the end obviates the possibility of telegraph errors when ordering rubber insulated wires, and the heavier mains of the vulcanised bitumen, paper insulated, lead sheathed, and steel tape armoured types.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

AT a meeting of the directors of Vickers, Sons, and Maxim, Limited, held on the 20th inst., Mr. Frank Barker, director of Parsons Foreign Patent Company, Limited, was elected a director of the company.

MESSRS. J. BEARDSHAW AND SON, Limited, of the Baltic Steel Works, Sheffield, have just appointed Messrs. W. A. Walber and Co., 38, Victoria-street, Westminster, their agents for London and the South of England.

THE sole control of sales in the Eastern Hemisphere of the "Schureman" switch gear, has now passed into the hands of the Adams Manufacturing Company, Limited, of Bedford, and 106, New Bond-street, London.

MR. JENS ORTEN-BOVING, M.I.M.E., informs us that he has taken into partnership Mr. Douglas Spencer, and Mr. P. R. Cobb. The style of the firm will henceforth be Jens Orten-Böving and Co., and on and after Monday, 26th inst., the address of the firm will be 9½, Union-court, Old Broad-street, London, E.C. Telegrams: "Jenorten, London." Telephone: London Wall 6480.

JOHN I. THORNYCROFT AND CO., Limited, ask us to state that, having disposed of their Chiswick works, they have made the following alterations in their addresses:—The head office has been transferred from Church Wharf, Chiswick, to Caxton House, Westminster, S.W. The marine motor, stationary motor, and motor launch sales department is also situated at Caxton House. For the car and vehicle repairs department they have acquired a large and well-equipped garage and repairing works, the Vauxhall Bridge Garage, 5-11, Vauxhall Bridge-road, S.W.

CONTRACTS.—Ed. Bennis and Co., Limited, have recently received orders for over thirty stoking plants of various types, many of which are, we understand, repeat orders.—Willans and Robinson, Limited, have just received an order from the Lambton Collieries for a pump on the Orten-Böving principle, to deliver 2500 gallons per minute against a head of 315ft. at 1170 revolutions per minute. This firm is also employed on an order for two similar pumps for Messrs. Isaac Holden and Sons, of Reims. Each of these pumps will deliver 400 gallons per minute against a head of 170ft. at 950 revolutions per minute.—In addition to the 100-ton electric Giant crane which Applebys Limited have supplied to Earle's Shipbuilding and Engineering Company, the former firm is erecting a similar 100-ton crane at the works of George Clark, Limited, at Sunderland, and has just shipped to Japan a Giant crane of 150 tons power, and has recently completed a 75-ton floating crane.—On July 21st the opening ceremony of the new refuse destructor installed by the Gainsborough Urban District Council took place. The plant is a two-cell "Meldrum" destructor of the back-feed type, capable of efficiently destroying 1½ tons of general house refuse per hour, the heat being utilised for steam raising in a Lancashire boiler 30ft. by 7ft., working at 150 lb. per square inch pressure.—The contracts for seven Warner trucks—non-parallel axle—10ft. wheel base, for the Llandudno Tramways Company, has been awarded to Mountain and Gibson, Limited, of Bury, Lancashire.—We understand that Sir Raylton Dixon and Co., Limited, have secured a further order from the Rea Shipping Company, Limited, for a duplicate of the steamer they are now building for that company's general trade.

NOTES FROM GERMANY, FRANCE, BELGIUM, &c.

(*From our own Correspondent.*)

Rhenish-Westphalian Iron Trade.

SALES have been restricted to the utmost during the past week. The steel works of the district are reported to intend stopping the production of rails and sectional iron for a while owing to a want of orders. Quotations for pig iron again met with a reduction of M. 1 p.t. on the 16th inst., chiefly in consequence of the exceedingly keen competition for next year's purchases.

Iron and Steel in Silesia.

Though activity is moderate and output has been restricted in many departments, stocks have increased and very low rates are complained of. The business in merchant iron, as well as in plates, is getting more languid every week, and prices leave next to no profit.

The Coal Trade.

Concerning coal, the reports of previous weeks can only be repeated; there is very little activity shown, and purchases are not extensive. Silesian coalowners are doing a fair trade with Russia; gas coal is in improving request; engine coal remains in moderate demand. A steady trade is done on the Rhenish-Westphalian coal market. Owing to the favourable state of the Rhine, shipments to South Germany have been lively. Deliveries in steam coal are reported to be much higher than in last month. In coke likewise an improvement against previous weeks can be noticed.

Austria-Hungary.

Considering the general depression in the iron industry, sales of the United Austrian Ironworks for June of the present year have been fairly satisfactory, as may be seen from the following:—

	1909.	1908.
	q.	q.
Bars	267,189	310,377
Girders	141,859	121,165
Heavy plates	40,579	42,684
Rails	73,620	85,209

Production since the 1st of January.

Bars	1,549.4[illegible]9	1,891 168
Girders	630,721	625,213
Heavy plates	[illegible]82, 47	277,825
Rails	5[illegible]5 040	541.813

The building department is likely to be better employed during the next few weeks, owing to the commencement of some large public buildings. Both pit coal and brown coal have shown a good deal of firmness. In the Ostrau-Karwin district output goes into immediate consumption, and orders for forward delivery are numerous.

Good Accounts from France.

Pig iron has been in increasing demand during this and last week, and activity in the semi-finished steel trade and at the construction shops has been more lively than before. Additional blast furnaces have been blown in at various establishments in the Meurthe-et-Moselle district. Girders show increasing animation, and the business in machines has developed satisfactorily. Stocks in coal show a decrease, in consequence of more demand for most sorts. Rates are firm.

Steady Business in Belgium.

In finished iron a slight upward movement is noticeable, while pig iron shows a weakening tendency in consequence of strong foreign competition. Basic, however, remains firm at 66 to 67f. p.t. Of 44 existing blast furnaces 37 are in blow at present. Rails and also merchant iron show increasing strength. Foreign business in bars is rather better than previously, but in girders little has been done for abroad. Plates, both light and heavy sorts, sell freely at fair rates, although German competition is very active and successful in sheets. An abatement in deliveries of dry coal is noticeable, owing to a very moderate demand from the brick kilns. The prolonged rainy period has been most unfavourable for the brick industry, and this is naturally influencing the demand for coal. An official change in prices for coal and coke has not taken place.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, July 19th.

THE pipe line builders are entering upon constructions of lines which will create a heavy demand upon mills furnishing pipe and upon furnaces making pipe iron. Among recent orders are one for 12 miles of 20in. pipe, another for 30 miles of 6in. and 8in. pipe. Inquiries are in the market for 400 miles of 8in. pipe to be laid in the State of Illinois, to be constructed by the Pure Oil Company. The Hope Natural Gas Company will construct a line between 400 and 500 miles long, from the oil field in West Virginia to the city of Baltimore. The Union Petroleum Company, of Buffalo, will construct a line 60 miles long with 8in. to 10in. pipe. Under this heavy present and prospective demand prices have been advanced 2 dols. to 4 dols. per ton.

The tin-plate manufacturers are making a stubborn fight against the Union, and are endeavouring, without present pronounced success, to operate their mills. The amalgamated membership ceased work July 15th. Some tin-plate mills are working, especially the independent mills. The demand for plates is good, and prices have hardened. The last Panama Canal steel order is for 1600 tons shapes for lock gates. The Jones and Laughlins Company will soon make 6000 tons of shapes for its new open-hearth plant at Alliquippa, and 4000 tons for its new tin-plate plant under erection. There are even now probabilities of speculative advances in steel, but manufacturers are lending no countenance to those who would buy for speculative purposes. The Carnegie Steel Company will name its price this week on enough steel plate to construct 34,000 freight cars which have been contracted for.

Large blocks of pig iron are now under negotiation for delivery during the rest of the year. An upward tendency has developed in pig, and a number of makers are declining to quote prices for late delivery until after mid-August. Industrial activities are bringing out a good many orders for light rails ranging from 16 lb. to 45 lb. sections. The locomotive works are steadily filling up, and full time will be the rule within a few weeks. Nearly all railway systems are increasing their motive power, and, as a rule, engines of a larger driving capacity than formerly are being built. There are not a few evidences to lead to the probability of excessive activity in the steel industry. Congress will soon adjourn, and with that body not sitting people will begin to get busy.

Copper interests anticipate an active buying movement will set in about August 1st. There is no threatening accumulation to deal with, and the consuming industries are becoming more and more active. Electrolytic is selling at 13.

THE Highways Committee of the London County Council estimates that the tramcars on the northern and southern tramway systems will number 1425 at the end of the financial year.

BRITISH PATENT SPECIFICATIONS.

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

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

Copies of Specifications may be obtained at the Patent-office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

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

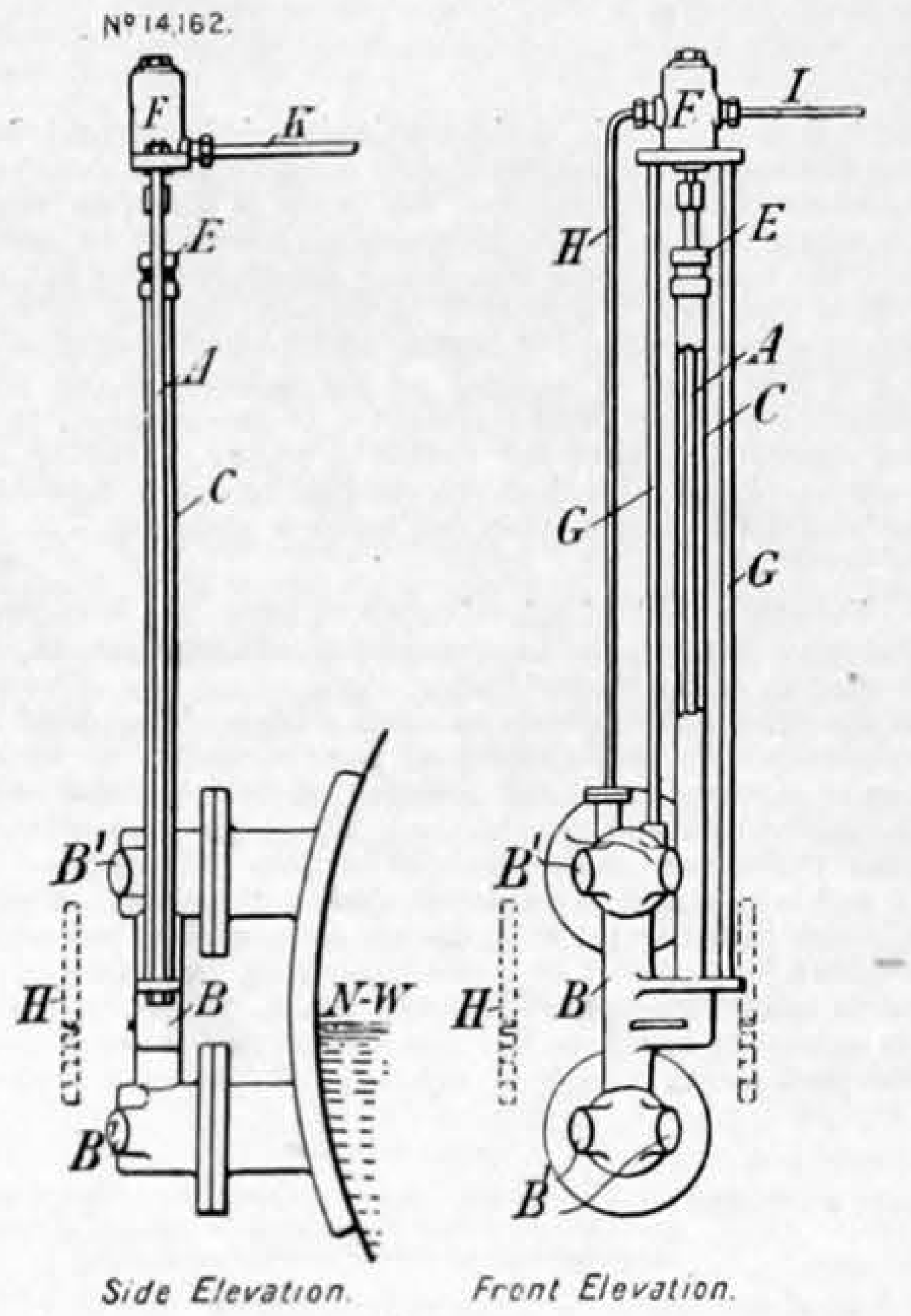
Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-office of opposition to the grant of a Patent.

STEAM GENERATORS.

14,162. July 3rd, 1908.—A COMBINED WATER GAUGE AND FEED-WATER REGULATOR, by *Herman Garbe, of* 17, *Sybelstrasse, Charlotterburg, Berlin, Germany.*

This feed-water regulator presents the special arrangement that the expanding body A is fixed in a lateral widening of the water-gauge casing B and enclosed in a narrow cooling tube C, so that only a small quantity of steam is able to enter the cylindrical space between the expansion body and the cooling tube. The casing B has sockets B[1] formed thereon, which serve for securing the water-gauge cock and the gauge glass H (shown in dotted lines). If the water level in the boiler falls below the normal water line N—W, the lateral widening of the water-gauge casing becomes filled with boiler steam, and, consequently, the cooling tube is filled also; by raising the temperature this steam causes the expansion body A to expand. This causes feed-water to be supplied to the boiler, the water in the gauge again rises, and access of steam to the expansion bar is prevented. The steam contained in the cooling tube speedily condenses as the water drawn in becomes cooled by yielding up its heat to the exterior, and thereby causes the expan-

Nº 14,162.



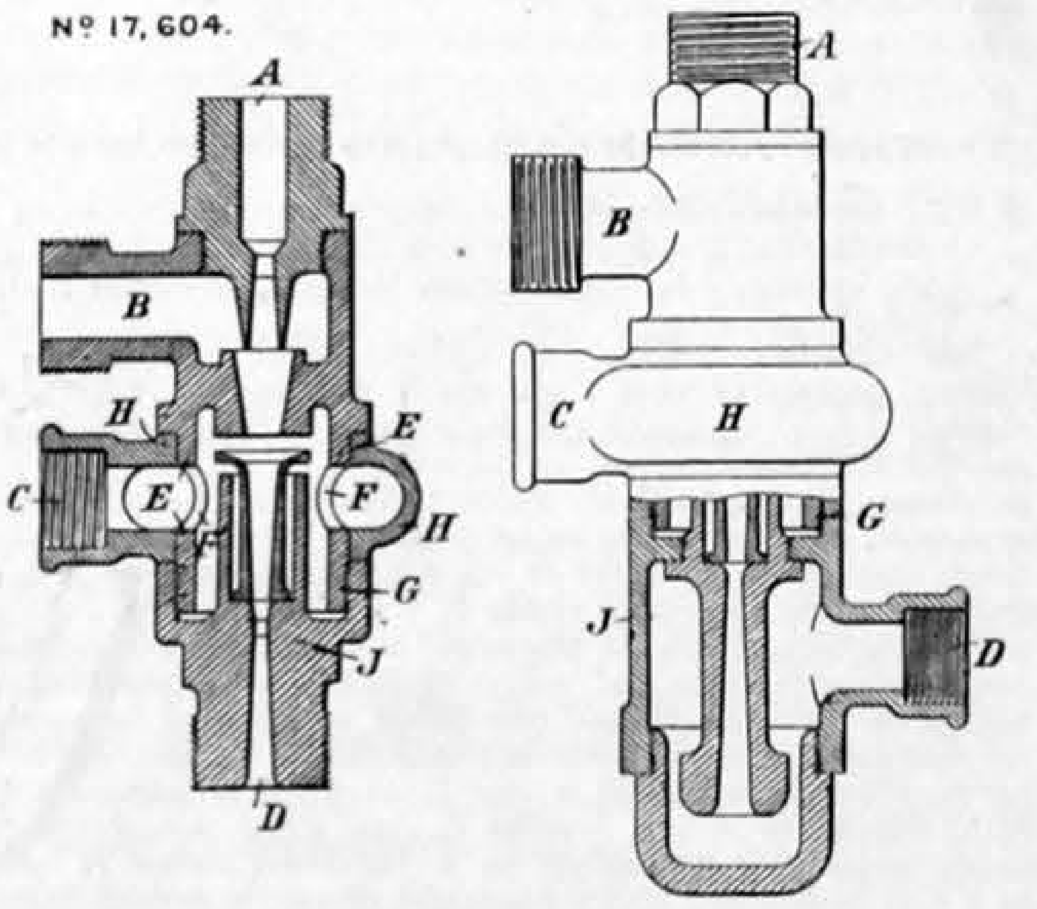
Side Elevation. *Front Elevation.*

sion bar to contract and, consequently, cuts off the supply of feed-water. The arrangement is such that the apparatus operates very sensitively. The free end of the bar A passes through a stuffing-box E to the outside of the cooling tube and comes directly into contact with the guide pin of a valve mounted in the upper valve casing F, and held against its seat by means of a spiral spring. The valve and its spiral spring are not, however, illustrated. The valve casing F is rigidly connected with the gauge tube by the rods G, G. When the valve is closed the conduits H and I are subjected to the pressure of the boiler steam. The tube I transmits this pressure to the cut-off valves of the feed pump, which are thus maintained closed in the known manner. An exhaust conduit K is also fitted to the valve casing F. If now the valve be opened by the expansion of the bar A, the steam flows out of the two tubes H and I through the valve and the exhaust pipe K into the atmosphere, the cut-off valves of the feed pump being thereby relieved and opened, so that the feed-water can be supplied to the boiler until the valve is again closed by the cooling, that is to say, the contraction of the bar A, thereby preventing the escape of the steam from the valve casing F.—*July 7th*, 1909.

17,604. August 21st, 1908.—IMPROVEMENTS IN INJECTORS, Robert Grundy Brooke, Upton Grange, Macclesfield, Chester.

The object of this invention is to provide improved constructions whereby the adjustment, setting and removal of the overflow chamber and branch can be effected upon the manipulation of a portion of the body of the injector to which the lower cones are attached, the

Nº 17,604.

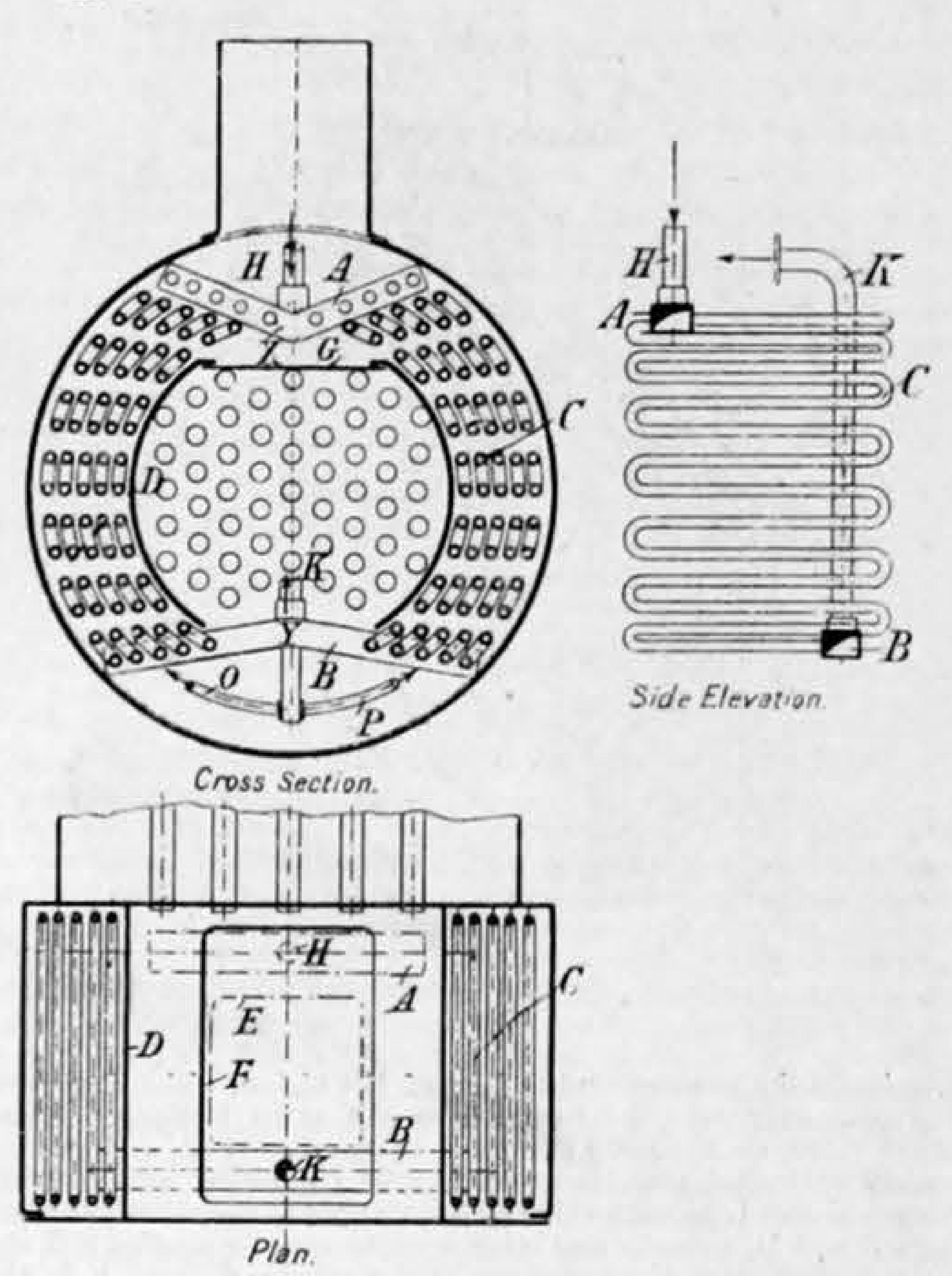


arrangement being such that the cones are removed with the body portion when it is desired to remove the overflow chamber. The accompanying engravings illustrate in longitudinal section two constructions of injectors according to this invention. In each case A is the steam inlet, B the water inlet, C the overflow branch and D the delivery. In the arrangement shown on the left the upper portion of the injector from which the water branch B extends is formed with an extension that is externally cylindrical at E and is formed with ports F and a threaded portion G. The overflow branch C projects from a channel or trough section ring H which forms a passage through which the overflow escaping through the ports F passes to the branch C. The ring H fits the cylindrical portion E and is faced at its ends so that when the lower portion J of the injector is screwed up tight on the threaded part G of the upper portion, the ring H is held tight in its adjusted position. By slightly screwing back the lower portion J, the ring H can be turned on the cylindrical extension of the upper portion so as to bring the branch C into the required position. The right-hand engraving illustrates a modification, in which the delivery D is at the side.—*July 7th*, 1909.

27,761. December 21st, 1908.—IMPROVEMENTS IN SMOKE-BOX SUPERHEATERS FOR USE WITH BOILERS OF THE LOCOMOTIVE TYPE, *T. Heinrich Lanz, of Mannheim, Germany.*

The object of the present invention is to produce a simple and effective smoke-box superheater arranged in an annular space. According to the form shown two headers A and B are arranged in the smoke-box of the boiler. These headers are connected by zigzag tubes C which are arranged in concentric cylindrical planes. The header A receives steam from the boiler through a pipe H, while the superheated steam passes from the header B by the pipe

Nº 27,761.



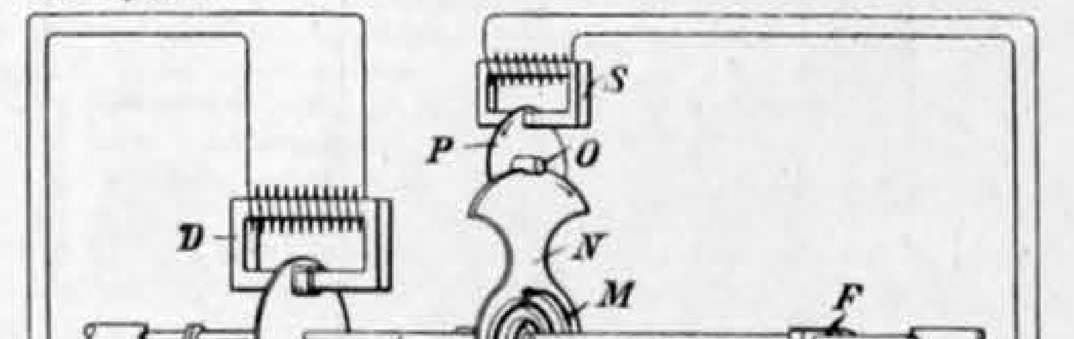
K. The tubes passing from the header A to the header B are arranged in two groups lying on opposite sides of the central axis of the boiler. To facilitate this grouping, the headers A and B are preferably bent at X and Y inwardly towards the axis of the boiler. The annular space occupied by the zigzag tubes C is on its inner part closed off by a wall D which shows the openings E and F at the top and bottom. In the form of the invention shown the opening E is provided with a damper plate G. A tube having branches O and P is preferably provided for the purpose of cleaning the tubes of the superheater.—*July 7th*, 1909.

DYNAMOS AND MOTORS.

19,992. September 23rd, 1908.—IMPROVEMENTS RELATING TO AUTOMATICALLY REGULATING DIRECT-CURRENT AND ALTERNATING-CURRENT MACHINES, *the Aktiengesellschaft Brown, Boveri et Cie, of Baden, Switzerland.*

A metal disc B is mounted on the spindle or shaft A, on which disc an electro-magnet D, fed by the current, in this case a shunt current of the generator C to be regulated, exerts a torque which is normally counterbalanced by a weight E. Further, a plate spring F, having a point bearing G, is mounted on this spindle A. This spring presses a sector H resting with its point in the bearing G, against stationary resistance contacts X which are arranged along an arc and provided with resistances K, connected in the shunt circuit of the exciting dynamo L, the arrangement also being such that the sector H can roll along the contacts in order

Nº 19,992.



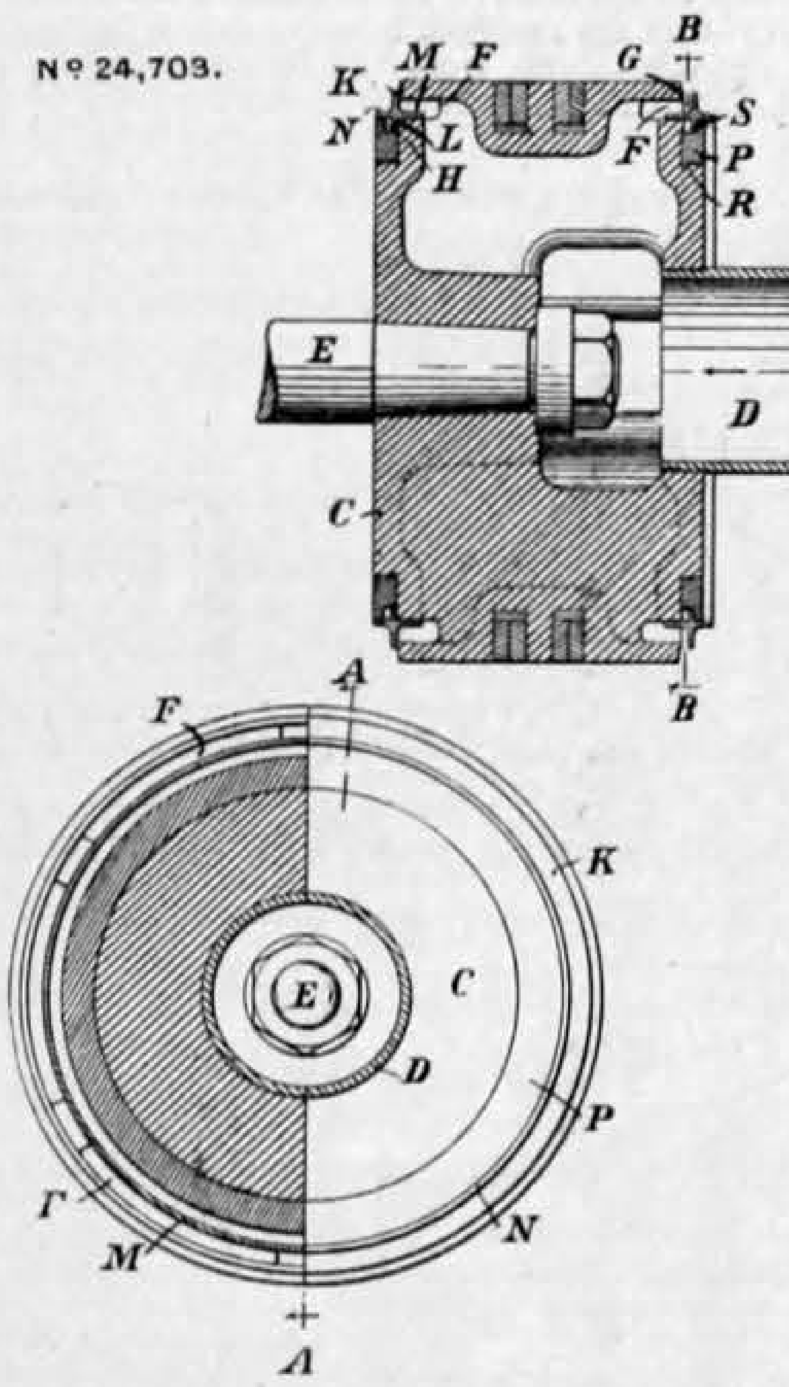
to vary the effective field resistance. A spiral spring M is connected at its inner end with the spindle A, and at its outer end with a disc N loosely mounted on this shaft or spindle. This disc has a serrated or toothed portion engaging with a small wheel O, of a damping device consisting of a disc P, mounted together with the small wheel O on a shaft, and of a direct-current electro-magnet S, which on movement of the disc exerts a torque on the same. If the pressure of the generator C varies, then the torque exerted on the disc B also varies, that is to say, the disc will rotate with the spindle A, and consequently roll along the arc of the sector H on the contacts X in such a manner that according to the variation and pressure more or less resistances are inserted.—*July 7th*, 1909.

PUMPING AND BLOWING MACHINERY.

24,703. November 17th, 1908.—IMPROVEMENTS IN VALVED PISTON AIR OR GAS COMPRESSORS, *Ingersoll-Rand Company, of 11, Broadway, Manhattan, New York, U.S.A.*

The upper engraving is a longitudinal central section through the piston taken in the plane of the line A A of the lower engraving, looking in the direction of the arrows. The lower engraving is a face view of the piston, one-half of the view being taken in section in the plane of the line B B of the upper engraving, looking in the direction of the arrows. C designates the hollow piston of a double-acting air compressor. The central pipe D is connected to the piston and constitutes the inlet for the fluid to be compressed. In the example represented the piston is furnished on the side opposite to the central pipe D with a rod E for the purpose of making connection between the piston and the motor for driving it. The piston is provided in one or both of its faces, in the present instance both of its faces, with annular passages F, arranged near the periphery of the piston. Ring valves are arranged to open and close the passages F. An annular seat G is provided exterior to each passage F, and an annular seat H is provided

No 24,703.



interior to the passage on the face of the piston. The ring valve comprises external and internal flanges K and L forming the face of the valve, an inwardly extended annular stem M, and an outwardly extended annular stem N. The external and internal flanges K and L provide valve faces arranged to engage the annular seats G and H, exterior and interior to the annular passage F in the piston. The inner circumference of the annular passage F in the piston is turned truly to form a cylindrical guide for the inwardly extended annular valve stem M, the stem being turned to fit the so formed cylindrical guide with an easy sliding movement. A plate P is screwed on to the piston face, as shown at R, which plate is provided with a circumferential flange S, which is arranged to overlap the internal flange L of the ring valve so as to limit the outward movement of the valve. The periphery of the flange S is turned truly to form a cylindrical guide for the outwardly extended annular valve stem N, the inner wall of which is turned to fit the said cylindrical guide with an easy sliding movement. The valve in this instance is thus guided inside and outside of its external and internal flanges K and L which form the face of the valve.—*July 7th*, 1909.

SHIPS AND BOATS.

23,946. November 9th, 1908.—IMPROVEMENTS IN PLUGS FOR REPLACING RIVETS, William Bagguley, of 3, Kyle Park, Uddingston, Glasgow.

This invention relates to improvements in plugs for replacing defective rivets for ships. The top left-hand engraving is an elevation. The top right-hand engraving is an end view of the plate of a ship showing the expanded tube taken through the line C D. The bottom engraving is an end view of the inner portion of the bolt when screwed up, taken through the lines A B looking in the direction of the arrow. A tube A^1 is provided, the diameter being equal to that of the rivet hole B^1 in the

No 23,946.

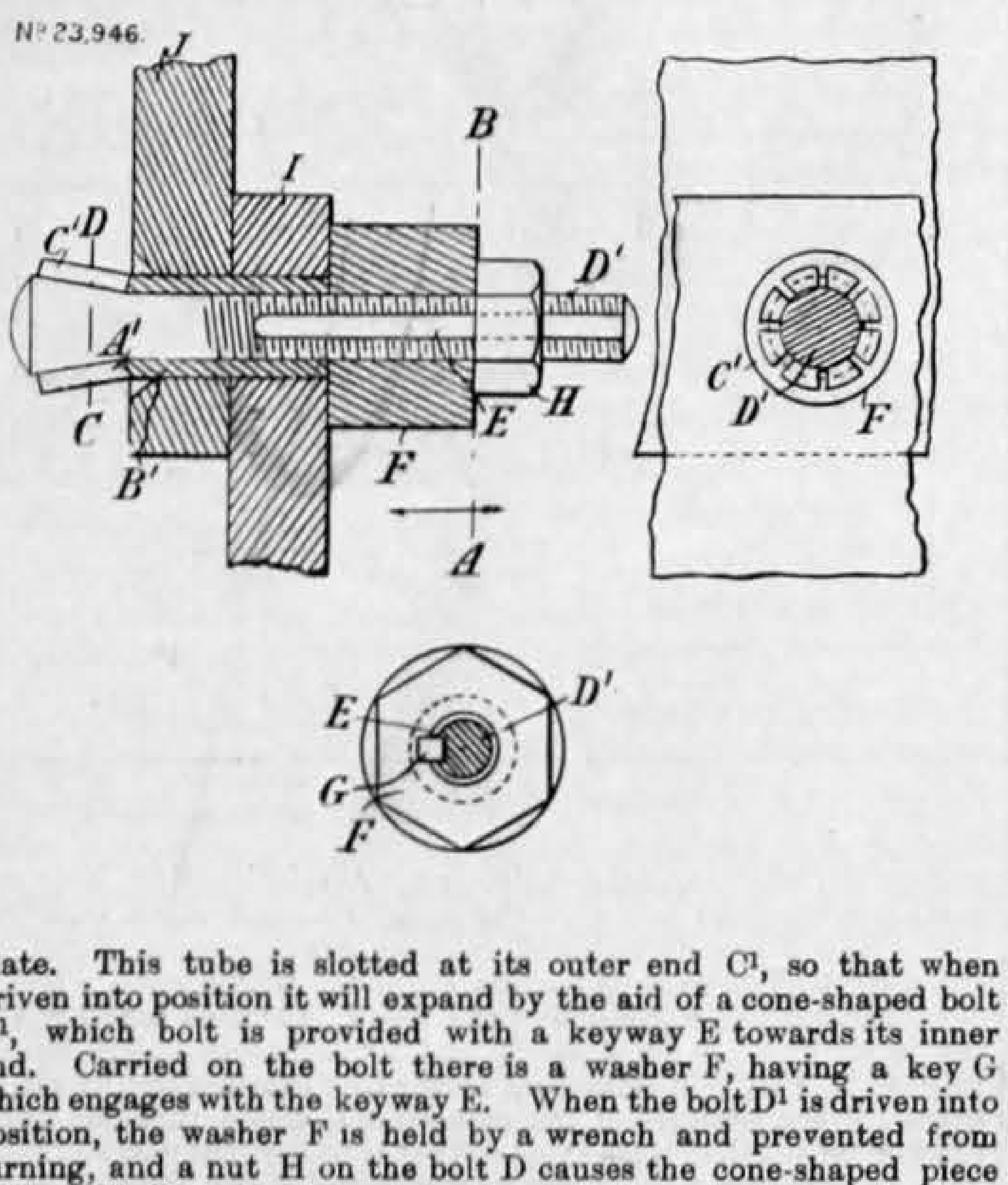


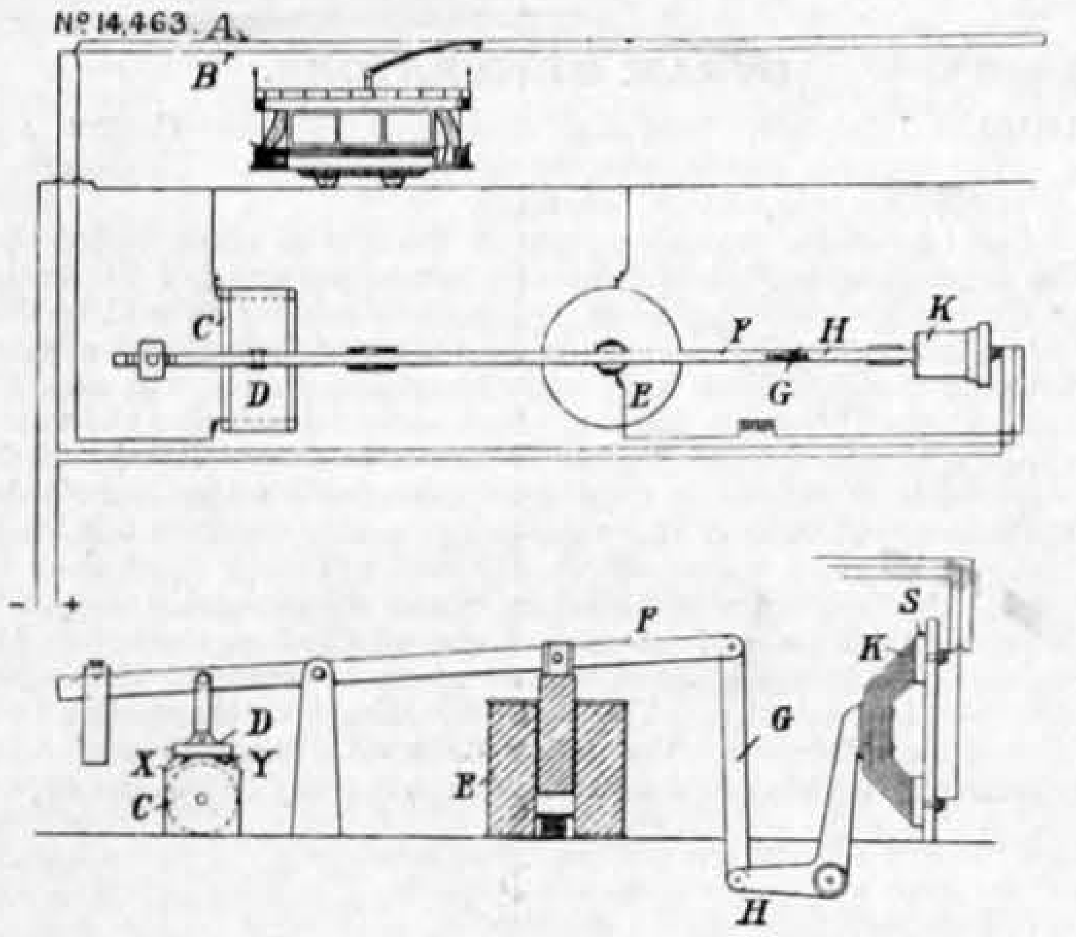
plate. This tube is slotted at its outer end C^1, so that when driven into position it will expand by the aid of a cone-shaped bolt D^1, which bolt is provided with a keyway E towards its inner end. Carried on the bolt there is a washer F, having a key G which engages with the keyway E. When the bolt D^1 is driven into position, the washer F is held by a wrench and prevented from turning, and a nut H on the bolt D causes the cone-shaped piece of the bolt D to be drawn into the slotted part of the tube, thus expanding it beyond the diameter of the rivet hole, as shown, so making it water and air-tight, and at the same time drawing the two plates I, J, into their normal position.—*July 7th*, 1909.

TRAMWAYS AND RAILWAYS.

14,463. July 8th, 1908.—NEW OR IMPROVED AUTOMATIC ELECTROMAGNETIC SWITCH OR CUT-OUT FOR DISCONNECTING CHARGED CONDUCTORS IN OVERHEAD SYSTEMS OF ELECTRIC TRACTION OR THE LIKE, Willie Barraclough, of Bankfield, Rayner-road, Brighouse, York.

This invention relates to overhead electric wires or conductors, particularly the overhead trolley wires in electric traction systems, and comprises a new or improved automatic electro-magnetic switch for disconnecting or cutting off the current to the wires in the event of a breakage or other disturbance in the continuity of the system, the object of the improvements being to provide simple and effective means for this purpose which can be applied to existing traction systems at comparatively little cost. If one of the con-

No 14,463.

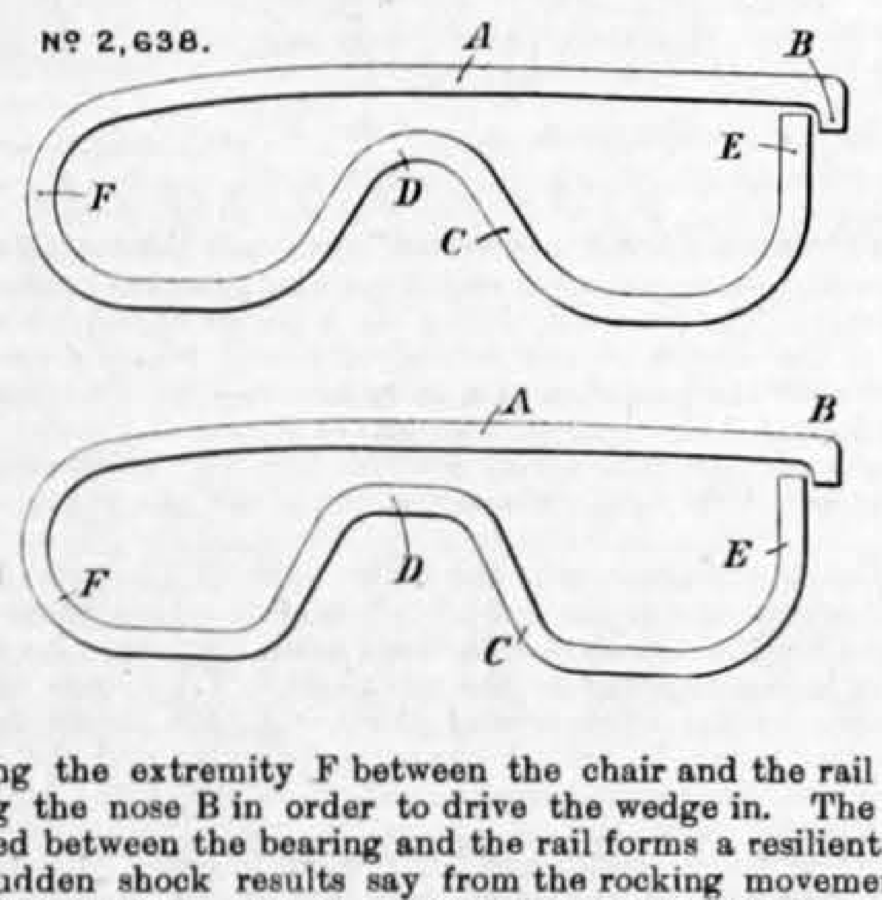


ductors A B should break, or the continuity of the current through them be disturbed, the magnet C is de-energised and consequently fails to attract the armature D. The latter is therefore released, and the action of the solenoid E causes the lever F to be rocked on its pivot, the motion of the lever being transmitted by link G and lever H to the switch K, which is thereby opened, cutting off current from the section. A spring or like buffer cushions the descent of the core or plunger of the solenoid. To prevent adherence or sticking of the armature to the magnet, through residual magnetism, when the circuit is broken, adjusting screws X Y are employed to adjust the air gap or space between the magnet and the armature when the latter is attracted.—*July 7th*, 1909.

2638. February 3rd, 1909.—IMPROVEMENTS IN WEDGES FOR RAILWAY TRACKS, *Société Anonyme Etablissements Arbel, Forges de Couzon, of 25, Rue de Rocher, Paris.*

This invention has reference to metal wedges of that kind which are constituted by two branches, one parabolic in form and another of sinuous form, and adapted to be interposed between double-headed rails and their chairs. This wedge is constituted by two arms; the arm A is parabolic in form and provided with a nose B and is intended to be placed against the chair. The other arm C which is in contact with the rail is formed by two arcs of a curve united by a curved or a rectilinear part D, the concavity of these arcs being directed towards the arm A. The arm B ends at its free extremity in a nose E. The arms A and B are united by a circular part F. A wedge of this kind is placed in position by

No 2,638.



engaging the extremity F between the chair and the rail and in striking the nose B in order to drive the wedge in. The wedge arranged between the bearing and the rail forms a resilient joint. If a sudden shock results say from the rocking movement of a train the parabolic arm A comes into contact with the nose E, which gives rise to a fresh resistance and, owing to the movement continuing the arm A encounters the shoulder D. This shoulder is capable of great deformation while at the same time remaining perfectly resilient owing to its form. It enables the wedge to remain always in contact with the rail, and this at a considerable pressure; finally it imparts smoothness to the running whilst not interfering with the necessary rigidity of the track. The parts D and E of the arm thus constitute two resilient bearings. The shoulder D may present various forms. The engravings illustrate two examples.—*July 7th*, 1909.

TESTING AND MEASURING INSTRUMENTS.

18,952. September 9th, 1908.—IMPROVEMENTS IN PRESSURE AND VACUUM GAUGES, Walter Charles Hill, of 28 29, St. Swithin's-lane, London, E C., and Richard Matthes, of Goethe Platz 10, Chemnitz, Saxony, Germany.

This invention relates to improvements in pressure and vacuum gauges of that class which comprises a flexible tube capable of axial expansion and contraction under the action of the positive and negative pressure respectively of the gaseous or liquid substance the pressure of which it is desired to indicate, the expansion and contraction being used to operate through appropriate mechanism a pointer or other indicating member or device. Extending into the gauge casing in the usual manner is the pressure or vacuum pipe A, to the upper end of which is attached the length of expansible and contractible tubing B provided with helical corrugations C, the number of which may be increased or decreased according to requirements. To the upper end of the tube is attached a cap D, to which is pivoted a lever E fulcrumed at F in a bracket G, the other end of the lever being adjustably connected to a bell-crank lever H pivoted at S, and having adjustably connected thereto a racked quadrant J meshing with a pinion K on the spindle L of the pointer M. The lever H and spindle L are carried in a bracket N, which, together with the bracket G, may be mounted within the casing on a removable plate O. As a means of connecting the tubing B to the pipe A and cap D respectively in such a manner as to make a fluid-tight joint, the upper end of the pipe and the lower surface of the cap are each provided with a groove P, into which the ends of the tube B are inserted, the connection being effected by means of a soldered or brazed joint. The sensitiveness of the tubing to

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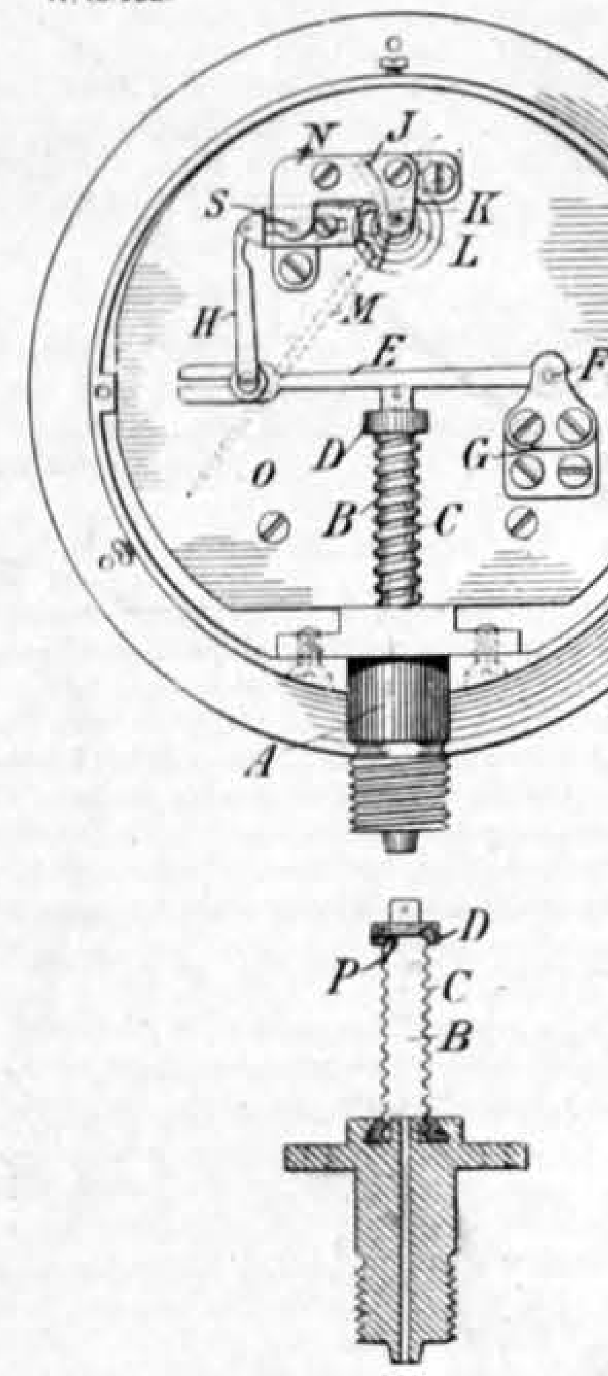


changes of pressure for a given diameter is dependent on the thickness of the tubing and on the number of corrugations or equivalents within a given length thereof.—*July 7th*, 1909.

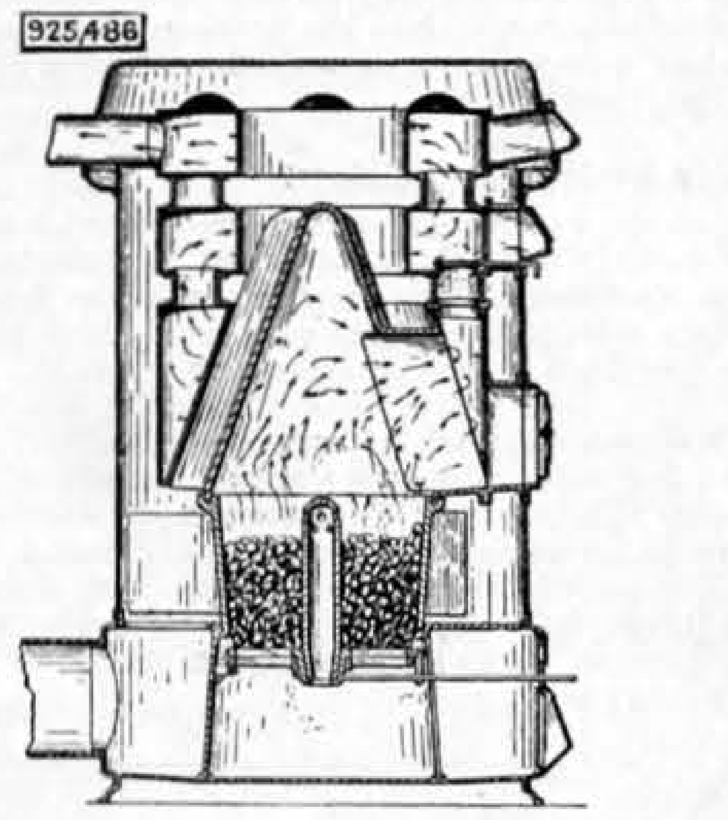
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

925,486. FURNACE, *F. S. Lang, Seattle, Wash.—Filed June 5th*, 1908.

There is only one claim, which is as follows:—In a furnace, a grate member having a depending hub, a tubular member fixed

925,486

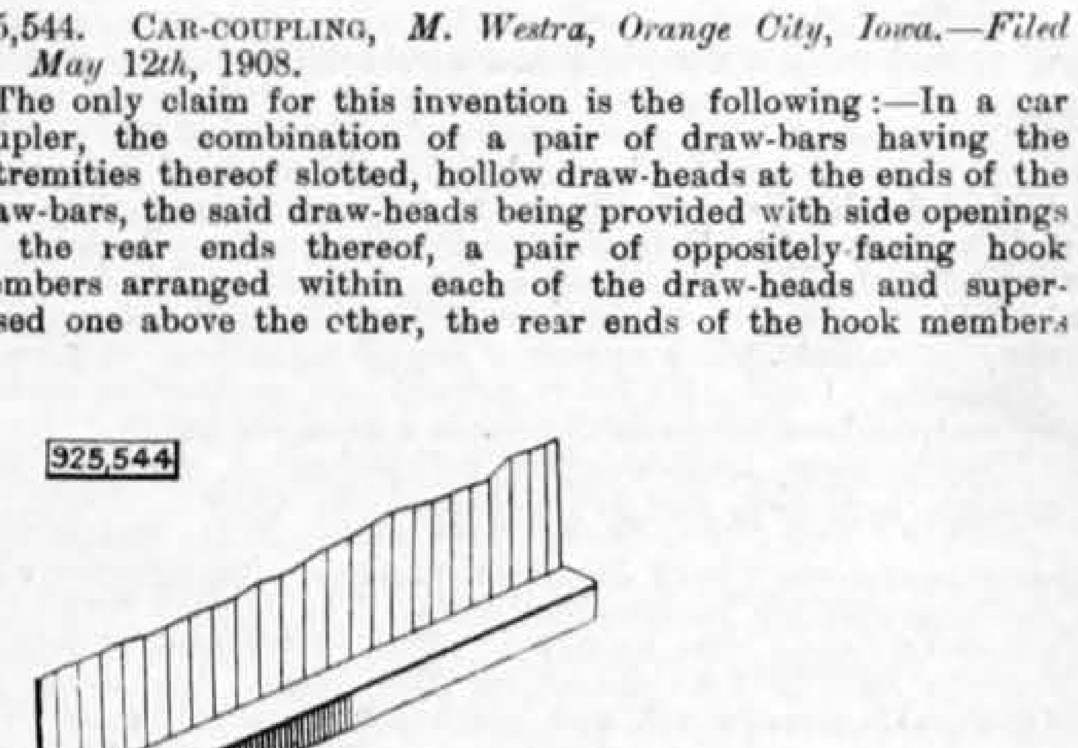


in said hub and provided with openings at its upper and lower ends, and a second grate member having a hub portion in which the hub of the first said grate member is journalled.

925,544. CAR-COUPLING, *M. Westra, Orange City, Iowa.—Filed May 12th*, 1908.

The only claim for this invention is the following:—In a car coupler, the combination of a pair of draw-bars having the extremities thereof slotted, hollow draw-heads at the ends of the draw-bars, the said draw-heads being provided with side openings at the rear ends thereof, a pair of oppositely facing hook members arranged within each of the draw-heads and superposed one above the other, the rear ends of the hook members

925,544



being pivoted within the slotted extremity of the draw-bar, while the outer ends project beyond the draw-head and terminate in bevelled noses, spring strips bearing against the hook members and normally tending to force the same inwardly, the said spring strips extending through the side openings of the draw-heads and being secured to the exterior of the draw-heads; means for moving the hook members outwardly against the action of the springs, and a laterally extending pin upon one of the hook members of each draw-head for engagement with the opposite hook member when the two hook members have been swung inwardly into operative position.