

THE ENGINEER.

A Seven-Day Journal.

The R.A.F. Display.

ON Saturday, June 26th, probably a quarter of a million people—counting those outside the aerodrome as well as those who passed the turnstiles—received at Hendon an impressive indication of the manner in which and the extent to which Great Britain's re-armament programme, so far as the air is concerned, is forging ahead. While a number of the items included in the display had been rendered familiar by previous performances, the mass flight of 250 aeroplanes of all kinds, from heavy bombers to light fighting scouts, was something new and created very obviously a deep impression on all who saw it. The machines taking part in the mass flight began to get into formation near Northampton and with perfect timing and in almost perfect alignment passed like a cloud across the aerodrome and then dispersed. To get such a group of widely differing aircraft into the air and to keep them together for half-an-hour or so in close flying formation was to give a demonstration not only of skilful pilotage and command in the air but of remarkably efficient ground organisation. In addition to the machines in the mass flight some two hundred others took part in the display. Nevertheless the total represented just a little over one-quarter of the number of aircraft now available for the defence of these islands. The fact that the display itself and the rehearsals which preceded it during the earlier days of the week were carried through with only three very minor mishaps demonstrates that urgent although the expansion of the Air Force may be the training of the pilots and the ground staff is being maintained at a high level of thoroughness and is not being sacrificed merely for the sake of piling up numbers.

Battersea Power Station Extension.

ON Thursday, June 24th, the Minister of Transport, speaking in the House of Commons, outlined the present position with regard to the application of the London Power Company, Ltd., to the Electricity Commissioners for consent to begin the erection of the second half of the Battersea power station and the installation of a 100,000-kW generating set. In his reply, Dr. Burgin stated that the London County Council and other Councils concerned had been afforded an opportunity to make representations, and that they had notified the Electricity Commissioners that they did not offer any objection, provided that the consent was made subject to certain conditions for the avoidance of nuisance, which had already been applied in relation to the first part of the station. The report of the Government Chemists Committee, Dr. Burgin said, had expressed satisfaction as to the efficacy of the gas-washing plant installed in the station, and it would shortly be published as a Command Paper. The Minister of Health and the First Commissioner of Works concurred with him that, subject to the conditions referred to, there was no objection to the proposed extension, and he was informing the Electricity Commissioners accordingly. In reply to a further question as to whether the Ministry of Transport had consulted the Defence Departments about the danger of having so much power centralised in the centre of London, particularly in time of war, Dr. Burgin stated that the Minister for the Co-ordination of Defence had been consulted, and had agreed to the extension proposed.

The Swanley Railway Collision.

It is with deep regret that we have to record a serious collision on the Kent line of the Southern Railway on Sunday evening, at 11.20 p.m., at Swanley. The official statement issued on Monday by the Southern Railway Company states that the accident was caused by the 8.17 p.m. steam train from Margate to Victoria running into a siding at Swanley, where it collided with two empty coaches.

According to witnesses, the train passed through the station at between 50 and 60 m.p.h., and shortly after crashed into the empty coaches in the siding and telescoped them. The engine became embedded in the high bank of the siding and was smashed and the tender crushed. The two first coaches of the train were telescoped and splintered. The train was carrying about 300 persons, and the casualties so far are four dead and about fifteen seriously injured. A preliminary inquiry into the cause of the collision was begun at Swanley on Monday, when Southern Railway and Ministry of Transport officials spent some time at the scene of the accident. It is announced that the Ministry of Transport inquiry will be opened to-day, Friday, at the Charing Cross Station Hotel and conducted by Lieut.-Colonel A. H. L. Mount, the Chief Inspecting Officer of Railways. The accident occurred clear of the main line and little delay to passengers was caused. Those travelling on the train involved in the accident were taken to their destinations by means of an emergency bus service, which was run from Swanley to Bickley, from which station a special electric train to Holborn was run.

The Indian Railway Report.

IN a Journal note of October 3rd, 1936, we referred to the appointment of an Indian State Railway Enquiry Committee under the chairmanship of Sir Ralph Wedgwood, who was assisted by Mr. W. A. Stanier and Mr. Forbes; Mr. L. H. Kirkness, of the Indian Railway Board, and Mr. B. M. Strouts acting as secretaries. The Committee's report was issued in Simla on Monday morning, June 28th. According to the cabled summaries which have been published in this country, the Committee rejects the idea of large amalgamations. It further urges the need for an adequate depreciation fund, and stresses the importance of building up a general reserve fund, which may serve as an equalisation fund. The report gives a broad and detailed survey of the finance and statistics of the Indian State-owned railways since 1924, and the conclusion drawn is that the results are better than those of other comparable railway systems. With regard to workshops, it is recommended by the Committee that there should be a better standard of supervision, and that the training should be by a European supervisory staff. As regards traffic, a general acceleration of all trains is recommended. The relation of rail and road traffic is reviewed and the suggestion is put forward that railways should interest themselves in road transport schemes. With regard to the future, the opinion of the Committee is that railways, after charging for depreciation, are not likely over a period of years to earn more than will meet interest charges. They should no longer be looked upon as a means of producing revenue for the relief of general taxation.

Society of British Aircraft Constructors.

THE Flying Display and Exhibition of the Society of British Aircraft Constructors was held at Hatfield Aerodrome on Monday and Tuesday last, June 28th and 29th. This year marks the Society's twenty-first anniversary, and on this occasion the display was held on two successive days. On Monday the aerodrome was open to the guests for the inspection of aircraft and the Static Exhibition of engines, parts, materials, and accessories. Some 5000 visitors and guests attended the display, which was followed in the evening by a banquet at Grosvenor House, Park-lane, at which about 800 members and guests were present. The flying display was held at the aerodrome on Tuesday, when the visitors, representing about fifty countries, were shown the flying qualities of the latest British civil and military types of aircraft. Among the many interesting aircraft were shown several new types of service trainer aeroplanes which are capable of high speeds and afford an improved means of training pilots under service

conditions. The de Havilland "Albatross," which is to be used for experimental Transatlantic flights, showed its excellent flying qualities, both at high speed and for landing and slow flying. A Hawker "Hart" biplane demonstrated the new Rotol automatically controlled constant-speed variable pitch airscrew. This machine, fitted with a Mercury engine and the Rotol airscrew, took off from the aerodrome in between four and five seconds from the time it started to move, and climbed at an extremely steep angle. A new type of single-seat fighter monoplane, the Vickers "Venom," demonstrated extraordinary response to the flying controls, the pilot showing the ability of the machine to execute quick turns and rolls.

The "Coronation Scot's" Trial Run.

ON Tuesday, June 29th, the new L.M.S. Railway streamlined train, the "Coronation Scot," which was described in our issue of June 4th, made a trial run from London to Crewe and back again. The train left Euston at 10.50 a.m., with the company's representatives and guests, and we had the pleasure of accompanying the train, which consisted of eight coaches, or one less than the train which will begin the regular service of July 5th. The train weighed 263 tons, as against 297 tons for the service train. The outward journey was made in 2 h. 9½ min., 5.25 min. under the scheduled time; but just after leaving Whitmore on the downhill run into Crewe a top speed of 114 miles per hour was recorded, thus beating the record of 113 m.p.h. held by the L. and N.E.R. On the return journey the train was 15 min. ahead of the scheduled time, and the average speed was 80 miles per hour, whilst just before Wolverton an average speed of 100 miles per hour was recorded. At Tamworth the train was 3 min. ahead of time, and this gain was increased to 5½ min. at Nuneaton, the gain being added to as the journey continued, the 158 miles being covered in one minute under two hours. The train was driven by Mr. Tom Clark, of Crewe, who, it may be recalled, was in charge of the special experimental train on the London to Glasgow run in 1936. We hope to be in a position to give full details of the run in our next issue.

The Battersea Park Collision.

SHORTLY after eight o'clock on the morning of April 2nd an electric passenger train from Coudsdon came into violent collision with the rear of a train from London Bridge which was waiting near Battersea Park Junction on the Central Section of the Southern Railway. Both trains were proceeding towards Victoria. As a result of the collision nine passengers and the guard of the London Bridge train lost their lives. Lieut.-Colonel A. H. L. Mount's report on the circumstances of the accident, issued on Monday of this week, fixes responsibility for the accident upon the signalman at Battersea Park Junction Box. As a result of an error on this man's part the Coudsdon train was wrongly admitted into the section occupied by the London Bridge train. He was a relief signalman on duty in the Battersea box for the first time on the morning of the accident. To rectify an irregularity of working he unsealed his Sykes instruments and manipulated the equipment in a manner which led to a breakdown of block working. It is to be noted that the company's instructions permit signalmen to break the seals of their instruments in special circumstances, namely in the event of failure of the special cancelling apparatus. Colonel Mount however finds that in the circumstances which led to the Battersea accident "this action was both unusual and unnecessary and certainly should not have been taken by an experienced signalman." Immediately after the accident the company replaced the seals, which could be cut with a knife, by padlocks with the result that no one except a skilled lineman can now open the instruments.

Market Research in Engineering.

By DUDLEY W. WALTON, F.S.S.

No. I.

I. EXPLORING AVENUES OF DISTRIBUTION.

MARKET research signifies a mode of inquiry which endeavours to discover the buyers of saleable merchandise, and the extent of their requirements. In this general sense, market research must have been known in the earliest days of trading. The Phœnician merchant had a nose for business, making long voyages to extend his market. The purpose of his adventure was profit. There is, indeed, a view of history which interprets its main outlines as being influenced wholly by the urges of commerce. The Crusades, for example, are regarded as enterprises to open up trading routes with the East. The voyage of Columbus was an attempt to find an unhampered trade route to India. British colonial policy, in the days of "John Company," was directed towards commercial development. In the last century it used to be said that "trade follows the flag."

There are some indications that British merchants and manufacturers at the beginning of the nineteenth century began in a tentative and systematic way to study their markets. By the end of the century it was evident that any manufacturer who wished to prosper must have some kind of marketing policy, even if it were a policy of merciless competition, selling the cheapest goods in the dearest market, and charging, as railwaymen said, "all the traffic would bear."

This twentieth century has seen the development of a new implement of salesmanship—the power of the advertisement medium to reach and influence buyers otherwise difficult or expensive to contact. Those interested in the profits and technique of advertising began to organise themselves some twenty-five years ago. When the late Thomas Russell established the Incorporated Society of Advertisement Consultants in 1911 he declared that the formulation of a selling policy was the most important principle in any distributive system. It was at about that time the term "market research" began to be used to describe the inquiries necessary to formulate a selling policy. Since then certain broad principles that govern market research have come to light.

To-day, market research is as systematically pursued as is production research. Production research seeks for the one best way of making something; market research for the one best way of selling it. In many new enterprises it is better to start from the market end, asking what the consumer needs and then finding the best, or at least a profitable, way to supply the need.

PRINCIPLES OF MARKET RESEARCH.

Market research as an aid to selling any product involves the systematic observation, collection, arrangement, and study of all the relevant facts, figures, causes, effects, circumstances, contingencies, and conditions which exist, or are likely to exist, in the field of distribution. The scope of the inquiry is governed by two considerations:—(1) The disposal of the actual or potential output of an existing plant, or (2) the production of a new or modified commodity which consumers want in quantities which they can absorb.

From the world-trade point of view, a good deal of the time of the 1933 Monetary and Economic Conference, in its committee work, was directed towards the study of these problems. The discussion on the production and distribution of tin illustrated this.

Systematic market research includes such aims as—

- (a) Studying the possibility of introducing a new or improved product, and the methods of establishing a demand for it.
- (b) Testing a new method of selling or marketing and comparing its results with older methods.
- (c) Investigating the possibilities of widening the market for existing products or services.
- (d) Seeking to ascertain the reasons or causes for arrested or declining sales.

When a proposal is made to institute a market investigation in a field which had not been systematically explored, a common objection by the manufacturer is, "Our business is unique and peculiar. It is all right for the soap boiler to find out how much soap is used or wasted per person per day, and what grades of soaps are favoured, and for what reasons. But we make soap-boiling plant, and 75 per cent. of the soap boilers are already our customers. Let them do the research. If they can sell more soap per capita they will automatically buy more plant."

This kind of objection is not valid. No business is so unique or so peculiar that it will not change its methods within the next ten years. No established demand or regular channel of distribution is so established that it will not fluctuate, and if left alone will decline. It is conceivable in the case of soap that some unexpected discovery in the medical field might trace the cause of some common disorder to the use of some soap ingredient, calling for an entirely new

production method. A few years ago a large soap firm allied itself with a maker of disinfectants. The chemical staff worked out a plan for producing a soap which would have the properties of the disinfectant. They produced samples which were tested from many angles. The extensions of plant needed were planned. The advertising department prepared a campaign; but that soap was never put on the market. The sales research department found that it was unacceptable in colour and odour. The whole plan was referred back to the experts. If and when they solve the problem, an entirely new market for a special soap will be developed, and an entirely new factory needed for its production. In a word, in answer to the hypothetical soap plant engineer's objection, the markets and selling policies of his soap-boiling customers are of vital interest to him.

METHODS OF MARKET INVESTIGATION.

Nor is it true that the general methods of market research cannot be applied to peculiar cases. The three main methods of investigation are applicable to every selling problem. One can either take a snapshot of consumers; make a cross section of a localised market; or build up a composite picture of the whole body of consumers.

A snapshot must be taken under normal conditions and each trade has its own ascertainable norm. If a snapshot be taken under abnormal conditions, the necessary allowances, plus or minus, can be made with regard to any inferences arising. An outlet for quite a number of minor engineering products is the ironmonger's shop. There are some 7000 of these in Great Britain. The average number of householders per shop is ascertainable. The circumstances of the normal ironmonger can be defined. A hundred or so of such traders can be listed. Sales records will show their average distribution power. A new project can be presented to them and their reactions analysed. Thus some approximate measure of the potential demand can be determined in advance. Such a case arose recently in the matter of a device which might have been of service to plumbers. It was time-saving and foolproof. Investigation showed that the plumber could not make any additional profit by using the device, and the project was abandoned.

An instrument of market investigation is the "sample." The sample of the hundred ironmongers just described would have been systematic and selective. Usually a sample is "random," as when names are taken by chance from a trade directory. There is an ascertainable number of samples which is representative of general conditions, and statistical formulæ are available to show when the number of samples taken is large enough for valid conclusions. The statistical methods necessary for conducting such an inquiry were fully described in a series of four articles in THE ENGINEER in December, 1932. When it is desirable to start *ab initio*, random sampling is recommended. When something is known already, the results of selective sampling can be added to what is already known. A manufacturer's own list of buyers is a sample of his market. It may not be a representative sample. It may have merely grown up from the efforts of a group of travellers who have picked out the plums, and have not been over-energetic in cleaning the last straw. An examination of internal sales records for a series of years will bring such circumstances to light.

A test of a new proposition on a selection of existing customers in comparison with a test of a list from a directory would show to what degree the customer list was truly representative. Incidentally, if a test of a new proposition brings negative results, the new proposition need not at once be condemned. A new test should be instituted from an entirely opposite angle. For example, in the plumbing proposition mentioned in a preceding paragraph, after it was found that the device was of no advantage to the actual tradesman, it was also found that it would have been unacceptable to a more or less small market of amateurs who dabble in wiping joints.

A great deal about an actual or potential market can be discovered without external investigation in the open field. There is a mass of usable facts embalmed in Government Blue Books, in annual publications, in the study of travellers' reports, and in sundry trade and technical publications. For instance, one can infer from an analysis of the "Directory and Buyers' Guide," issued by THE ENGINEER, that there is an active market for machine tools, which is the largest section of the Directory. Help can be had from newspaper cutting agencies and from various organisations who report on the tenders wanted and contracts placed. Travellers' reports, when studied by a sympathetic and imaginative person, will often yield valuable indications of fresh selling opportunities.

As an example of a pending project which, when carried out, will open up an entirely new market for a wide range of engineering products, may be men-

tioned the Severn Bridge and barrage schemes, which have been under investigation for a whole decade. A lengthy Government report is available, from which a far-sighted sales manager can make some useful deductions. The project, when accomplished, certainly will change the economic conditions of an area bounded by Bristol, Stroud, Gloucester, and Chepstow, and will affect the whole of any navigation of the Severn which may be made available. Here the sales manager's problem is one of exercising foresight.

An example of an entirely modern problem is that of the treatment of, and the possible purification of the waste waters from sugar beet factories. This is an example of a technical problem; of finding what the user needs and endeavouring to supply the need. Another pending change of many details of factory equipment arises out of the recent studies designed to decrease the volume of noise.

STUDY OF INTERNAL RECORDS.

Valuable information can be obtained from the study of internal office records. Sales per region, per month, per department, per article, or per salesman can be analysed and lines of least resistance discovered. In one such investigation or example, considerable differences were found as between the North and the South of England, and these differences were traced to the fact that in the South the domestic operation known as spring-cleaning commenced about one month earlier than in the North, and thus accelerated by a week or so the demand for a certain kind of equipment.

The method of using the questionnaire to elicit market information has been described as an invention of the devil and an inspiration of much perjury. Without doubt, not every reply to a set of questions is reliable, but the law of averages holds good. The unwitting lie is balanced by the scrupulous truth. An all-Europe questionnaire conducted on behalf of a firm interested in a transport accessory brought to light many contradictions, but an analysis of the whole set of answers and an attempted synthesis enabled a map to be flagged which took on a reasonable pattern to indicate potential demand.

A questionnaire should begin by assembling every possible and impossible question concerning the market, but by elimination, selection, and combination, the number of questions actually sent out must be reduced to a reasonable quantity. Seven is the advisable number when writing to strangers, but questionnaires addressed to a firm's agents or to people who may be especially interested can contain up to twenty separate queries. A questionnaire is a gauge dipped into a barrel from which calculations can be made rather than an attempt to take an actual measurement. Taking a questionnaire is a process of sampling, and the size of the sample has to be considered. A sample need not be large. Oral questions once addressed individually to some thirty members of a staff showed that most of the members of the staff had no clear understanding of the purposes of the firm's chief product in relation to the market. Here the methods of recruiting and training the staff were faulty.

The market research department can make studies of peoples, localities, and occupations—the trinity of folk, place, and work—with the effects of sex and age ratios, education, thrift, and other habits. Thus in regard to the market for any article connected with the preparation of food, from a gas cooker to a frying pan, there are notable differences between, say, Yorkshire and Lancashire. The potential market for gadgets for motor cars can be proved from the Ministry of Transport's figures to be fairly equally diffused in all but four counties in England. In Wales and in Scotland generally, the demand as deduced from the motor licensing statistics, is too small to justify any great amount of selling effort. It is, of course, because of this diffused demand that the centre of the motor car trade is somewhere about the centre of the map. Population figures are of considerable value in overhauling a sales policy. For instance, half the population of England is concentrated within a circle 80 miles from Leeds. A fact like this has a bearing on distribution policies and the establishing of distributing depots.

When an engineering product is mainly sold to the consumer through agents or dealers, the number of existing and potential outlets, and the attitude of dealers can be determined. Many firms do not influence all possible outlets. They allow their travellers to pick and choose. The sales office has but little knowledge of what the ideal sales volume place by place should be. To help here there is an elaborate piece of recording machinery. It needs a large room to house it, and by means of moving frames, hangers, and flags it can show at a glance both the general and the particular conditions in any part of a market. For actual quantitative sales records, two established card-punching systems are available. As an instance of their actual use in regard to an engineering enterprise, one of these systems is used by the Birmingham Corporation gas department. A gas mains inspector can telephone from any part of the city, and while he holds the line a clerk can manipulate a series of buttons and report on the average consumption of gas in any district, street, or even in any house.

Some subsidiary studies of use in market research converge on geographical studies—the transit zone,

for instance, in the terms of hours' travel. Rates of distribution and consumption and the time lags between ordering and actual sales can be determined. Seasonal fluctuation can also be recorded, and normal times of maximum activity during the year. There are broad relationships between the habits of domestic consumers and manufacturing processes. The habit of buying underwear in the spring, for example, is the crest of a regular wave which can be traced back from the time the sheep are sheared on the other side of the world. If, as at present, the whole fashion in underwear is changing, new machinery will need to be installed at some point in the whole chain of production, processing, and finishing. It is not beyond the capacity of a market researcher to map out the whole process in a way that will indicate some ultimate development which will affect the engineering equipment needed.

TENDENCIES WHICH SHAPE THE FUTURE.

Professor Durkheim's philosophy views the present as the moment when the whole of the past meets the whole of the future. If, therefore, by some process of analysis we can discern those events of the past which have brought about the present situation, we should be able to discern also those tendencies which will shape the future. Attempting such an analysis, we can observe the emergence of two distinct types of economic organisation—that which is finding expression in the United States of America and that which is being applied, admittedly with enormous difficulty, in Soviet Russia. We should investigate the potentialities of both with impartiality. Both systems represent attempts at readjustment of distribution (i.e., sales) methods. They are destined to impinge upon each other, and it is conceivable that Britain's opportunity will be found in combining the most

acceptable elements of both—a combination of production efficiency and distribution service. The future will need nearly all the things that are being produced to-day—the traditional skill of our craftsmen; the technical ability of our engineers; and the developed acumen of sales directors. There is enough accumulated knowledge, experience, and ingenuity available to solve most current and future problems. What is absent is a willingness to abandon preconceived ideas, initiative to make experiments, to look out into new directions for sales opportunities which have never been found before, to leave off leaving the future to chance—in a word, to depend more and more for increased sales upon market research in the fullest sense of the words.

Market research in the sense of anticipating needs is not a new mode of inquiry. What is new is the idea of planning for co-ordination, so that the conditions to bring about a state of equilibrium between production and consumption can be approximately determined. Then, when the data are examined, a compromise can be effected between the different standards of efficiency demanded by producer and consumer.

Assuming, in an ideal way, there exists an engineering firm producing every kind of engineering product, the basic principles in marketing their whole line would be to consider the market in the different aspects of past, present, and potential purchasing capacity. It is useful in a broad way to take this view and look first of all at the geographical factors. Can every part of every market be conveniently reached and influenced by a combination of advertising and personal selling, and, further, if an order is booked can the goods be conveniently transported and received by the buyer at any distance in serviceable shape?

(To be continued.)

The Analysis of Superheater Problems.

By D. W. RUDORFF, Dipl. Ing.

OWING to the steady increase in steam pressures and temperatures employed in the present-day power plant, the superheater has become a major component of the modern steam boiler; for this reason the design of the superheater is often of decisive influence upon the design of the entire boiler unit. As regards its action as a heat exchanging apparatus, the development of the superheater, like that of the boiler proper, has taken place along almost entirely empirical lines. Even to-day attempts to study the operating characteristics of the boiler by analysing them on the basis of the operating characteristics of a heat exchanger are rather rare,* and this in spite of the fact that fairly satisfactory data and theories relating to radiant heat absorption in the furnace and to radiant and convection heat transfer in tube bundles are now available. It is therefore not surprising that the analytical treatment of the superheater has likewise been neglected. The problems both of high steam temperature and of constant steam temperature—constant, that is, over the operating range of the boiler—are to-day more important than ever, and a general theoretical treatment of the various factors influencing design and operating characteristics of the superheater appears to be badly wanting, particularly since the development of the superheater has now reached a stage where theoretical analysis is essential to further progress. It would be beyond the scope of these notes to attempt an exhaustive *exposé* of the various theoretical aspects relative to the heat exchanger action of the superheater, but an attempt can at least be made to indicate the principal lines along which the establishment of a theory of the operation of the superheater in the boiler—that is, a theory of the operation of a heat exchanger within another heat exchanger—might fruitfully proceed.

In order to avoid complexity of treatment the theoretical investigation of the heat exchanger characteristics of the boiler proper is here omitted and in its place a given boiler performance—somewhat simplified for the sake of greater clarity—is made the basis of the theoretical treatment of the superheater.

For an investigation of the superheater surface requirements and also of the superheater characteristics as influenced by the position chosen for the superheater within the boiler (excluding the case of the radiant superheater), both the amount of flue gas passing through the superheater per unit of time and the temperature of the flue gas entering the superheater coil must be known over the load range considered. Obviously, the final steam temperature and the pressure and moisture content of the saturated steam, as well as the steam quantity passing through the superheater per unit of time, must also be specified.

In this instance the investigation is based on a boiler (the kind of boiler is quite immaterial in this connection, since design problems are not treated

here) of a normal evaporation of 200,000 lb. of steam per hour and of an operating range from 50,000–200,000 lb. of steam per hour at 450 lb. per square inch absolute pressure and 800 deg. Fah. steam temperature at the superheater outlet at normal load. To simplify matters the ratio of pounds of flue gas per pound of steam generated is assumed to remain at a constant value of 1.25 over the operating range. In order to reduce further the number of variables,

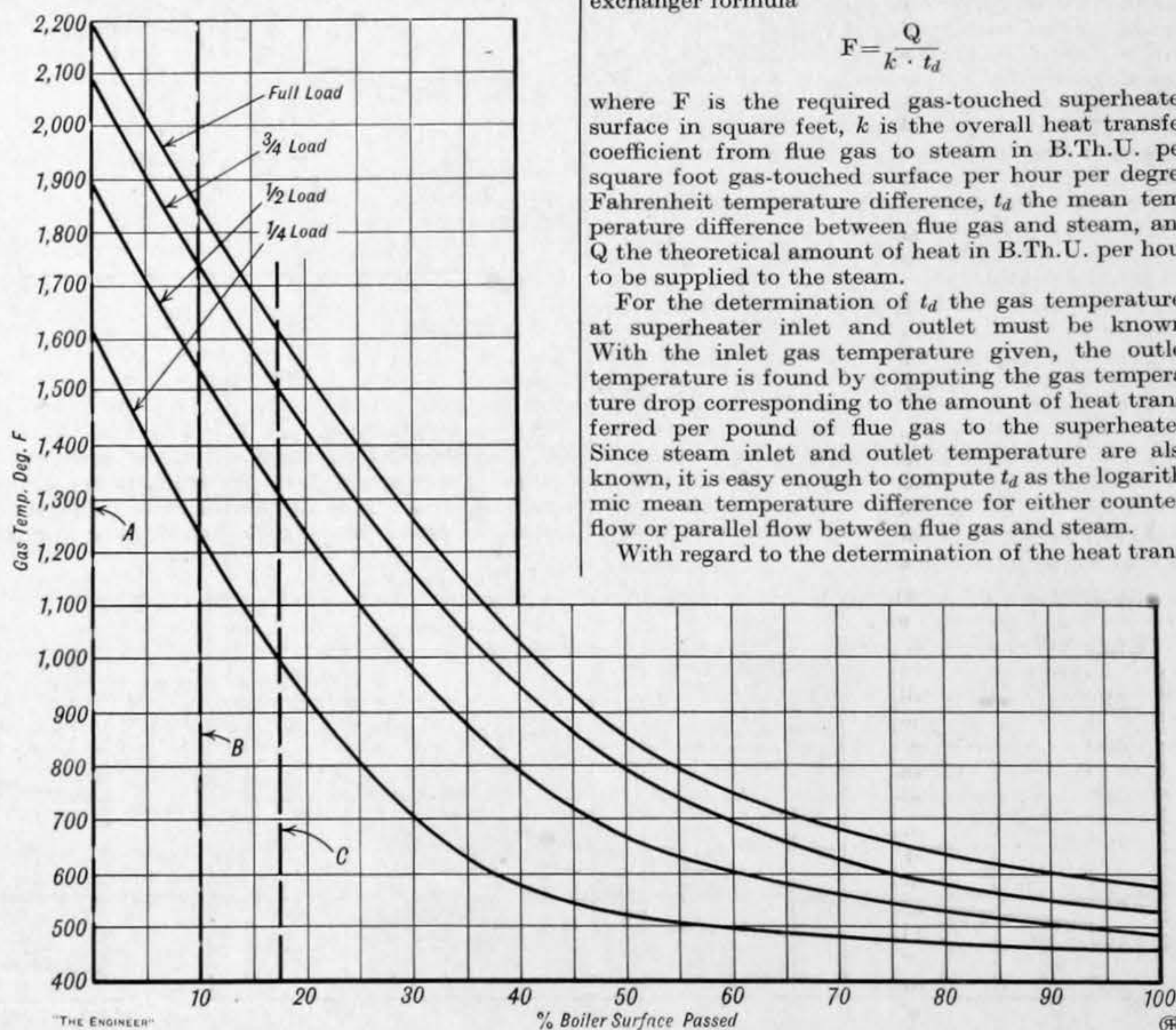


FIG. 1

the assumption is made that the gas flow through the superheater in the various positions considered takes place at right angles with the superheater coil and at the rate of 2500 lb. of flue gas per hour per square foot of gas flow area within the superheater, and it is also assumed that the flow conditions through the superheater coil are identical irrespective of the superheater position.

The temperature drop of the flue gases on their

passage through the boiler surface is in this instance considered as taking place according to the curves given in Fig. 1; these temperature curves are based on actual test results, but are somewhat idealised for the purpose of this investigation. As Fig. 1 shows, the gas temperature curves are established for four different load conditions; that is, for one-quarter, one-half, three-quarters, and full load, respectively. The temperature zones into which the superheaters to be investigated are assumed to be inserted are designated as A, B, and C and correspond to gas temperatures of 2180 deg. Fah., 1850 deg. Fah., and 1610 deg. Fah. at full load respectively. Actually, present-day superheaters are as a rule not exposed to gas temperatures of substantially more than 1850–1900 deg. Fah. at the superheater gas inlet, but it is not unlikely that in connection with very high steam temperatures of 1000 deg. Fah. and more the superheater position will ultimately have to be advanced into gas temperatures of 2000 deg. Fah. and higher. The zones A, B, and C correspond in this instance respectively to 0 per cent., 10 per cent., and 17.7 per cent. boiler surface placed ahead of the superheater, not counting any water wall surface in the furnace. As regards zone A, it is assumed that no direct heat transfer by radiation takes place between superheater and furnace; the superheater is therefore considered as shielded from all furnace radiation. This assumption is of course, purely arbitrary, but, any error introduced by it will have no fundamental influence upon the final result of this investigation—a point to be discussed below.

In Fig. 2 is given the variation in gas temperature with the load for various points of the gas passage through the boiler surface. In this chart the curve 0 per cent., corresponding to zone A in Fig. 1, is identical with the furnace exit temperature. These temperature curves are better adapted to use in connection with superheater analysis than those of Fig. 1. Although not required for the purpose of this investigation, temperature curves for various large boiler surface percentages (up to 100 per cent.) are included in Fig. 2, and it is of interest to note that the character of these curves changes considerably in a region between 70 per cent. and 100 per cent. boiler surface.

THE INFLUENCE OF SUPERHEATER POSITION WITHIN THE BOILER SURFACE UPON THE SURFACE REQUIREMENTS FOR A GIVEN SUPERHEATER DUTY.

The first problem to be considered is that of the influence exerted by the superheater position within the boiler surface upon the surface requirements of the superheater for a specified superheater duty. The relation between superheater surface required and thermal duty is contained in the general heat exchanger formula

$$F = \frac{Q}{k \cdot t_d}$$

where F is the required gas-touched superheater surface in square feet, k is the overall heat transfer coefficient from flue gas to steam in B.Th.U. per square foot gas-touched surface per hour per degree Fahrenheit temperature difference, t_d the mean temperature difference between flue gas and steam, and Q the theoretical amount of heat in B.Th.U. per hour to be supplied to the steam.

For the determination of t_d the gas temperatures at superheater inlet and outlet must be known. With the inlet gas temperature given, the outlet temperature is found by computing the gas temperature drop corresponding to the amount of heat transferred per pound of flue gas to the superheater. Since steam inlet and outlet temperature are also known, it is easy enough to compute t_d as the logarithmic mean temperature difference for either counter-flow or parallel flow between flue gas and steam.

With regard to the determination of the heat trans-

fer coefficient k, this coefficient can be taken as the composite of a convection and of a radiation component. The convection component for a given coil arrangement is in the main a function of the mass velocity of the gas and to a lesser degree a function of the composition of the flue gas and of its temperature. In contrast the radiation component is independent of the mass velocity and varies among other factors with the composition of the flue gas

* A remarkable but now out-dated attempt is contained in C. H. Roszak et M. Véron, "Nouvelles études sur la Chaleur," Paris, 1929.

and with its temperature. Since both gas temperature and gas flow change with the load, it is necessary to determine the change of k with the load for each superheater position. Such values of k can either be taken from empirical data showing the variation of k with the mass velocity and with the gas temperature for the given superheater coil arrangement, or they can be computed by the use of the well-known formulae for convection and radiant heat transfer in tube bundles: In Fig. 3 the values of k used in this investigation are given as function of the load for the temperature zones A, B, and C.

Fig. 5 gives the surface requirements found for the case investigated. As this chart shows, the surface

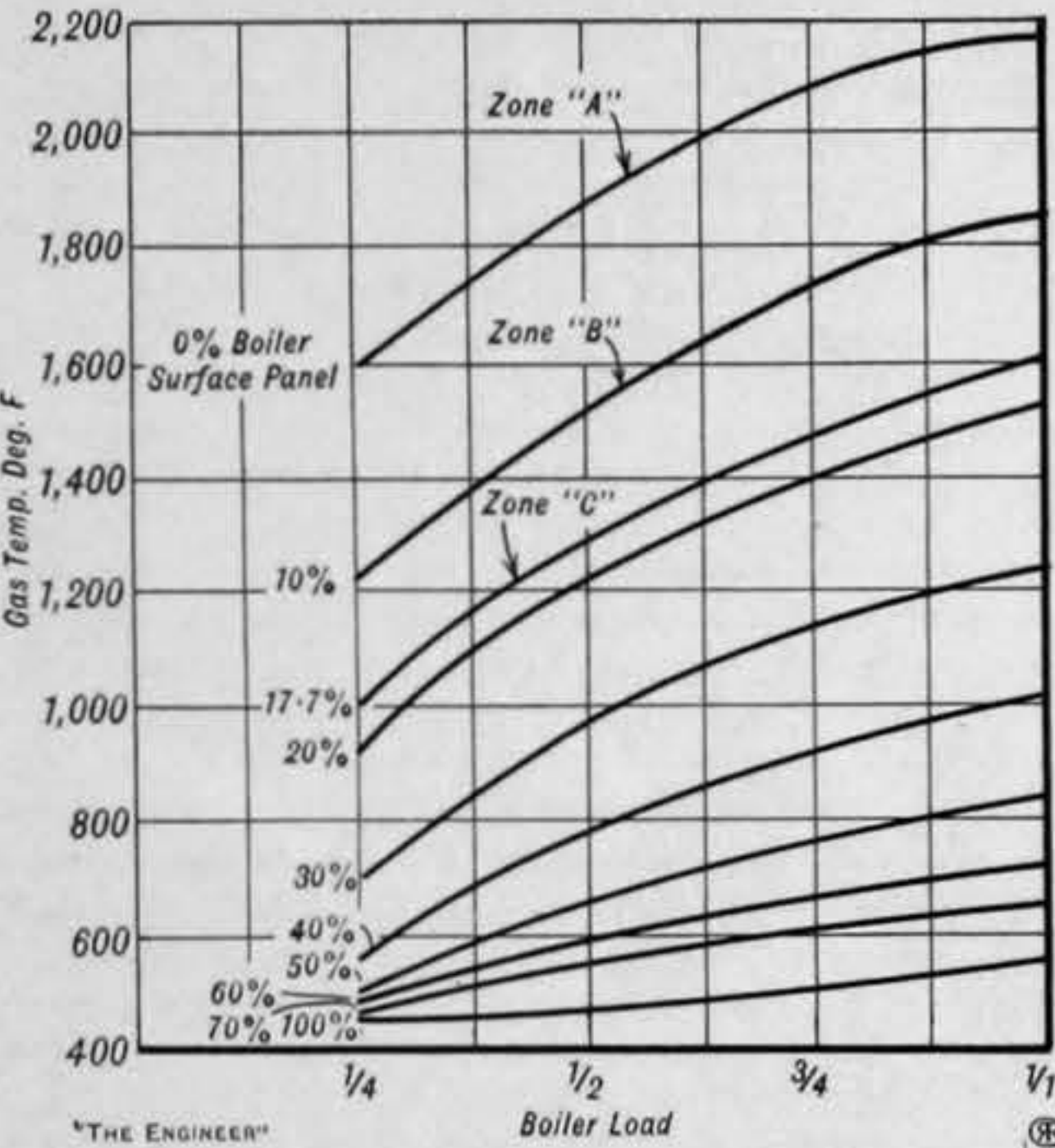


FIG. 2

requirements for counterflow and parallel flow approximate to each other with decreasing amounts of boiler surface interposed between furnace and superheater; that is, with increasing gas temperature. This tendency is due to the fact that with increasing margin between gas and steam temperature, the difference between the values of t_d for parallel and for counterflow decreases. *Vice versa*, the smaller this margin between gas temperature and steam temperature, the greater is the difference between t_d for parallel and for counterflow. Fig. 6 is another representation of the surface requirements for the two kinds of flow arrangement. In the upper part of this chart the specific surface requirements of each of the two flow arrangements are assumed to be unity for the temperature zone A; and it can be seen that the curve representing the specific surface requirements for the case of parallel flow is considerably steeper than that for the case of counterflow. This chart is based on the prevailing gas temperatures at the superheater inlet instead of upon the percentage of boiler surface placed in front of the superheater. This is done in order to bring out more clearly the dependence of the superheater surface requirements upon the gas temperature at the superheater gas entrance. In the lower part of Fig. 6 are shown the variations in the magnitude of the ratio R of the specific surface requirements for parallel and counterflow, and this graph of R shows convincingly that with decreasing gas temperature the counterflow arrangement becomes increasingly more preferable. In the region of high gas temperature, the magnitude of R is hardly sufficient to make the choice of counterflow preferable, since in this arrangement—in contrast with the parallel flow arrangement—the tubes carrying high temperature steam are placed in the zone of highest gas temperature, and are thereby subject to most severe

ferable to make the superheater surface 13 per cent. larger and to use a parallel flow coil of inexpensive mild steel tubing instead of a counterflow coil built of much more expensive special alloy tubing. The choice between counterflow and parallel flow is

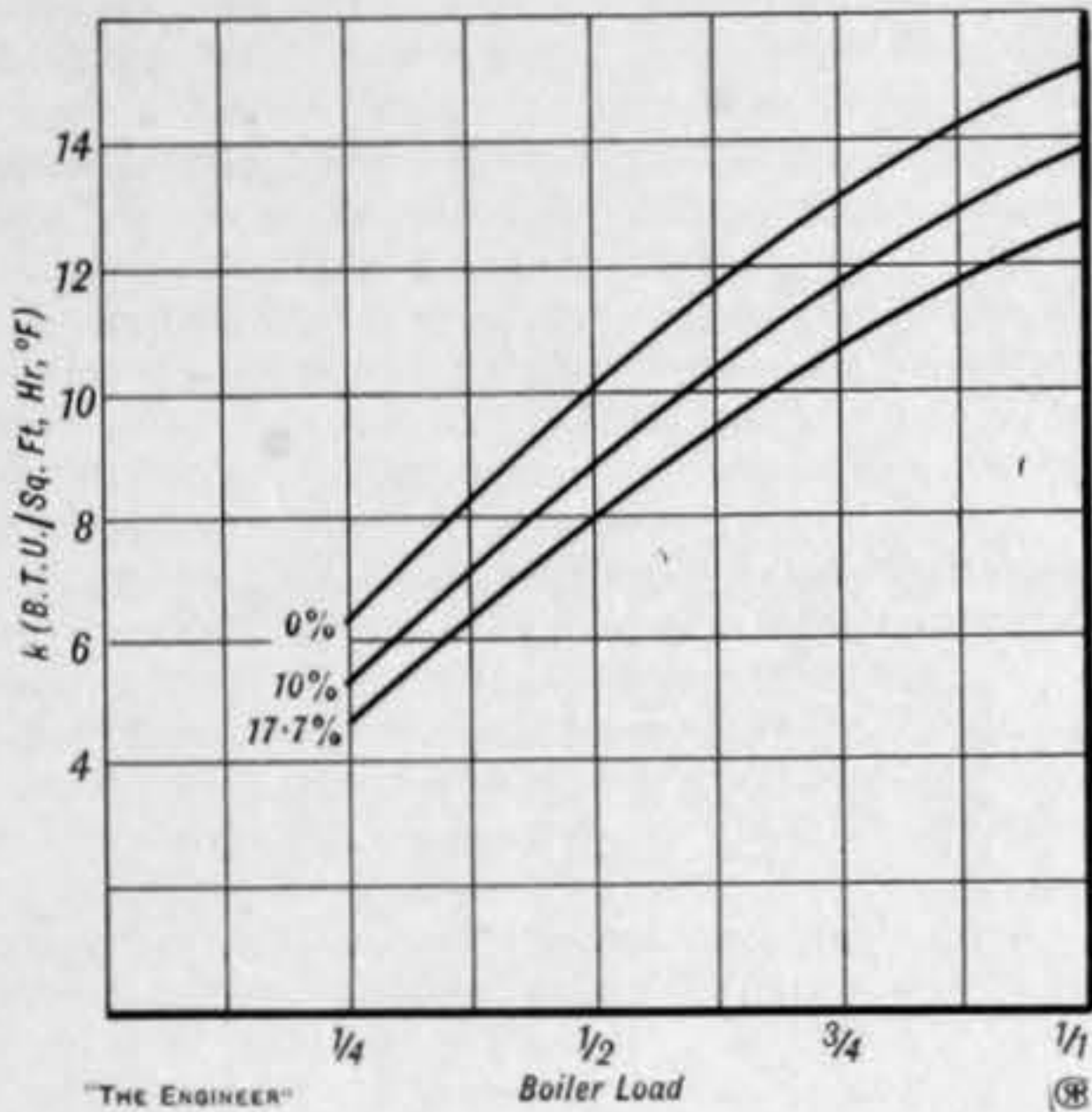


FIG. 3

therefore largely a question of minimum surface cost, if capital cost alone is considered, but this choice can also be influenced by consideration of superheat stability, which latter depends both on flow arrangement and superheater position.

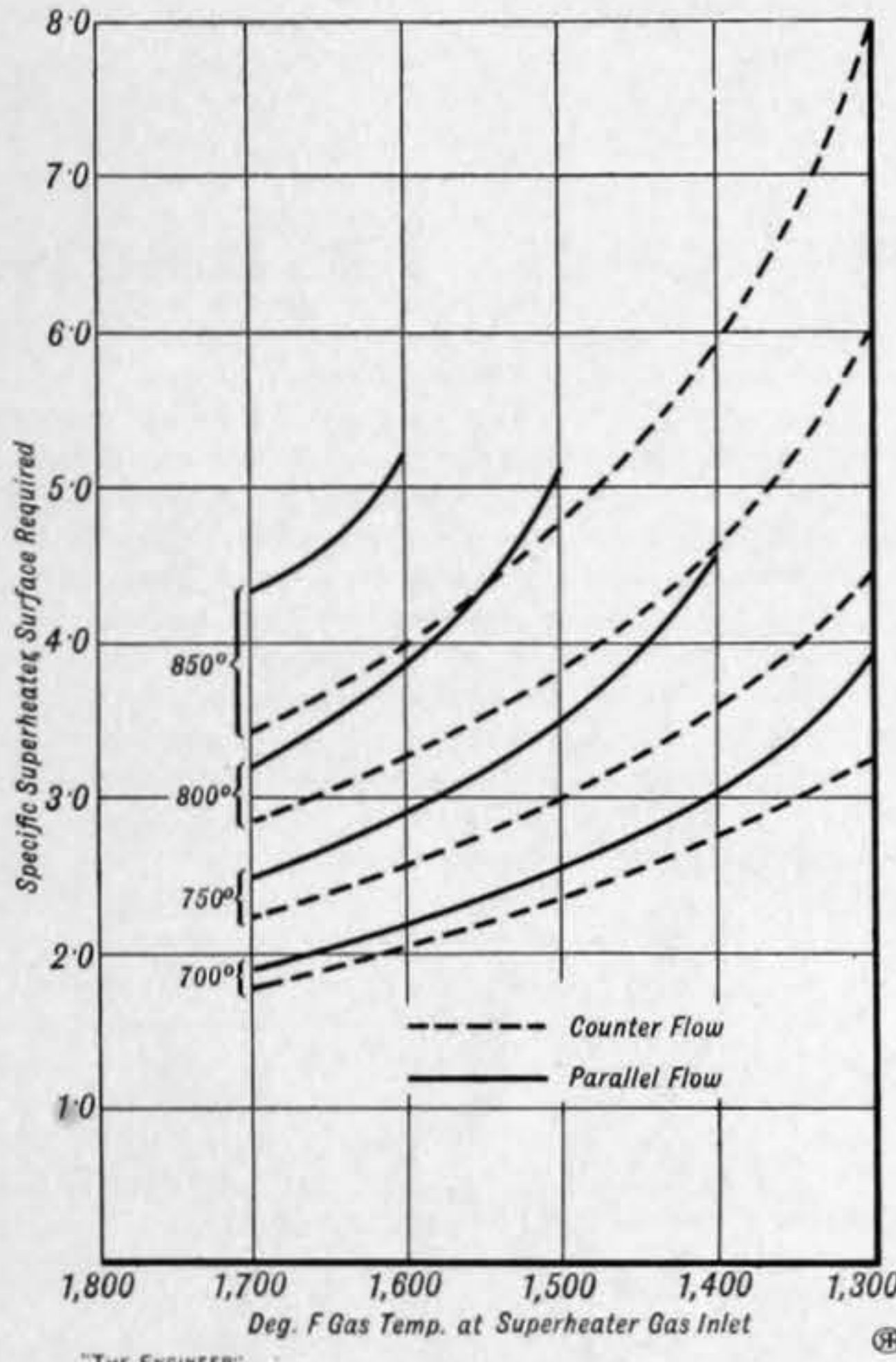


FIG. 4

The choice between parallel flow and counterflow also depends on the final steam temperature required for a given flue gas temperature in the superheater inlet zone at normal load. This interrelation between final steam temperature and gas

increase in steepness as higher steam temperatures are required. Likewise the curves for counterflow show the same tendency, but for each of the steam temperatures for which these curves are established, the curve for parallel flow shows a relatively greater steepness than that corresponding to counterflow. Also, below certain gas temperatures (the minimum gas temperature depending on the final steam temperature required), parallel flow ceases to be applicable at all since the gas exit temperature at the superheater outlet begins to approach the steam temperature prevailing in the high-temperature part of the superheater coil, which part, in the case of parallel flow, is situated in the zone of lowest gas temperature in the superheater. This tendency increases rapidly with increasing steam temperature required. Due to this fact, superheaters for 900–1100 deg. Fah., and more, will in most cases have to be designed for counterflow.

THE INFLUENCE OF SUPERHEATER POSITION UPON THE SUPERHEATER CHARACTERISTIC.

A study of the influence of superheater position within the boiler surface upon the superheater characteristic is highly important from the viewpoint of plant economy, since decreases in steam temperature at lower than normal load adversely affect plant efficiency and also impair returns on the additional capital outlay involved in the building of boiler and turbine for high operating temperatures. The theoretical study of the superheater characteristic is preferably made with the help of the two general heat exchanger formulae for counterflow and parallel flow respectively. The equation for parallel flow reads:

$$t_2' = t_1' + \frac{q}{q + q'} (t_1 - t_1') \left[1 - e^{-\frac{k \cdot F}{q} \left(1 + \frac{q}{q'} \right)} \right] \quad (1)$$

where

t_1' = temperature of the saturated steam in deg. Fah.

t_2' = temperature of the superheated steam in deg. Fah.

t_1 = temperature of the flue gas entering the superheater in deg. Fah.

t_2 = temperature of the flue gas leaving the superheater in deg. Fah.

$q = W_s \cdot c_{ps}$, where W_s = lb. of steam passing the superheater per hour, and c_{ps} = average specific heat of the steam.†

$q' = W_g \cdot c_{pg}$, where W_g = lb. of flue gas passing the superheater per hour, and c_{pg} = average specific heat of the flue gas.

The equation for counterflow reads:

$$t_2' = t_1 - (t_1 - t_1') \cdot f \quad (2)$$

where

$$f = \frac{1 - \frac{q}{q'}}{1 - \frac{q}{q'} \cdot e^{-\frac{k \cdot F}{q} \left(1 - \frac{q}{q'} \right)}} \quad (3)$$

The application of formula (2) for counterflow is preferably made with the help of a chart giving values of f in function of $\frac{q}{q'}$ and $\frac{F \cdot k}{q}$. A chart of

this type is reproduced in Fig. 7. In cases where such chart is likely to be frequently used, it will be found advantageous to design a special large-size chart, since, as equation (3) shows, a quite accurate determination of f is essential for the achievement of satisfactory results.

It should be mentioned that the two formulae (1) and (2) are, strictly speaking, only applicable in the case of heat transfer by convection alone, but for the purpose of comparative superheater analysis their application appears quite permissible

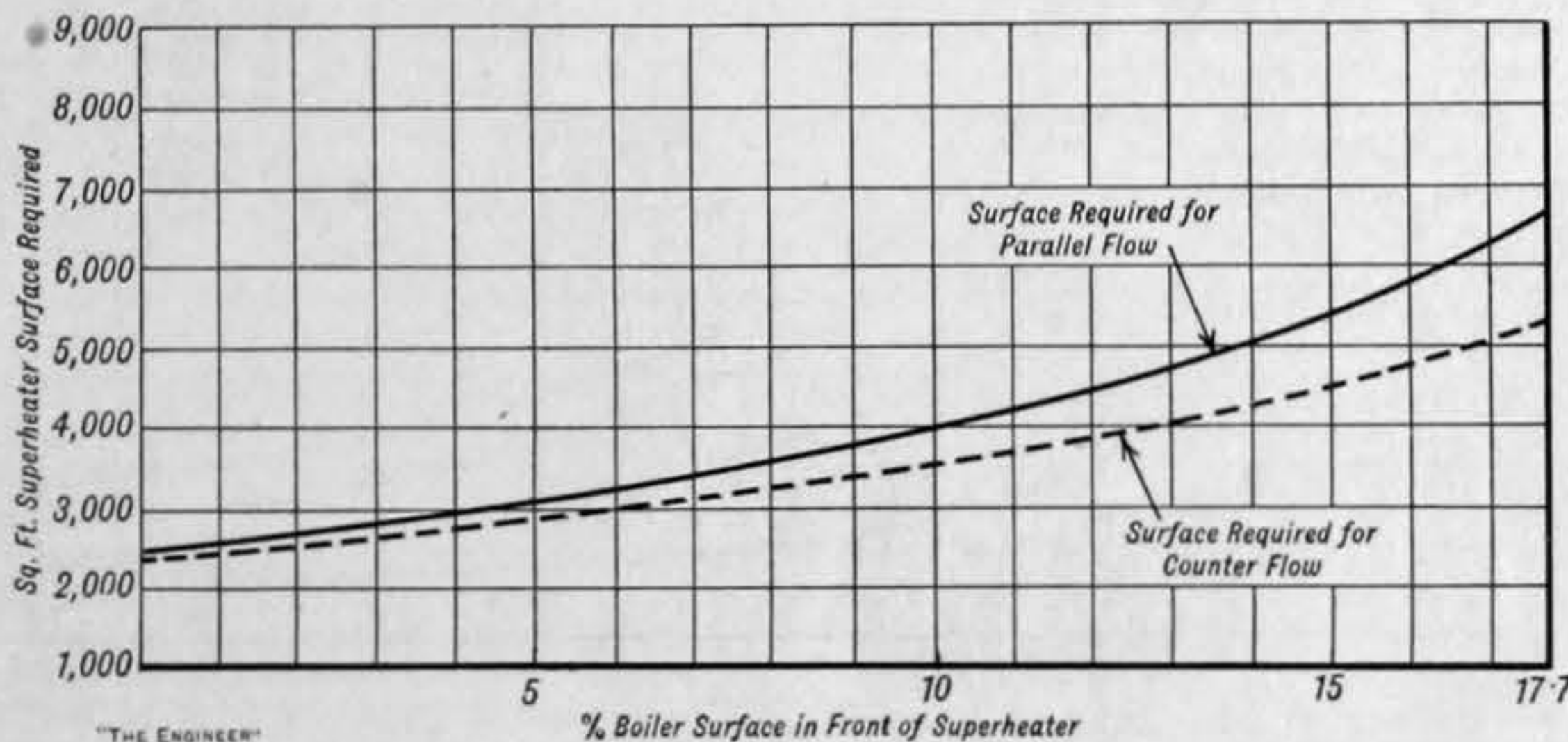


FIG. 5

punishment. This fact would in many cases call for the use of a higher and disproportionately more expensive grade of heat-resisting steel than is required for the parallel flow coil. The preferableness of counterflow must therefore be ruled out in such cases. Thus, taking, for instance, the case of 1800 deg. Fah. gas temperature at the superheater entrance, for which Fig. 6 shows a ratio of $R=1.13$, it will appear pre-

temperature is shown in Fig. 4 for both flow arrangements. Here it can be seen how the specific superheater requirements—computed for conditions similar to those on which the preceding investigation is based—increase with both increasing superheated steam temperature required and for a given gas inlet temperature. Considering the family of curves for parallel flow, these show a pronounced tendency to

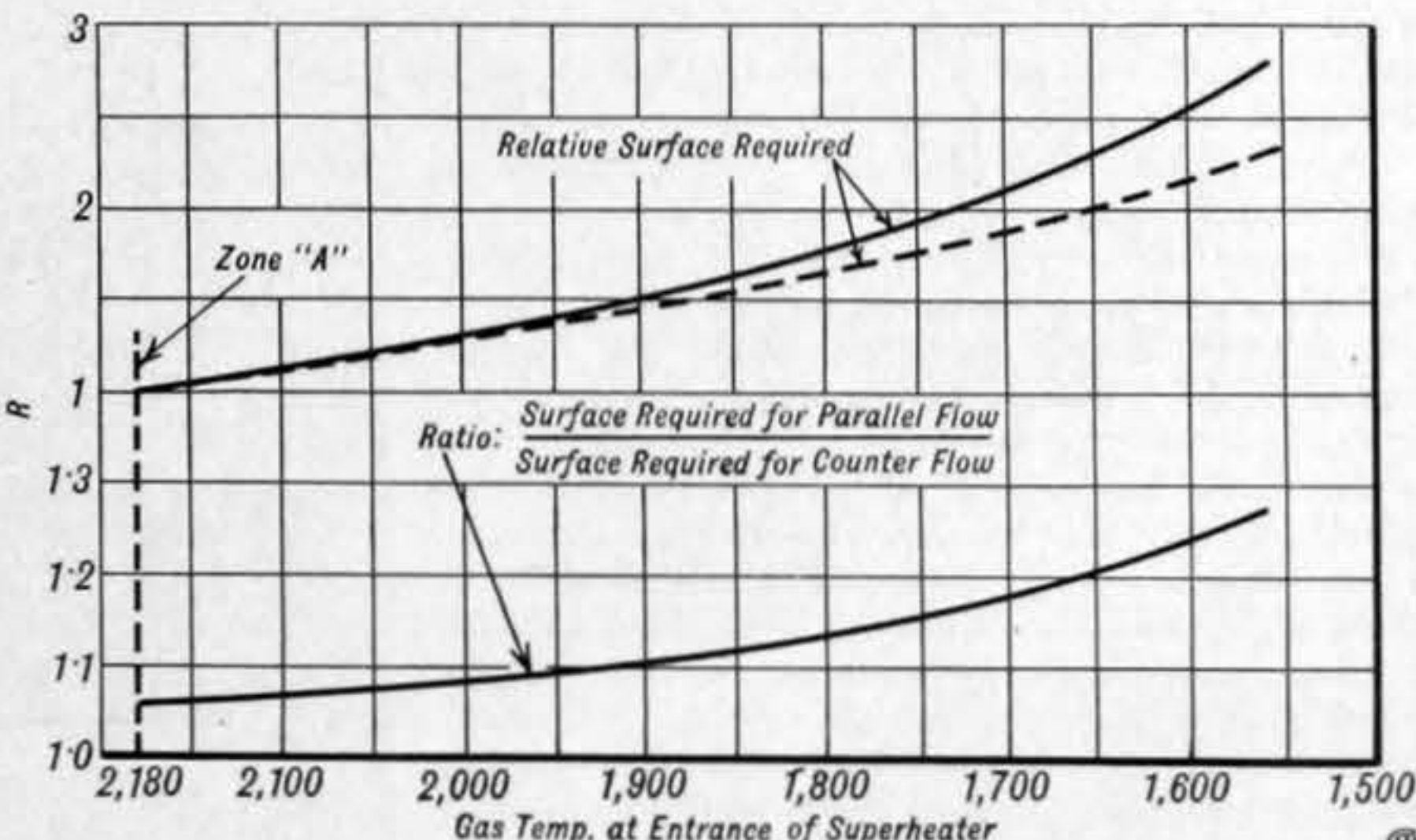


FIG. 6

in spite of the fact that heat transfer in the superheater is effected by both convection and radiation.

Fig. 8 shows the superheater characteristics for the three superheater positions A, B, and C, which characteristics were arrived at by inserting the various

† This average specific heat should be established by taking into account the amount of heat required for the evaporation of the moisture contained in the saturated steam.

values of k , F , q , q' , &c., into the formulæ (1) and (2). As is to be expected, this chart shows that the stability of the steam temperature depends largely on the superheater position and that the stability rapidly decreases with increasing amounts of boiler surface interposed between furnace and superheater. It also shows that the influence of the flow arrangement between gas and steam upon the stability of the steam temperature increases rapidly in the same direction. As to the curve representing the superheater characteristics in the temperature zone C, a

A and exposed to furnace radiation. As is to be expected, curve A' shows considerably greater stability than the curves A. Since radiant superheaters show a rising tendency of the steam temperature with falling load, one would feel inclined to believe that the characteristic A' should at least be horizontal if not slightly rising towards the lower load range. This would, indeed, be the case if the major part of the superheater surface were exposed to direct furnace radiation, so that a relatively large percentage of the total heat absorbed by the super-

stability is always due to the particular mode of boiler operation, a mode which may not be exactly that which the progressive plant engineer would wish to adopt as a standard for future installations.

RELATIVE SUPERHEATER STABILITY AND THE COEFFICIENT OF STABILITY.

For the comparison of steam temperature characteristics derived from superheater installations operating at different pressures and temperatures, the use of a chart of the type reproduced in Fig. 8 cannot be recommended, notwithstanding the fact that it is very frequently used in this connection. A much more satisfactory method of comparing

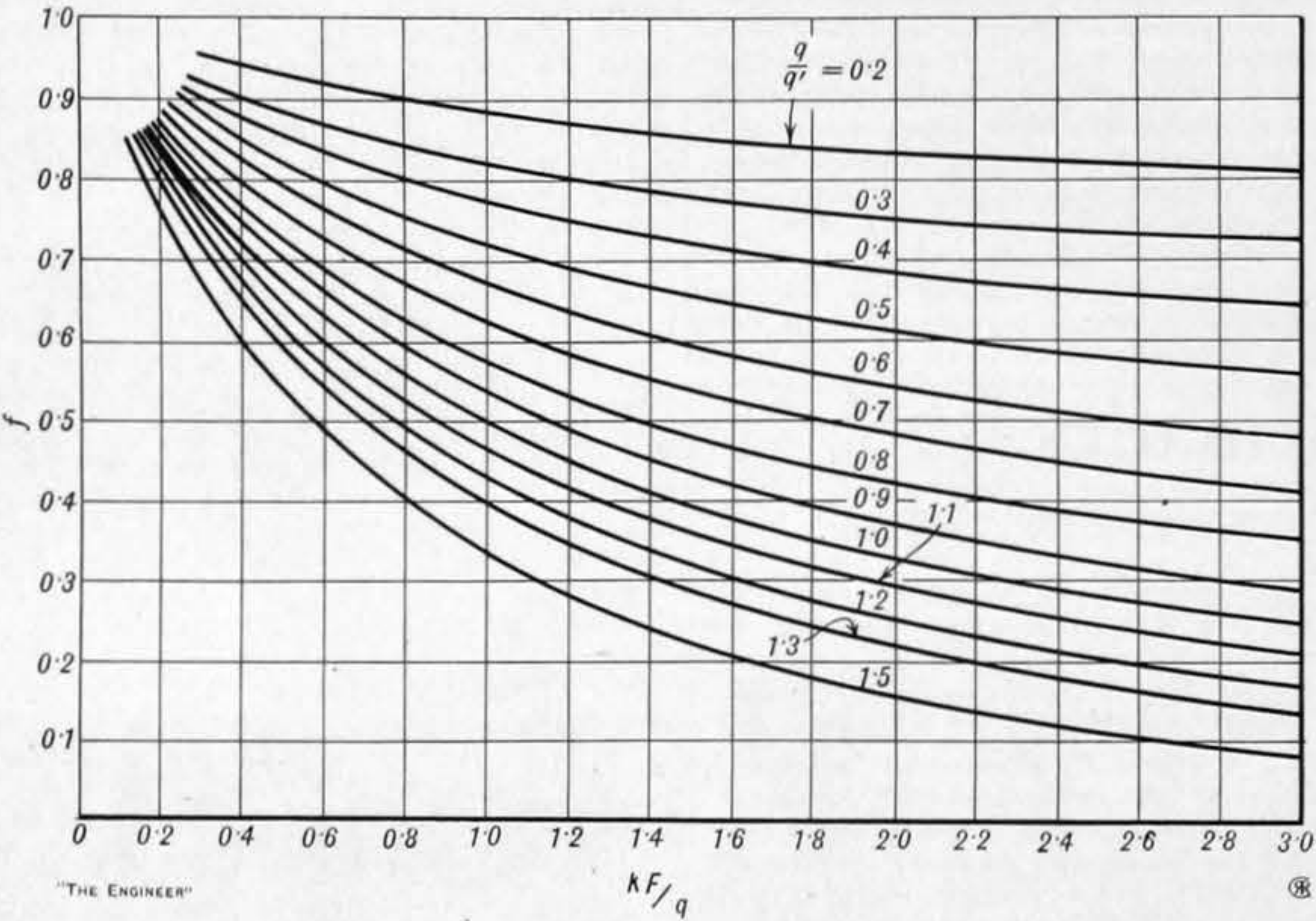


FIG. 7

characteristic of this kind does not appear to be particularly desirable if an operating range from one-quarter to full load is a regular operating feature, since even in the case of counterflow the steam temperature decreases from 800 deg. Fah. at full load to 646 deg. Fah. at one-quarter load. It must, however, be remembered that the theoretical characteristic established in this analysis does not take account of changes in CO_2 content with the load. In numerous actual installations the CO_2 content is considerably decreased in the lower load ranges. With decreased

heater would be transferred by direct radiation. But due to space restrictions, the required superheater surface can only be accommodated in the available boiler space by composing the superheater elements of several loops, of which only the front tubes can fully "see" the furnace, while all subsequent pipes are increasingly shielded from direct furnace radiation. This fact explains why the effect of direct furnace radiation does not play a more important rôle in the overall heat transfer of a superheater with its front tubes exposed to furnace radiation.

superheater characteristics is to reduce them all to a common standard of comparison by charting the percentage deviations in superheat from normal in function of the load. A chart of this type is given in Fig. 9, which is derived from the temperature characteristics of Fig. 8. In order to emphasise the desirability of a common standard of this kind in cases where the superheaters to be compared operate at different steam pressures, the temperature curve B for counterflow given in Fig. 9 has been redrawn for an operating pressure of 1200 lb. per square inch abs. (all other curves shown being based on 450 lb. per square inch abs.). This new curve B' clearly shows that identical steam temperature

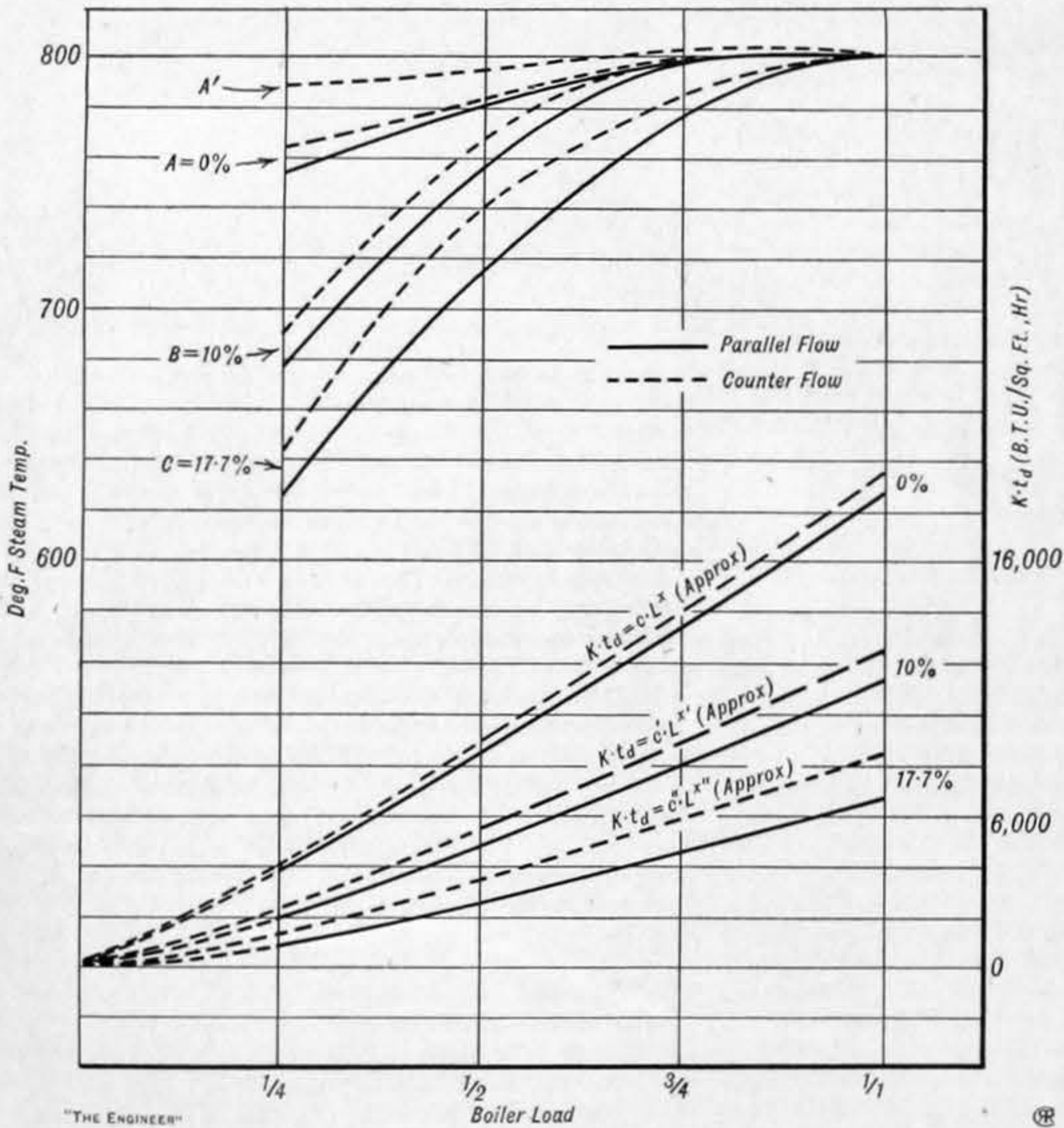
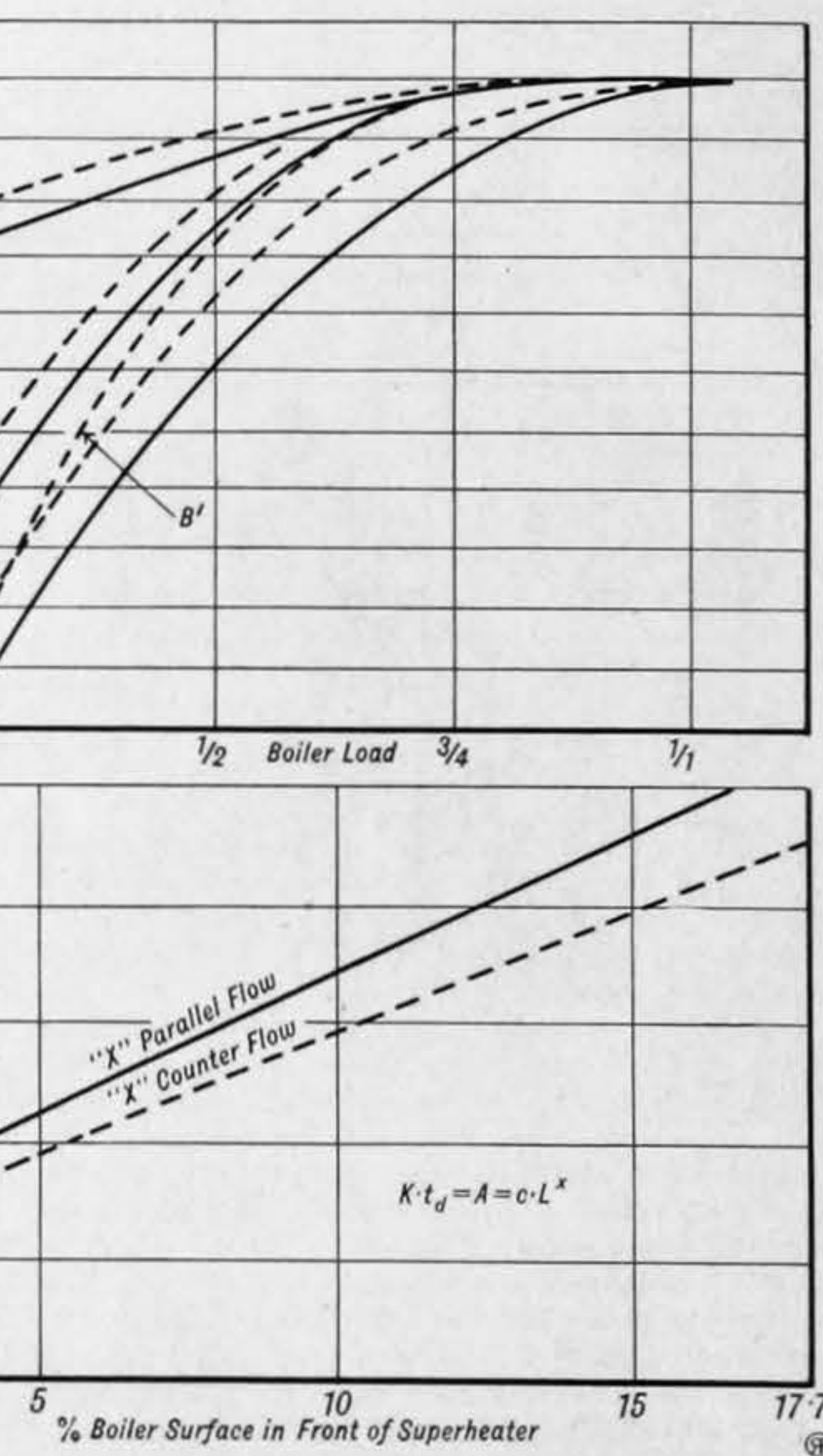


FIG. 8

CO_2 content as the result of larger excess air, the ratio R increases, and this results in turn into increased superheater absorption, so that the superheater characteristics in the lower load range can be considerably flatter than those shown in Fig. 8. A theoretical analysis of this influence of the CO_2 content upon the steam temperature will have to take into account the fact that a change in the CO_2 percentage reacts upon the values of R , k , and also of the gas temperature at the superheater entrance.

The topmost curve A' in Fig. 8 represents the estimated characteristic of a superheater placed in zone

This statement can easily be verified from the results obtained with intertube superheaters placed in the first bank of bent-tube boilers. Superheaters of this kind as a rule show temperature characteristics not materially more stable than those of superheaters completely shielded from furnace radiation. It is therefore not likely that it will be possible to materially better the characteristics in actual installations over the theoretically derived characteristic A'. It can be argued that even superheaters placed behind as much as 10 per cent. boiler surface actually show 100 per cent. stable characteristics, but such



FIGS. 9 AND 10

characteristics at different pressures are no indication of the true superheater performance, but that the correct method of judging superheater stability is to compare the deviations from normal superheat incurred over a given load range.

Another more general method of defining superheater stability consists in establishing a mathematical relationship between the product $k \cdot t_d$, representing the absorption rate per square foot of gas touched superheater surface per hour, and the load. In order to demonstrate this method, the absorption characteristics for the superheater posi-

tions A, B, and C are charted in Fig. 8 below the temperature characteristics based upon them. The trend of these absorption rates makes it apparent that in the load range considered they lend themselves to mathematical interpretation by means of a simple power function of the general form $k \cdot t_d = c \cdot L^x$, where c is a constant, L the load, and x a variable, the latter equalling unity in the case of constant steam temperature. The various values of x found from the evaluation of each of the three absorption curves of Fig. 8 are charted in Fig. 10 in function of the amount of boiler surface placed ahead of the superheater. In this figure, x , which could be termed the coefficient of superheat stability, is shown to have its relatively lowest value of 1.08—that is, its optimum value—indicating the relatively highest stability in the case investigated, for counterflow at the boiler surface percentage 0 per cent. For parallel flow in the same position, x is slightly higher at 1.1. The graph also shows that the stability of

the parallel flow arrangement decreases faster with increasing boiler surface between furnace and superheater than the stability of the counterflow arrangement.

Fig. 11, in which the coefficient x is charted in function of the gas temperature at the gas inlet of the superheater, affords what is believed to be a particularly good insight into the relationship between superheater stability and gas temperature under given conditions. Particularly promising appears the use of the stability coefficient wherever different superheater lay-outs and installations are to be judged according to their operating characteristics. Obviously, this method of stability analysis is not limited in application to the common one-stage superheater, but can be extended to the study of the stage characteristics of two-stage superheaters with a temperature-controlling desuperheater between the stages; it can also be applied to the study of radiant superheaters.

Mechanised Mathematics.

No. I.

THE application of mathematics to practical problems is frequently hampered by the tedious nature of the arithmetical computations which are necessary before the algebraic expressions involved can be evaluated numerically. Consider for example the two simultaneous equations

$$a_1x_1 + a_2x_2 = D_1 \quad (1)$$

$$b_1x_1 + b_2x_2 = D_2 \quad (2)$$

in which the a and b coefficients and the constants D are known numbers. For computation purposes the solutions may be expressed as

$$x_1 = (b_2D_1 - a_2D_2) \div (a_1b_2 - a_2b_1)$$

$$x_2 = (D_1 - a_1x_1) \div a_2$$

The determination of x_1 and x_2 therefore requires the performance of five multiplications, three subtractions and two divisions or a total of ten arithmetical operations. The number of operations required increases rapidly with the number of unknowns to be found. If there are three unknowns and three equations the determination of x_1, x_2 and x_3 will require 19 multiplications, 11 subtractions and 3 divisions or a total of 33 operations. With four unknowns 76 operations all told are required. With nine unknowns no fewer than 801 arithmetical operations have to be performed. In general with n unknowns and n simultaneous

solution of two simultaneous equations containing two unknowns. It will be assumed that the two equations are

$$a_1x_1 + a_2x_2 + D_1 = 0 \quad (3)$$

$$b_1x_1 + b_2x_2 + D_2 = 0 \quad (4)$$

in which the coefficients a, b and constants are known numbers and, in the first instance, are all positive.

Three tipping plates mounted to swing about horizontal axes at the midpoints of their lengths are represented at A B C. In the complete machine there are ten of these plates and in all cases the number of plates in use is one more than the number of unknowns to be evaluated.

Each plate carries a swinging arm D with a lower and upper wheel E F at its ends. A flexible steel tape anchored at G passes round a wheel on a truck H capable of running freely on a horizontal rail J and is then led vertically upwards to the lower wheel E of plate C and downwards to a second wheel on the truck whence it passes to similar trucks serving plates B and A in a similar manner. Thereafter the tape is led up to three other trucks running on a rail K. At each truck the tape descends vertically to the upper wheel F of the associated plate and is finally anchored at L.

The tape can also be anchored at an intermediate

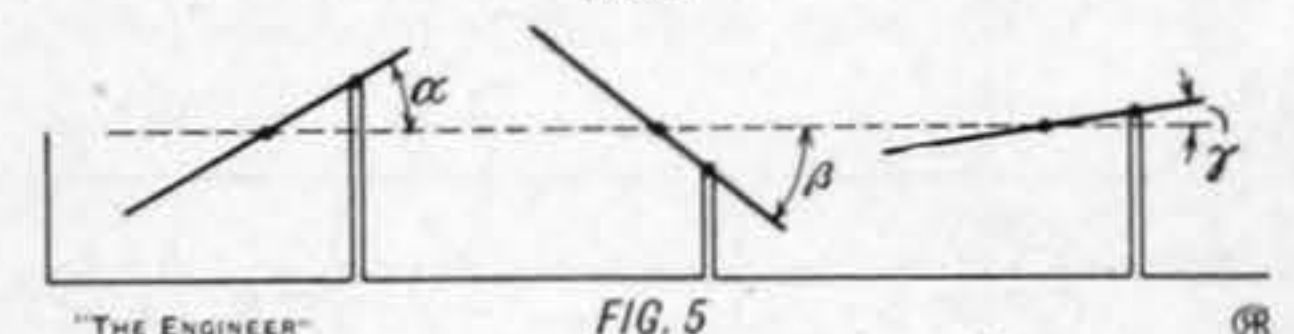
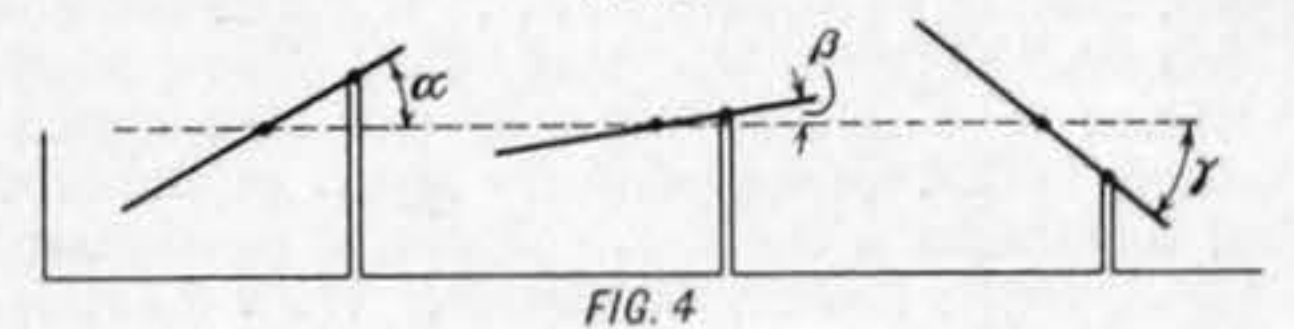
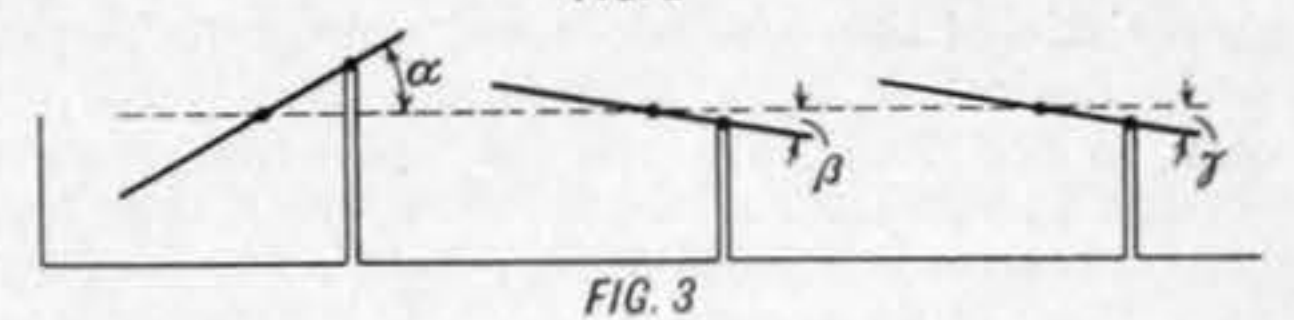
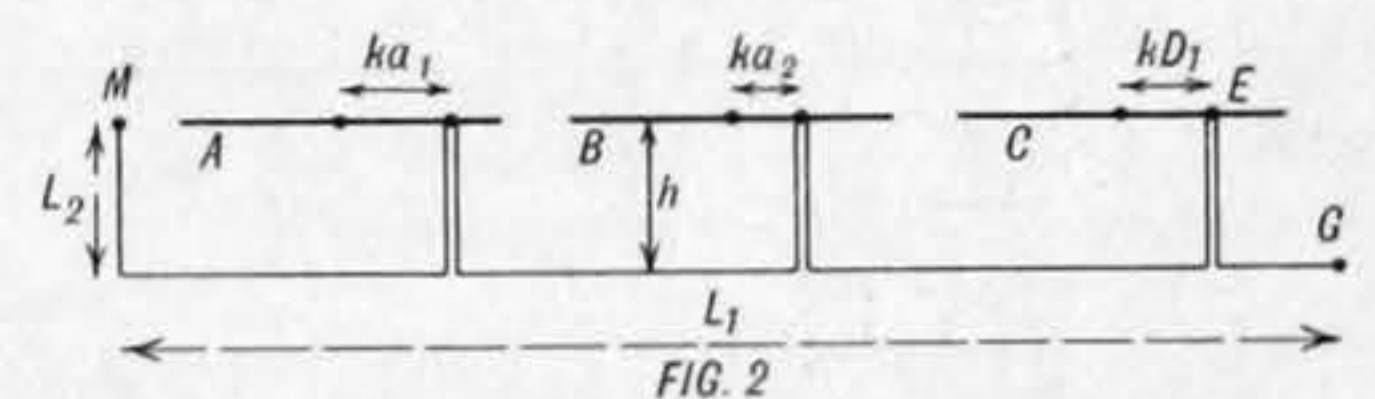
is $L_1 + L_2 + 6h$ and however the plates tip this length remains constant. Further, if the plates tip the lengths L_1 and L_2 do not alter. Hence in any configuration of the plates the total amount of tape absorbed in the three bights must be constant and equal to $6h$.

Let us suppose that plate A is tipped by hand through some definite positive angle α as in Fig. 3. The amount of extra tape thereby drawn into the bight of this plate is clearly $2ka_1 \sin \alpha$. This extra amount of tape is supplied by an equal net shortening of the amount of tape in the bights of plates B and C. The transfer of tape can however be made in an infinite number of ways. The whole supply might come from one of the bights while the other plate remained horizontal. It might be given by plates B and C tipping downwards to the same or different degrees as shown in Fig. 3, or it might be given by one of these plates tipping upwards while the other tipped downwards as shown in Figs. 4 and 5.

It follows then that a definite tilt α given to plate A—or to any one of the plates—induces indefinite tilts β, γ in plates B and C. Nevertheless, although the tilts β, γ are indefinite the three tilts α, β, γ must, taken together, conform to a certain requirement. This requirement may be expressed as follows:—Whatever the tilts the aggregate increase in the amount of tape in the three bights must be zero. The increase in the case of plate A is $2ka_1 \sin \alpha$. The increase in bight B Fig. 4 is $2ka_2 \sin \beta$ and the increase in bight C Fig. 5 is $2kD_1 \sin \gamma$. Hence as the total increase must be zero we have

$$2ka_1 \sin \alpha + 2ka_2 \sin \beta + 2kD_1 \sin \gamma = 0 \quad (5)$$

This expression covers all possible cases provided we



FIGS. 2 TO 5—ACTION OF MACHINE

pay proper attention to algebraic signs. Thus in Fig. 3 β and γ are both negative and therefore $\sin \beta$ and $\sin \gamma$ are negative. Hence for Fig. 3 the law (5) becomes

$$2ka_1 \sin \alpha - 2ka_2 \sin \beta - 2kD_1 \sin \gamma = 0,$$

implying as is the case that the increase in bight A has been made good by a decrease in each of the bights B and C. The expression (5) with due attention to sign also correctly represents the conditions shown in Figs. 4 and 5. Further it will be easily found that the expression is also applicable to any possible configuration of the plates resulting from an initial negative tip α of plate A—or of any of the plates, and to any possible configuration resulting from any combination of positive and negative coefficients and constants.

The fact that a definite tilt of one of the plates results in indefinite tilts in the other two plates is the mechanical analogue of the fact that it is impossible to solve a single equation containing two unknowns. To complete our solution we must turn to the second equation (4). Had we initially set up this equation on the machine instead of (3) we would have reached a similar form of general expression namely

$$2kb_1 \sin \alpha + 2kb_2 \sin \beta + 2kD_2 \sin \gamma = 0 \quad (6)$$

and again we would have found that a definite tilt α of one of the plates produces indefinite tilts β, γ in the others. To remove the element of indefiniteness we must do mechanically the same thing as we do with the given equations (3) and (4) if we wish to solve them namely deal with them simultaneously. To this end two tapes are employed and each plate carries two wheels E. One tape is led round the first set of three wheels E which are fixed at distances from the plate axes proportional to the numerics a_1, a_2 and D_1 of the first equation (3). The second tape is led round the second set of three wheels E which are positioned proportionately to the numerics b_1, b_2 and D_2 of the second equation. These six dispositions having been made the plates are levelled and the two tapes are clamped at the point M. If the first plate—or any plate—is now given a definite tilt α the joint effect of the two tapes will be to produce definite tilts β, γ of the other two plates. All three tilts now being definite the two equations

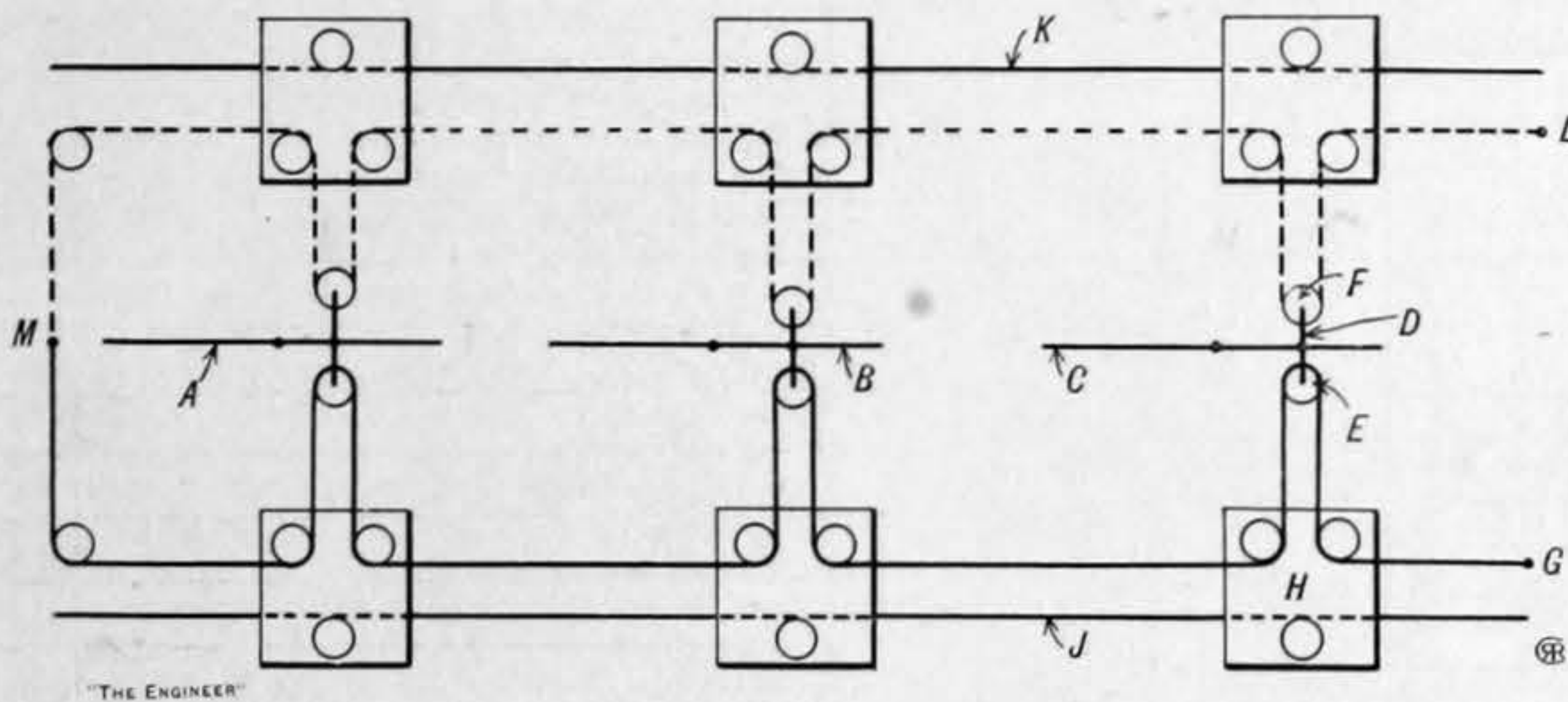


FIG. 1—DIAGRAM OF MACHINE FOR SOLVING TWO SIMULTANEOUS EQUATIONS

taneous equations the number of operations to be performed will be $n(n^2 + n - 1)$. The work involved may further not be confined to a single group of simultaneous equations. A common type of problem consists of discovering the manner in which the n unknowns alter in value with change or growth in the values of the coefficients $a, b, \dots$ and the constants D . Such a problem necessitates the performance of a fresh series of computations for each fresh set of coefficients and constants.

A second and more complex example of the manner in which the practical application of mathematics is hindered by computational difficulties will be discussed later. For the moment we will continue with the example with which we have begun and describe one way in which its solution may be mechanised. A machine for this purpose has recently been constructed at the Massachusetts Institute of Technology, a college already famous for other productions of a similar nature and in particular of the "differential analyser" * in the design of which Dr. Vannevar Bush of the Institute played a leading part. The machine which we are about to describe is capable of solving mechanically any number of simultaneous equations up to nine. A brief account of it was published by Professor John B. Wilbur in the "Journal" of the Franklin Institute for December 1936.

The general principle of the machine is indicated in Fig. 1, which represents it as arranged for the

point M. Its upper portion shown dotted serves merely to keep the whole system taut or in tension. The theory of the machine can be completely explained by considering only the lower portion of the tape. In order to facilitate understanding of the theory we will adopt the convention that distances along the plates to the right of the plate axes are to be regarded as positive as are any rotations of the plates about their axes in the contra-clockwise direction.

To set up the first equation (3) on the machine the axes of the swinging arms D are fixed at points on the plates A B C at distances from the plate axes proportional respectively to the coefficients a_1, a_2 and the constant D_1 , the points of attachment being to the right or left of the plate axes according as the coefficients and constant are positive or negative. When these dispositions of the arms D have been made the three plates are brought into horizontal alignment and the tape is clamped at M. In this condition if any one of the plates is tilted one or both of the other plates will also tilt. Whatever the angle of tilt however the induced movement of the trucks on the rail J will be such that each bight of the tape will remain at right angles to the rail.

We may suppose in the first instance that the three lower wheels E and the wheels on the trucks H are of negligibly small diameter and further that the axes of the wheels E lie not below but accurately in the planes of their respective plates. With these simplifications the machine as set up to represent the first equation (3) may be depicted as in Fig. 2. The total length of the tape between the points G and M

* See THE ENGINEER for July 19th and 26th, 1935.

(5) and (6) will apply simultaneously. Dividing each by $2k \sin \gamma$ we get

$$a_1 \sin \alpha / \sin \gamma + a_2 \sin \beta / \sin \gamma + D_1 = 0 \quad (7)$$

$$b_1 \sin \alpha / \sin \gamma + b_2 \sin \beta / \sin \gamma + D_2 = 0 \quad (8)$$

Comparing these equations with the equations (3) and (4) presented for solution we see that they are identical if we write x_1 for $\sin \alpha / \sin \gamma$ and x_2 for $\sin \beta / \sin \gamma$. Hence (3) and (4) will be solved mechanically by setting up the machine with two tapes in the manner described, tilting one of the plates and measuring the induced tilts of the other two plates and by dividing $\sin \alpha$ and $\sin \beta$ by $\sin \gamma$.

If we are given three equations with three unknowns four tipping plates will be required. Following a definite tilt α of the first plate the tilts $\beta \gamma \delta$ of the other three will be indefinite as before if only one tape is used. The application of a second tape will leave them indefinite but the use of a third tape will make all four tilts definite. The three unknowns will then be determined by dividing $\sin \alpha$, $\sin \beta$ and $\sin \gamma$ by $\sin \delta$. And so on for any number of equations and unknowns up to the limit of the machine.

It is unnecessary to give a proof of the statement that the theory of the machine is not in the least affected by the fact that the wheels E and the truck wheels round which the tapes pass have measurable diameters and that the wheels E are situated below the planes of the tipping plates. These are practical details which almost self-evidently do not affect the theory of the machine.

A view of the underside of one of the tipping plates of the machine as built is reproduced in Fig. 6. The

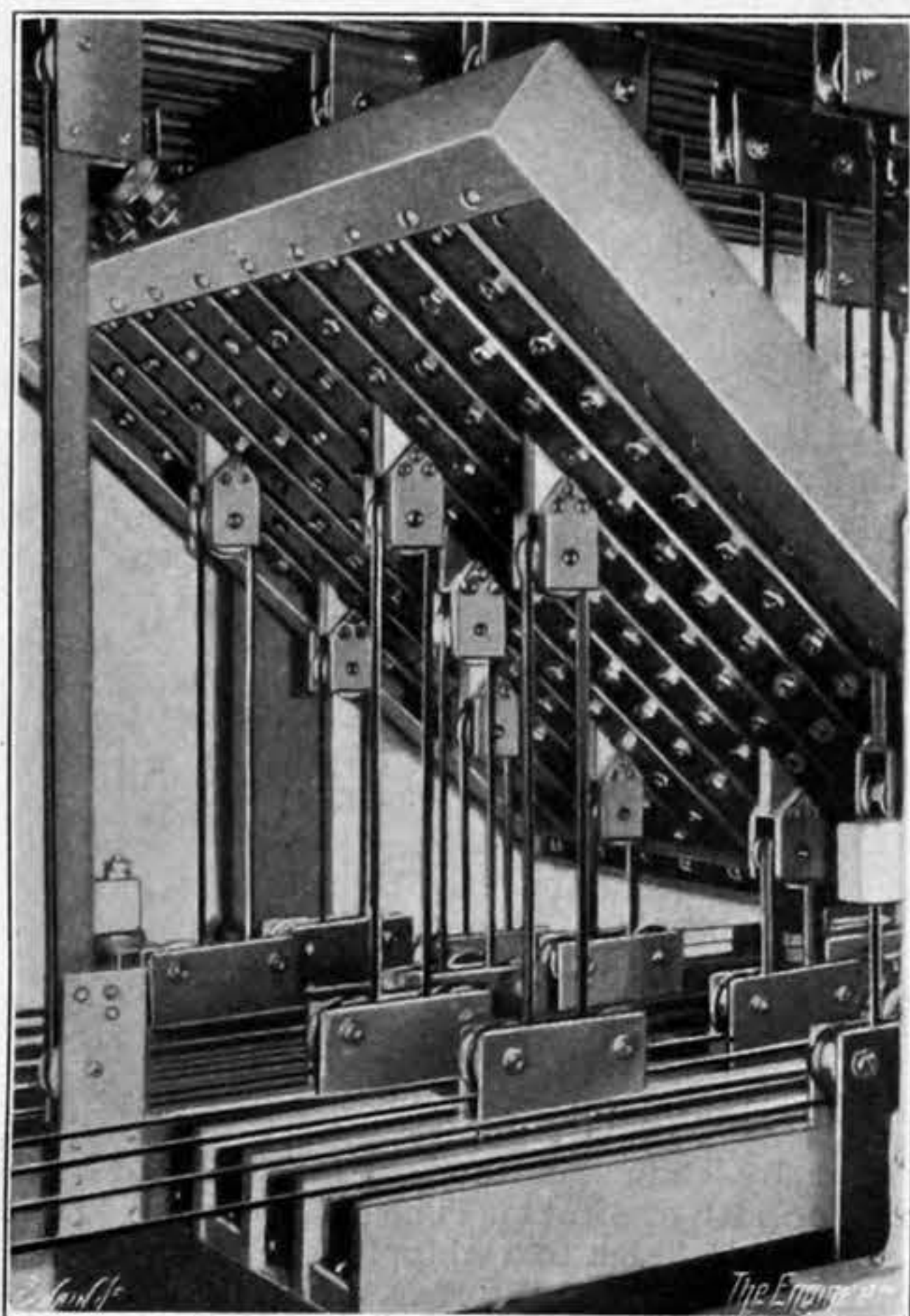


FIG. 6—ONE OF THE TEN TIPPING PLATES

engraving shows ten slots in the plate. Nine of these slots accommodate the swinging arms D with their upper and lower wheels. The tenth slot is provided with mechanism whereby the sine of the angle of tilt of the plate may be read directly off a scale. The arms D are set by micrometer screws to an accuracy of one two thousandth of an inch, an accuracy which corresponds with four significant figures on the scales for the coefficients and constants of the equations. Each of the nine tapes is about 60ft. long. In order to reduce strain in the tapes, any extension of which would affect the accuracy of the results, over one thousand ball-bearing pulleys are used in the machine. Each plate can be clamped against rotation in order that it may take no part in the solution of the equations if there are less than nine unknowns.

It will have been noted that when the machine has been set up it is immaterial which of the plates is initially tilted in order to induce tilts in the others. Further it has been tacitly implied that the initial tilt need not have any particular value. In practical use it is found that some of the plates are easier to turn than the others. The easiest to turn is that one from which the largest unknown will be read. This plate having been found by trial is given a rotation of about 40° clockwise and brought to rest with an oscillating motion intended to eliminate frictional restraints. The sines of the induced angles of tilt of the other plates having been read the driving plate is tilted about 40° in the contra-clockwise direction, the plate again being brought to rest with an oscillating motion. The sines are again read. The unknowns are determined by averaging the readings thus obtained.

As in certain other forms of mechanical computer the time involved in setting up the machine for solving a given set of equations is by far the largest part of the total time expended. The actual time required varies with the nature of the equations but as a rough guide it may be taken that to evaluate

nine unknowns from nine simultaneous equations to an accuracy of three significant figures absorbs from one to three hours. Once the machine is set the operation of the plates and the reading of the results occupy only a few minutes. Without the machine ordinary methods of computation, even when aids such as keyboard calculators are employed, would probably require something like eight hours for the solution of the same set of equations. Further with the machine set up for the nine equations very little extra work is required to change any one of the constants or coefficients and to repeat the evaluation under the new conditions. It is stated that as the operators acquire experience with the machine the time required to obtain a solution from it will probably be reduced.

The accuracy of the results given by the machine depends upon the nature of the equations to be solved. Some sets of equations yield good results with little effort but others which approach an unstable condition are difficult to handle on the machine. As a general rule, it is estimated that the errors in the values given by the machine will not exceed 1 per cent. of the largest unknown. If however it is required to obtain greater accuracy a method of successive approximation involving a first and a second and perhaps a third solution may be employed. This method consists of setting up the equations on the machine and obtaining first approxima-

tions to the values of the unknowns. These values are inserted in the original equations and the values of the constants $D_1 D_2$ &c. are calculated. The values so arrived at will in general differ slightly from those given in the original equations. The differences between the given and the calculated values of the constants are then set up on the last plate of the machine and the equations are again solved. The new solutions give the corrections to be applied to the originally deduced values of the unknowns. As this process involves no interference with the settings on the plates on which the coefficients $a, b \dots$ are set up the work of obtaining the second solution proceeds rapidly.

A method has been developed whereby the ten-plate machine can be adapted to the solution of as many as eighteen simultaneous equations. Particulars of this method have not as yet reached us but it is stated that it has been used in the solution of a group of eighteen equations arising from a study of the slope deflection of a building frame subjected to lateral loads. The estimated time for the machine solution of this problem under proper conditions is $7\frac{1}{2}$ hours. By direct means and using a keyboard calculator to assist in the performance of the 6138 arithmetical operations involved the time required for the solution of the same problem is estimated at 32 hours.

(To be continued.)

The Royal Show at Wolverhampton.

No. I.

THE ninety-sixth Annual Show of the Royal Agricultural Society of England, which is to be held at Wolverhampton from Tuesday, July 6th, till Saturday, July 10th, bids fair, from the point of view of engineering and machinery interest, to be one of the most successful of recent years. The entries of livestock, poultry and produce are well maintained, while the number of stands in the implement section and the amount of shedding devoted to implement exhibits is the largest since the Manchester Show of 1930. Nearly 160 firms are showing agricultural machinery and auxiliary apparatus, which number undoubtedly reflects the improved general outlook in the agricultural machinery industry which has been brought about by recent Government interest in the welfare of British agriculture, and a better overseas market. As befits a Show held in the Midlands, where the electrical industry is strong, there is a large electrical section. It takes the form of a joint exhibit designed to illustrate the use of electricity on the farm, and in the home, which has been organised by the British Electrical Trade Development Association, and is receiving the active support of ten electricity supply departments of the surrounding Midland cities, towns, and districts, and some fifteen electrical manufacturing firms.

A welcome feature of this year's Show is the greatly increased number of implements which have been entered for the Royal Society's Silver Medal as "New Implements for Agricultural or Estate Purposes," as against the comparatively few entries in the last few years. This year's entries number fourteen, and are representative of every branch of the industry.

In the following articles we propose as in recent years, to describe some of the more interesting exhibits, selecting those of recent design or those in which some improvement has been made.

THE BRITISH OXYGEN COMPANY, LTD.

The object of the exhibit arranged by the British Oxygen Company, Ltd., of Thames House, Millbank, Westminster, S.W.1, will be to demonstrate the manner in which the practice of welding and cutting is serving the rural community to-day. Attention is drawn to the ever-increasing use of welding, examples being taken from recent work carried out by the firm. The new Essex industry of scientific mushroom growing supplies such an instance. In one installation recently carried out, 108 wooden sheds, 100ft. by 14ft., with special concrete shelves, were built, giving a total area of 432,000ft. for mushroom growing. The shelves are supported by all-welded structures, consisting of $\frac{1}{2}$ in. diameter steel tube uprights with $2\frac{1}{2}$ by $2\frac{1}{2}$ angle iron horizontal members and cross supports of $1\frac{1}{2}$ by $1\frac{1}{2}$ angle iron at regular intervals. All the horizontal members and the uprights were welded, over 55,000 metal welds being made. Each shed was designed to carry a load of 3 tons. The building of welded greenhouses is illustrated, the construction of metal wheelbarrows for hot ash removal, and the making of welded bottle racks. The firm will also demonstrate its latest methods of electric and oxy-acetylene welding and cutting by means of a portable and straight line cutting machine.

HALLIDAY BOILERS, LTD.

The firm of Halliday Boilers, Ltd., of Saxon-road, Selhurst, London, S.E.25, will show a series of gas or paraffin-fired steam boilers and sterilising equipment for dairy utensils, which equipment has been

entered for the R.A.S.E. Silver Medal Award. In Fig. 1 we illustrate a typical gas-fired boiler and sterilising chest. The boiler consists of an inner and an outer steel shell, with cross tubes, so that a spiral-shaped flue is formed for the hot gases, which pass up the boiler. The outer surface of the boiler is finished in white vitreous enamel, while the inner surface is galvanised. Firing is by a suitable gas burner, or a single jet paraffin burner on a swivelling arm, which may be conveniently swung out for filling with spirit to heat the burner before turning on the paraffin fuel. The designed working pressure of the boiler is 25 lb., and as a superheater is fitted in the upper part of the boiler, dry steam is delivered to the sterilising chest at a temperature of about 400 deg. Fah. The water capacity of the boiler is 7 gallons,

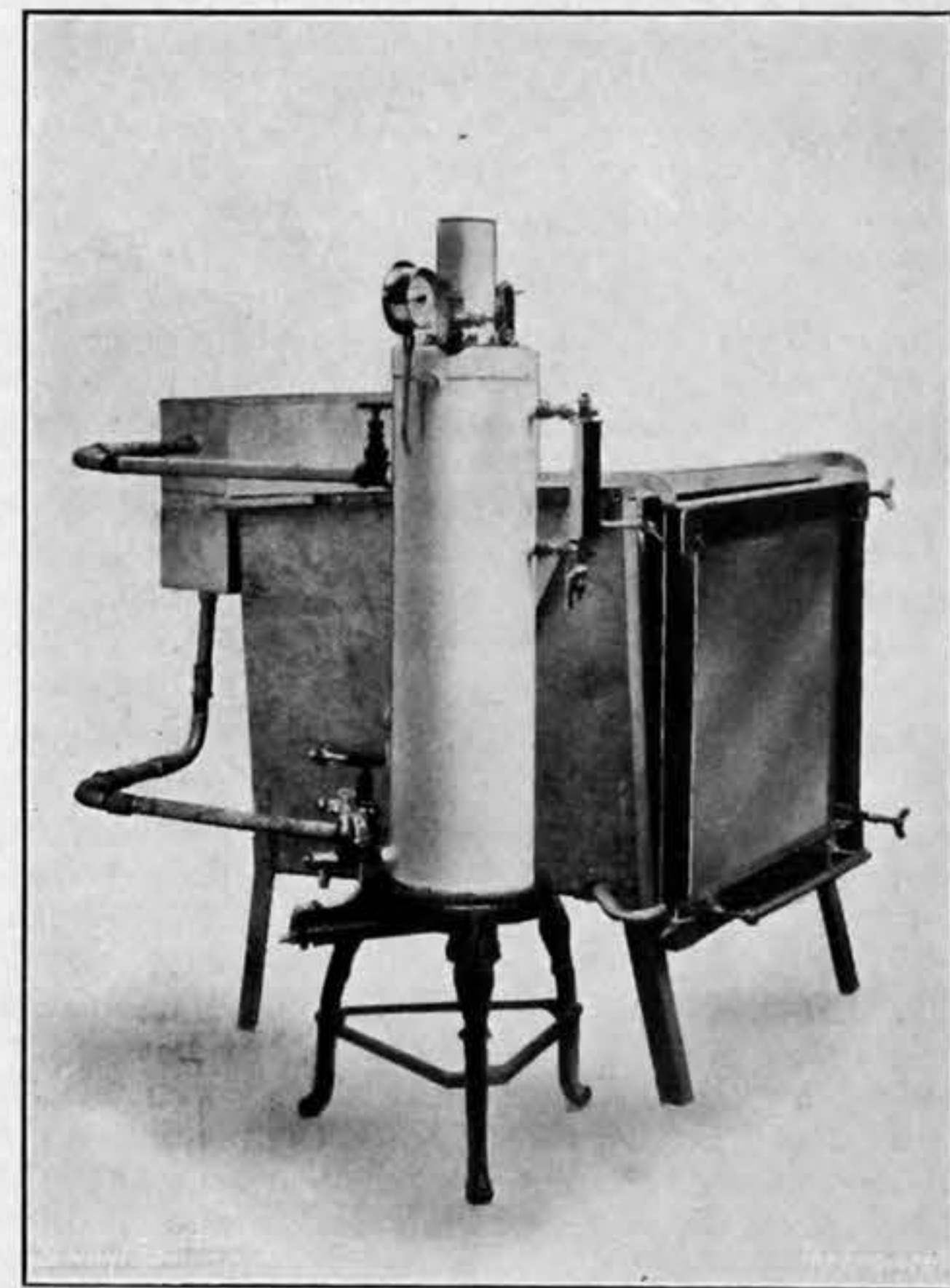


FIG. 1—GAS-FIRED BOILER AND STERILISER—HALLIDAY

and the evaporation rate is about 60 lb. of water per hour. The time taken to raise steam to a pressure of 25 lb. per square inch is 11 min. With paraffin fuel a general figure for consumption is about 1 gallon of oil for three hours' steaming. Various arrangements of fuel and water storage tanks can be provided in cases where gas and main's water are not available. If a main's pressure of about 35 lb. per square inch is available, then the boiler can be arranged to be first run as a non-pressure boiler for providing hot water for washing purposes before starting the sterilising process. All that is necessary is to close the hot water valves, thereby converting the installation into a steam-raising plant. Automatic change-over gear and gas control can be supplied. The sterilising chest, shown in Fig. 1, is of the firm's standard design, and a patent has been applied for, which on being opened will give protection until the steam which filled the chest has had time to escape. The door is so pivoted

that it can, when not required, be swung out of the way over the top of the chest.

MERRYWEATHER AND SONS, LTD.

The firm of Merryweather and Sons, Ltd., of Greenwich, has this year, as in previous years, been entrusted with the fire protection of the large number of stands which constitute the Show. It has again constructed its own fire station within the Show grounds, which will be staffed by a number of Merryweathers' fire-protection engineers. The equipment of the station includes a motor fire engine of the Hatfield type, with a designed capacity of 500 gallons per minute, and a first-aid equipment, with a 35ft. "Telescala" ladder. There will also be an "Xaust

the speed of the engine. The controls are so grouped that the machine can easily be manoeuvred with one hand, leaving the other quite free to control the implement which is being operated. The tractor is specially useful for working in confined spaces, since, if desired, it can be turned about its own axis by exerting full pressure on the steering lever.

WOLSELEY SHEEP SHEARING MACHINE COMPANY, LTD.

The Wolseley Sheep Shearing Machine Company, Ltd., of Witton, Birmingham, will exhibit a full range of machines for sheep shearing and horse and cattle clipping, as well as dairy machinery and stationary engines. An interesting exhibit on this stand will be the new Wolseley all-electric cream separator,

with the standard "Wolseley" clipping plates, combs and cutters, for which the firm's special sharpening service is available.

HARRISON MCGREGOR AND CO., LTD.

In addition to a wide range of harvesting, cultivating, and food-preparing machinery, Harrison McGregor and Co., Ltd., of Leigh, Lancashire, will show a new and interesting type of bracken breaker, constructed under the patents of Captain C. V. Holt. This is entered as a new implement for the R.A.S.E. Award.

The Holt bracken breaker was designed and tested last year, and has as its object the destruction of bracken on moorlands and rough grazings, the increase of which is causing great anxiety in many

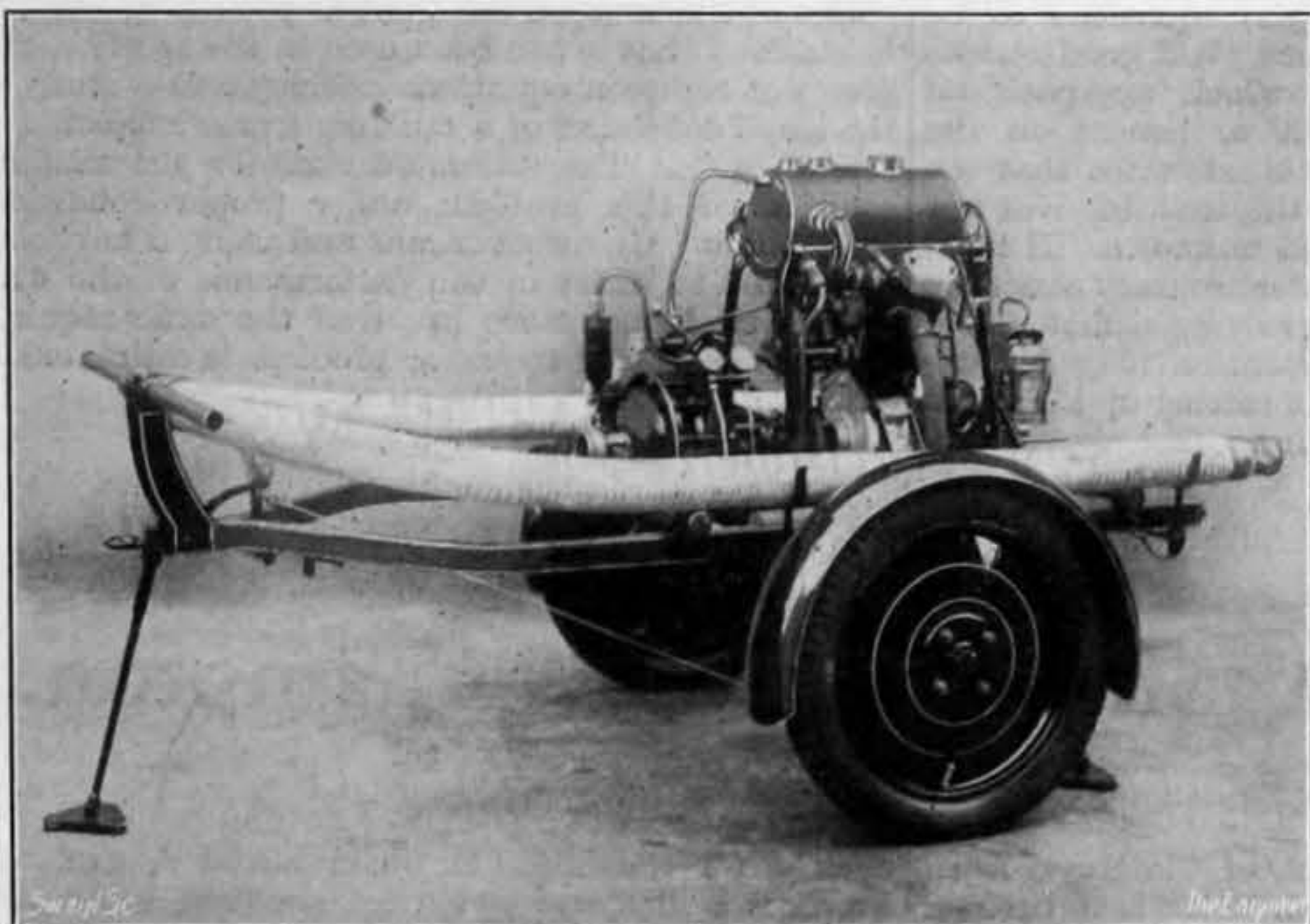


FIG. 2—PORTABLE FIRE PUMP—MERRYWEATHER

Suds" foam generator for dealing with oil fires, and a "Hatfield" trailer motor pump of 105 gallons per minute capacity. In Fig. 2 we illustrate a recent design of Merryweather portable fire pump, which was specially designed for the training ship "Warspite," from which it takes its name. The pump unit is carried on a light steel chassis with pneumatic-tired wheels, enabling it to be towed behind a motor vehicle. It can be quickly detached from its carriage, and can then be easily carried by two men. It comprises an 18 to 20 B.H.P. petrol engine, which is cooled from a tank with a connection from the pump. The pump is of the two-stage turbine pattern, and is designed for a working pressure of 150 lb. per square inch, and an output of 100 to 175 gallons per minute. A priming device for exhausting the air from the pump casing and the suction hose is provided. The rubber hose has a length of 15ft., and is furnished with the usual coupling screws, branch pipes and nozzles. The pump is built to throw four powerful jets of water simultaneously over buildings of average height. The carriage frame is mounted on light springs attached to a steel axle, and the wheels have roller bearings. Folding hinged struts are fitted below the towing bar and at the rear of the carriage. A hand brake operated by a lever adjacent to the towing bar, acts on both wheel hubs.

BRISTOL TRACTORS, LTD.

A British-built tractor is the "Bristol," designed and built by Bristol Tractors, Ltd., of Idle, Bradford, the latest model of which has been entered for the R.A.S.E. tractor trials, and is illustrated in Fig. 3. While it still bears some resemblance to the earlier models, the new machine incorporates in its design several important improvements which have been suggested by operation under various conditions of service. Not the least important is the placing of the air cleaner outside the bonnet, where it is clear of the fan air stream, which in agricultural practice is often dust laden. The other new features include automatic lubrication for the spindles of the track roller mountings, while the final drive hub and gear case is now a one-piece casting, and is fitted with a dust excluder and an oil seal. Care has been taken to provide accessible oil fillers for the oil baths on the final drive and the weight-carrying rollers.

The tractor has a twin-cylinder Jowett petrol engine, with a bore of 3in. and a stroke of 4in., and a designed output of 14.35 B.H.P. at a speed of 2000 r.p.m. This gives a draw-bar pull of approximately 2000 lb. in first gear and 1400 lb. in the second or ploughing gear. The tractor is small for its power, having an overall length of 86in., a width of 36in., and a height of 44in. The power is sufficient, the builders claim, to take a two-furrow plough or a seven-tine cultivator. There are three forward speeds:—First gear, 1.66; second gear, 2.8; and third gear, 4.9 miles per hour, with a single reverse at 1.5 miles per hour. The steering is light, and is operated by moving the steering lever to the right or the left, thereby partially stopping or wholly stopping the motion of either track, according to the amount of pressure applied. At the top of the steering lever there is a decelerator button for regulating

which, together with the "Wolseley Clipkit" electrically operated horse and cattle clipping machine, has been entered for the R.A.S.E. Silver Medal Award. Fig. 4 shows the new cream separator. It has a designed output of 110 gallons per hour, and is built to the company's standard specification. The driving unit is a small electric motor, with a low consumption of current. A special feature of the machine is the absence of all gearing. The drive is by means of a "vee" belt on the pulley of a motor to a pulley on the main spindle of the machine. It is claimed that the doing away with the gearing, which was previously employed, will not only ensure greater simplicity in the operation of the separator, but it is also expected that there will be less upkeep, as the expenditure in wearing parts will be reduced to a minimum. The "Wolseley Clipkit" consists of a



FIG. 4—ELECTRIC CREAM SEPARATOR—WOLSELEY

neat geared motor, which can be worn on a leather pad strapped to the back of the operator, and which is connected to the clipping head by means of a flexible shaft. The motor can be supplied for any voltage from 6 to 250 volts, and will run either with direct or with alternating current, the motor being of the geared series-wound universal pattern designed to take a current of 60 watts. A built-in switch is fitted to the motor.

The equipment is earthed by means of a third wire in order to comply with the electricity regulations, and the motor shaft and hand piece are all carefully insulated. For light and easy handling a wrist joint is fitted to the clipping head, which is furnished

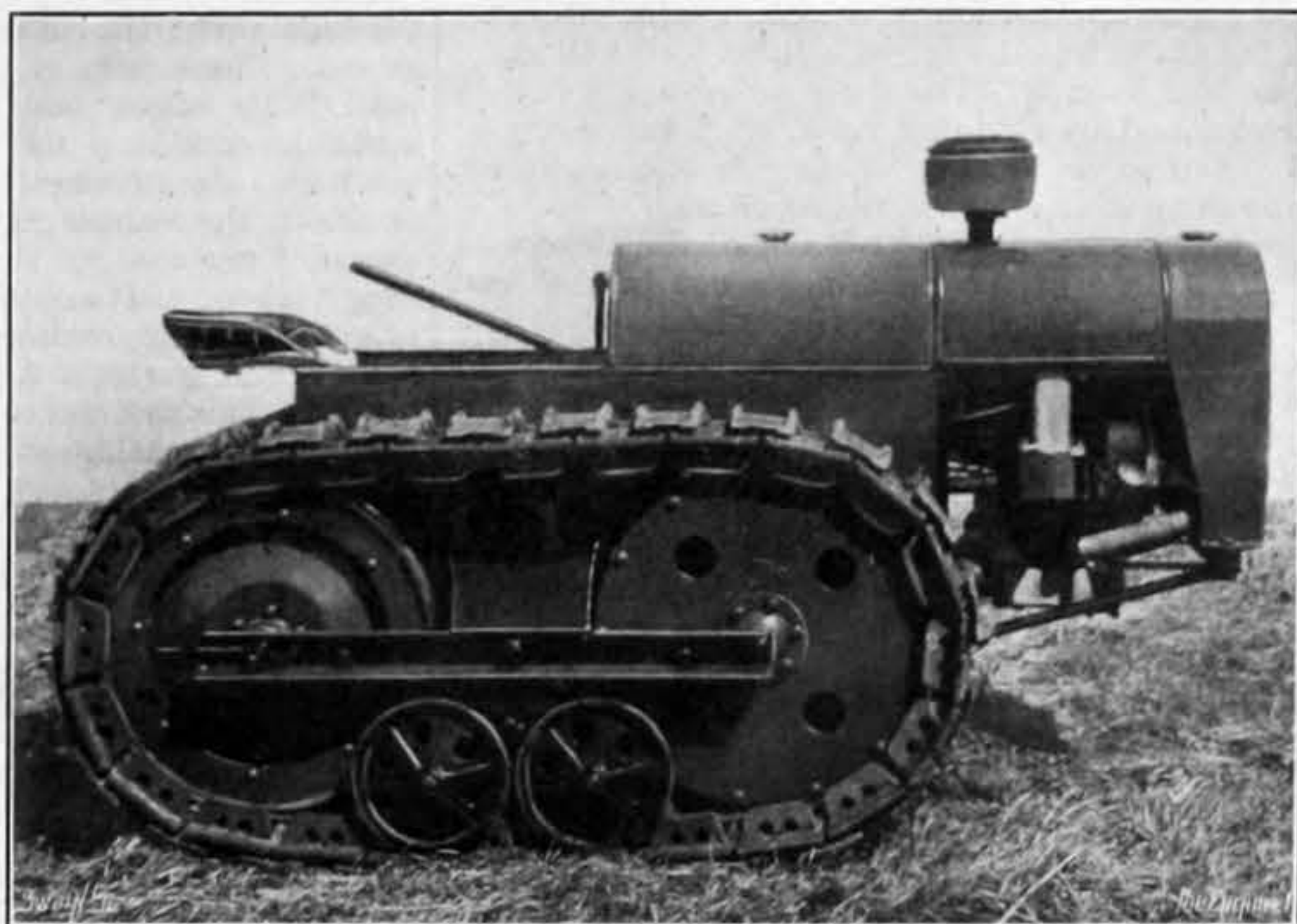


FIG. 3—PETROL-ENGINED TRACTOR—BRISTOL

parts of the country. In Scotland the Department of Agriculture has been authorised to make grants to owners and occupiers in order to assist them in the task of bracken destruction. It has been proved that if the young shoots of the plant be broken, a further weaker growth appears, which, if further bruised or broken, damages the root system of the plant. If the shoots be thus treated two or three times for two years, the plant is so weakened that it can be got rid of. The method applied by Captain Holt was to drag over the affected land one or more heavy iron or steel bars of square section, which were fitted with bearings and shackles to which horse traces were attached.

The implement shown on the stand at Wolverhampton will be of the double bar pattern, comprising two mild steel drag bars, each of 4½in. square section, with a length of 2ft. 3in., the bars being coupled together by chains in tandem fashion to give an effective width of 4ft. 2in. The drag bars are coupled by means of chains to a whippetree on the front or draught side, and on the rear side are tail weights, also attached to the bars by means of chains. The ends of the square bars are turned down so that a bearing is formed for the clips to which the chains are attached. In the chains coupling the bars to the whippetree a swivel link near the centre of the chain is provided in order to prevent any twist or strain being put on the chain when the implement is passing over rough ground. The front of the ash whippetree carries the trace chains for horse draught. These implements can be supplied with either 4in. or 4½in. square bars, according to the work to be done. The implement can also be arranged for either horse or tractor draught, and is made in various widths, being supplied from the 4in. single bar with a 3ft. cut up to 4½in. bars, each 2ft. 9in. long, in a five-gang arrangement, giving an effective cut of 12ft. 5in.

(To be continued.)

"THE SAID NOBLE RIVER."—To commemorate the Coronation, the Port of London Authority has published an illustrated book, price 2s. 6d., written by Alan Bell, on the Port of London. Whilst the volume is principally noticeable for its admirable pictures, there are many interesting chapters, both on the antiquities of the Thames and its present activities. Amongst them we might select "The Amazing Bridge," but all have a touch of romance, which will appeal to the ordinary reader, and none are without historical notes and entertaining quotations.

STEAM ROAD VEHICLE TARIFF.—On June 1st amendments to the Road Traffic Act came into force, designed to remove the disabilities which had previously resulted in the virtual disappearance of the steam road wagon. The amendments are understood to have been sponsored by the Coal Utilisation Council, with a view to obtaining once more a market which formerly consumed nearly half a million tons of coal per annum. The new regulations allow a four-wheeled steam wagon to operate with a gross load of 14 tons instead of 12 tons, as in the case of internal combustion engine lorries, which is tantamount to making the pay load the same. The six-wheeler is not so greatly favoured, since the increase is only 20 tons from 19, a figure insufficient to balance the increased weight of the steam vehicle.

Mosquito Control Engineering.

THE control of pest and malarial mosquitoes was begun some forty years ago. The average engineer to-day, however, knows comparatively little about developments in this field of engineering. That the problem is largely of an engineering nature there can be no doubt, for recent medical knowledge has not led to any solution other than by control of the mosquitoes themselves, and the conditions which are favourable to their existence. Engineers of many different kinds must concern themselves with this problem whenever constructional work is carried out in countries where climatic conditions lend themselves to the propagation of these pests and carriers of disease. A classic example of the necessity of

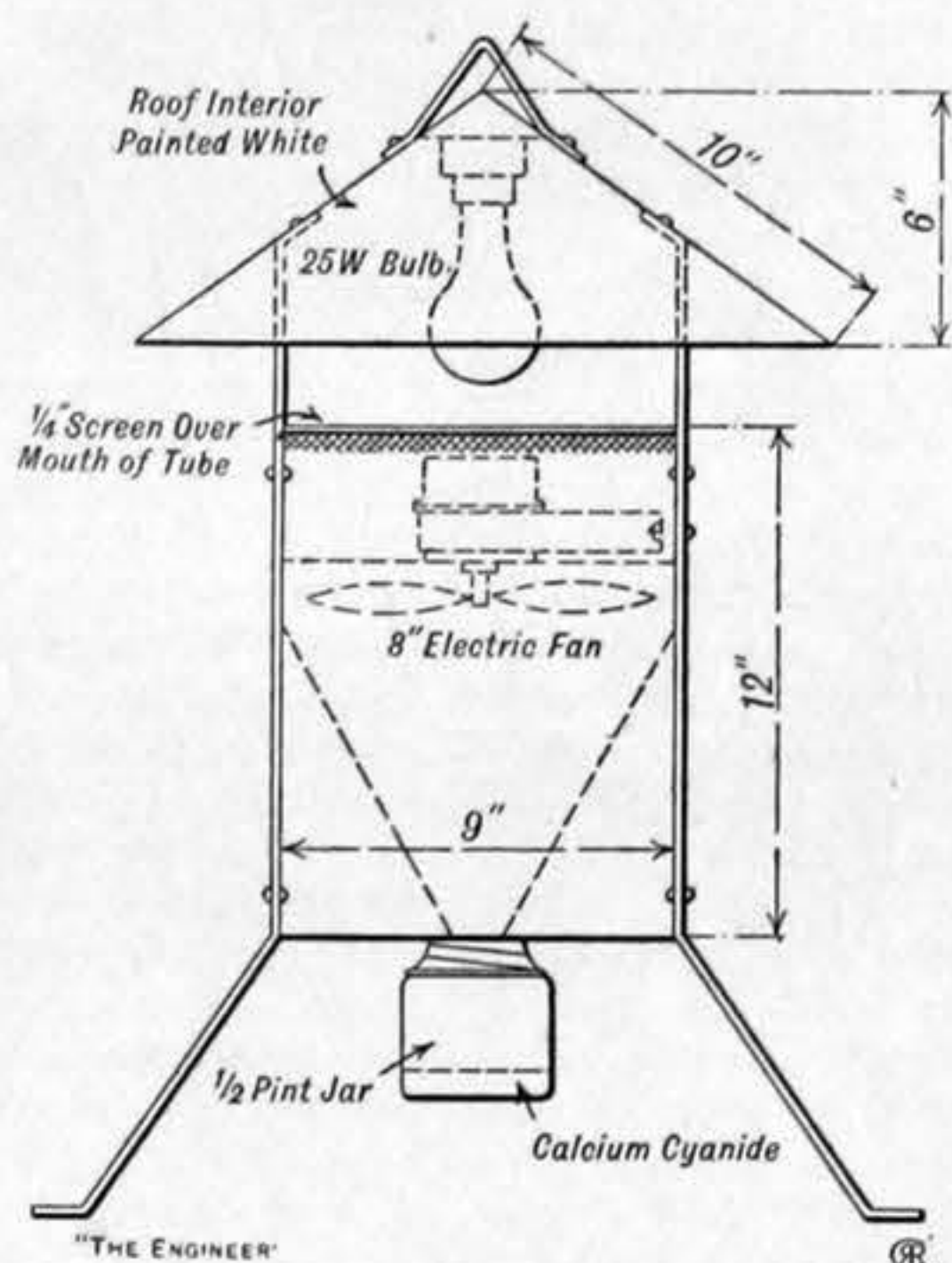
from this disease is not high, workers in a malarial region are rendered inefficient and enfeebled and consequently liable to other ailments. Some of the richest agricultural parts of the world cannot be properly exploited because of the ravages of malaria, and engineering works are frequently hampered because of yellow fever and malaria. When it became known that these two diseases were carried by mosquitoes, an anti-mosquito crusade was begun in all parts of the world. In order effectively to combat the menace a great deal of experiment and research was necessary. The first step was the study and classification of the numerous species of mosquito and their habitat—a problem which appears to be entomological, but which the engineer must study to some extent properly to understand the procedure of mosquito control.

All species of mosquito have four stages in their life cycle—the egg, the larva (or wriggler), the pupa, and the adult. If one of these stages can be eliminated by any practical means, the mosquito pest can be eradicated from the region in which it has been prevalent. Herein lies, however, the only similarity between the many species of mosquito. There is an enormous amount of variation in the habits, life history, and activity of different species. Some, under favourable conditions, fly as far as 65 miles from where they developed, others move only a few hundred yards. Some varieties do not bite man or domestic animals. Some species lay their eggs on moist soil, others only on water. Depending on

It is necessary to complete the survey by determining the local mosquito breeding places and identifying the species concerned. Correlation of the trap records and the survey of the breeding places will determine whether mosquitoes are immigrating from areas outside the region which it is proposed to control. If such is the case, the area under control will have to be extended to include the breeding places of the migrational species.

All mosquito control work is based on the fact that mosquitoes breed in water only. Consequently, all water which supports mosquito life should be eliminated or so treated that it will be incapable of supporting further breeding. The mosquito is most vulnerable in the breeding stage, and therefore it can be controlled most cheaply in this stage. The water for mosquito breeding must be at least $\frac{1}{2}$ in. deep; mosquitoes will not breed in clay pits or strong sewage; neither will fresh-water varieties exist in water of a greater salinity than 6 per cent.; nor will salt marsh mosquitoes exist in fresh water, unless the water is polluted. Water temperature is important and must reach a minimum of about 40 deg. Fah.—varying slightly with the species—before the eggs can hatch. Another necessary condition for breeding is that the water must be present for at least seven days and remain stagnant or slow moving. One of the chief natural enemies of the mosquito is the top minnow—a fish which eats the mosquito larva. The salt marsh mosquito is never very prevalent when members of the killifish group are present in the creeks and ponds forming tidal waters.

Breeding places may be classified as permanent or temporary. Temporary breeding places are often overlooked, as they constitute such receptacles as gutters, barrels, bottles, &c., but they are a source of a great number of mosquitoes, provided the water

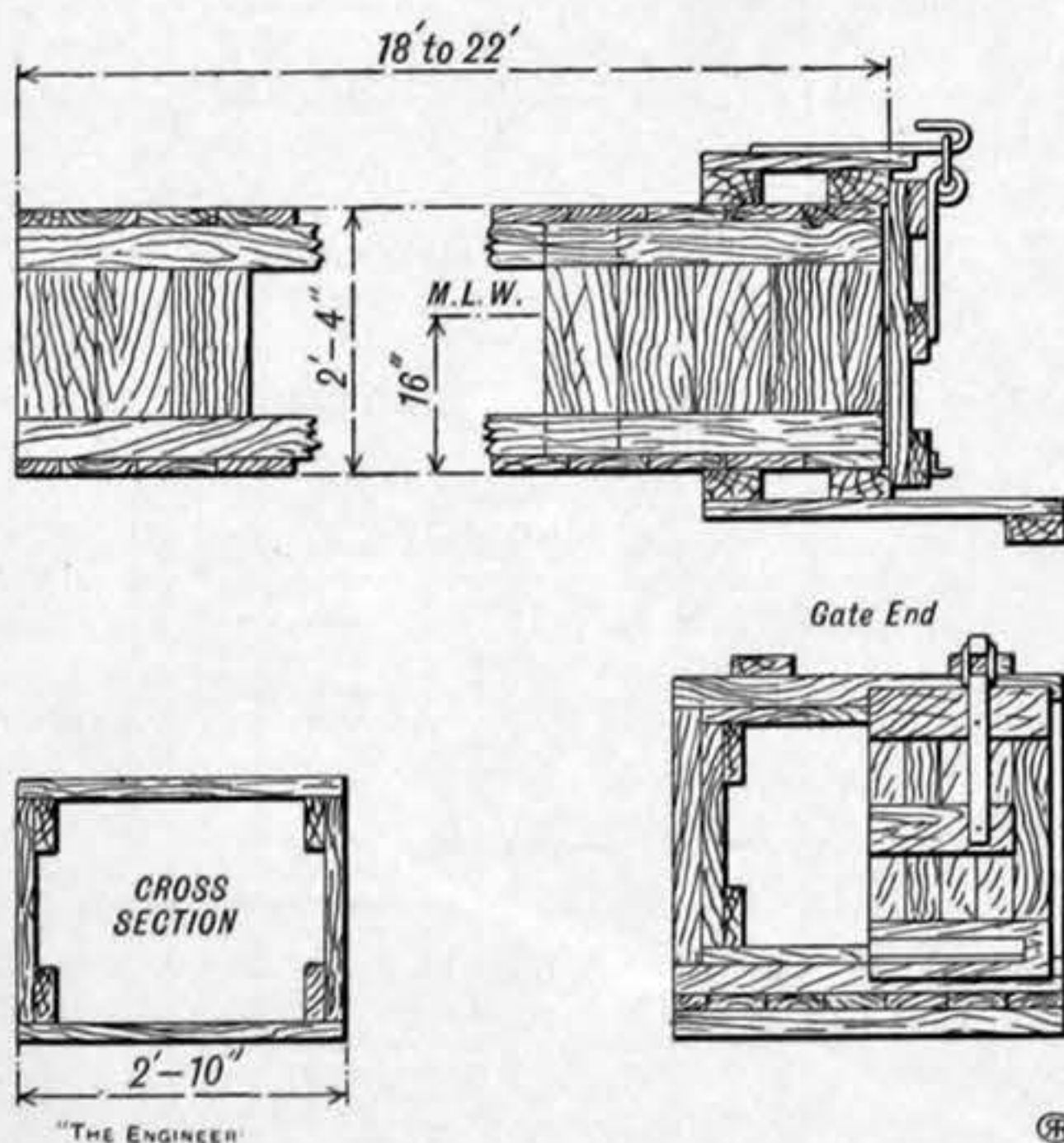


ELECTRIC MOSQUITO TRAP

effective measures being taken against malaria and yellow fever was provided during the construction of the Panama Canal, when the undertaking was finished only after the successful completion of a campaign to wipe out the mosquito peril.

There still is a tendency, however, to think of mosquito eradication or control as primarily a medical matter, or one of health inspection. Even where the control of mosquitoes is purely a matter of protecting centres of population from disease and annoyance, rather than that of permitting constructional work, the efforts which must be made are the responsibility of the engineer. Thus, the actual fact is that mosquito control is in every sense an engineering problem. Its engineering character is defined by the very nature of the operations which it involves.

The information contained in a series of articles



AUTOMATIC TIDE GATE

which has recently appeared in *Engineering News-Record* has been used as a basis for the following article. The series of articles, which is reprinted* in book form, was written by a group of recognised authorities on the control of mosquitoes in America, where the subject is one of rapidly growing public importance. It provides a concise and useful compendium of recent developments and makes the essentials of the subject available to the engineer.

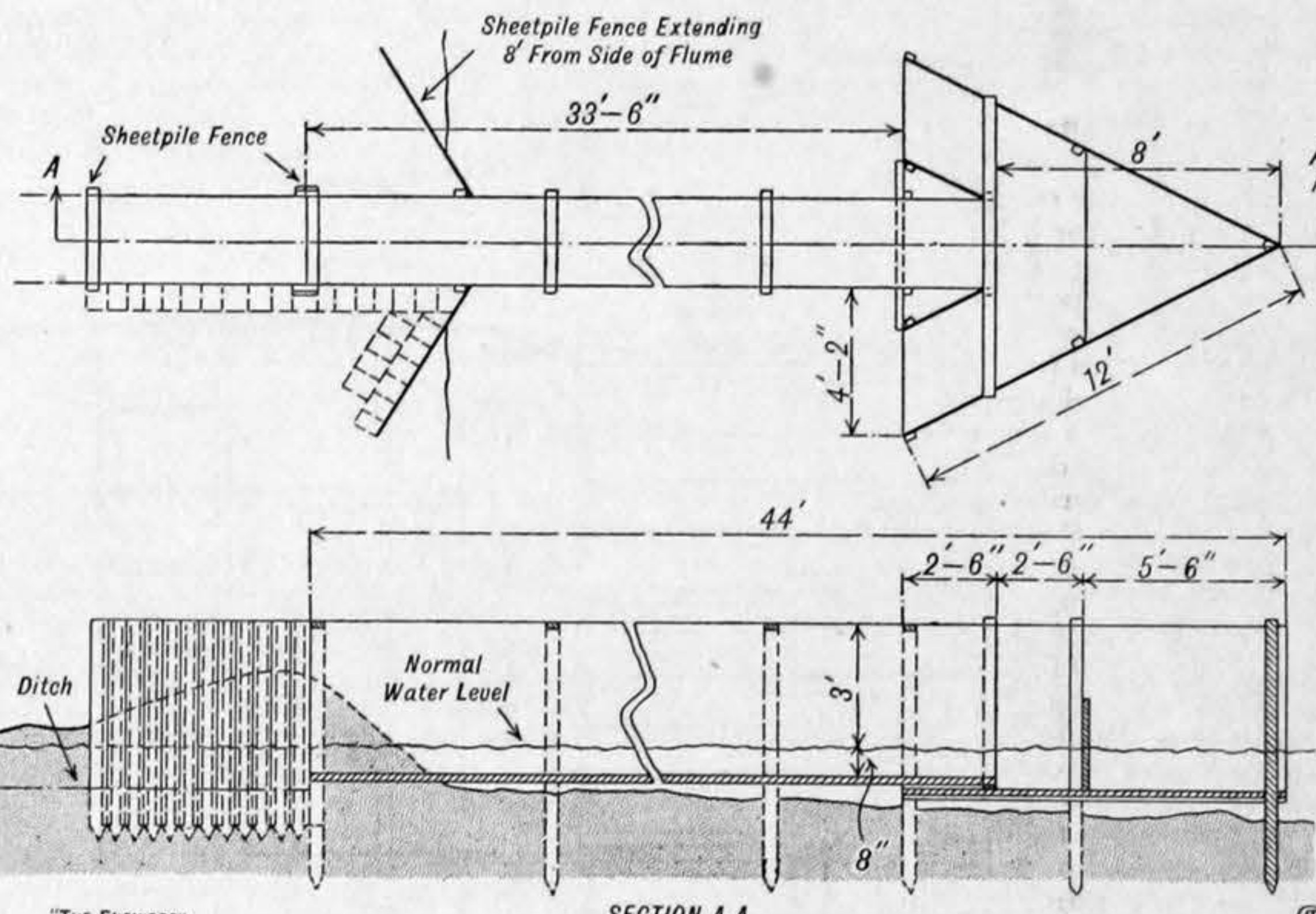
Less than forty years ago, mosquitoes were regarded merely as a nuisance, and it was not until 1898 that it was discovered that malaria is carried by certain species of mosquito. Malaria was extremely prevalent at that time, and, although the mortality

the species, they may breed on fresh, salt, or polluted water.

In North America there have been classified no fewer than 102 species of mosquito; however, only a relatively small number of these are of medical importance. It is very necessary for the engineer to know sufficient about mosquitoes to be able to identify species and obtain the relevant particulars of their habitat. This information is classified under the scientific name for the species in a large number of published works.

A necessary preliminary to any mosquito control work is a survey of the mosquito fauna characteristic of the area in which the work is to be undertaken. This survey should extend over at least one season, although more reliable results are obtained if the survey is carried out over two or three seasons. An experienced mosquito fighter, by making a survey of a given area, can estimate the types and numbers of mosquito there are likely to be, but this method is not altogether reliable.

In New Jersey a form of electrically operated mosquito trap has been developed, which is capable of sampling the mosquito fauna accurately. These traps, of which the construction is shown in our first engraving, are set up at the beginning of the season. They are set at a predetermined hour each evening throughout the season, and are in operation each night until the following morning. Each night's catch is then removed and identified and the results are carefully analysed. The traps, as can be seen in the engraving, depend on the use of an electric lamp and fan; the trapped insects are blown down into a jar containing calcium cyanide and are therein killed. The number of traps necessary depends upon the size of the area, the distribution of the human population, and the topographical features of the district. The greater the number of traps employed, the greater will be the accuracy of the survey. Fairly satisfactory results may, however, be obtained with only a few traps.



ARROW HEAD OUTLET CHANNEL

remains for seven days and the weather is sufficiently warm.

A mosquito abatement programme will vary with the size of the district and the problems encountered; but in general the fundamental principles will remain unchanged. First, there must be a definite amount of inspection to determine the situations of the breeding places and to provide weekly visits to these places during the breeding season. Then, where the breeding places are of a temporary nature, there must be regular treatment with larvicide and, finally, an engineering and drainage scheme must be instituted in order to effect the permanent elimination of as many breeding spots as possible.

The organisation of temporary control work, consisting of inspection and application of larvicides, will depend on local circumstances and the size of the region which it is necessary to protect. In many cases the only practical and economical method is to employ a gang of labourers equipped with spray cans to distribute the larvicide. In other cases, where the country is open and provided with means of communication, the larvicide solution can be pumped mechanically from lorries equipped with a tank, pumping machinery, and a length of hose. Slow-running streams, lakes, and other expanses of water can be treated by means of pumping larvicide from a boat. In the case of very large areas it may be found economical to use larvicide in the form of arsenical powders, which can be "dusted" on to the surface of the water from an aeroplane. All these methods of attack aim at destroying the mosquito larvæ as they feed on the surface of the water.

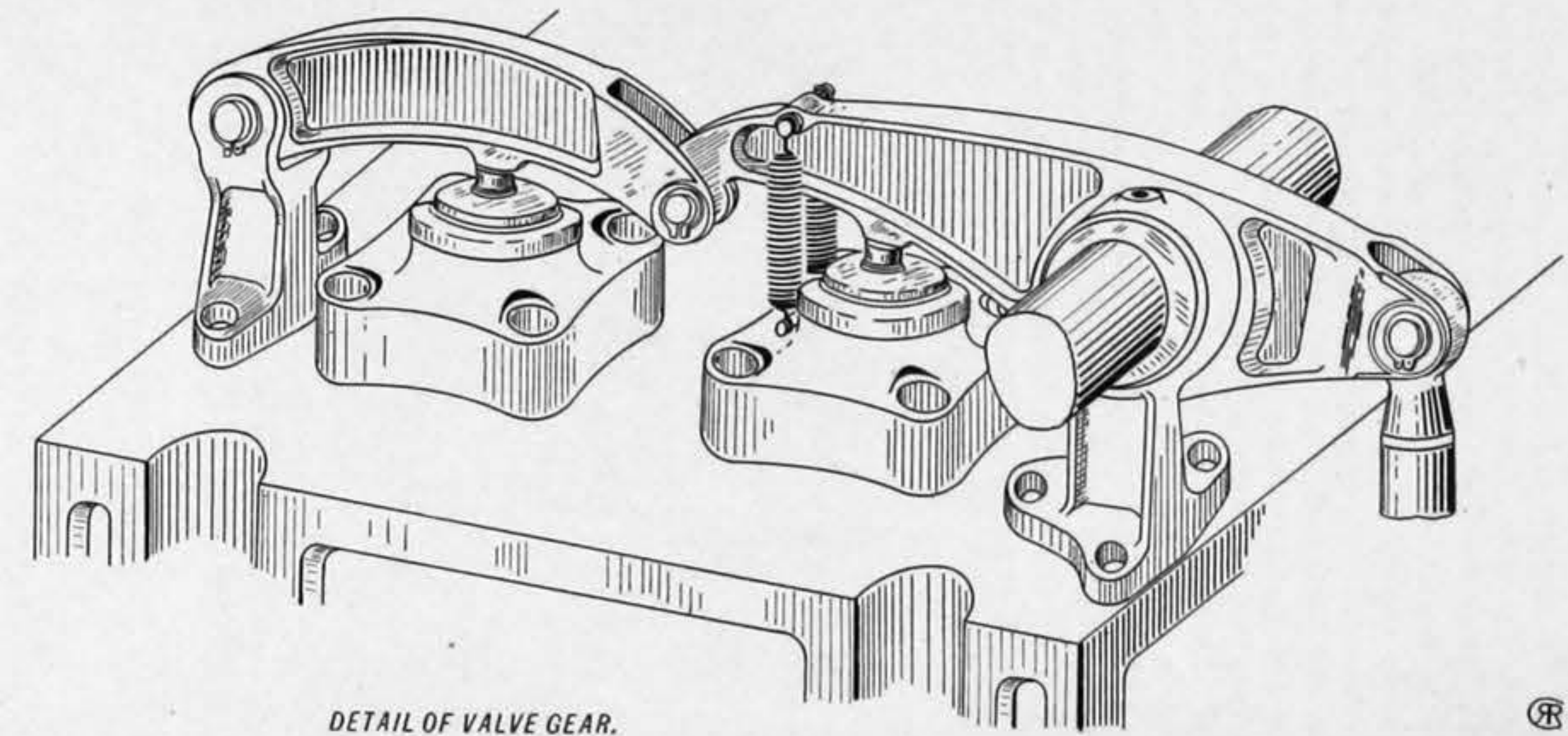
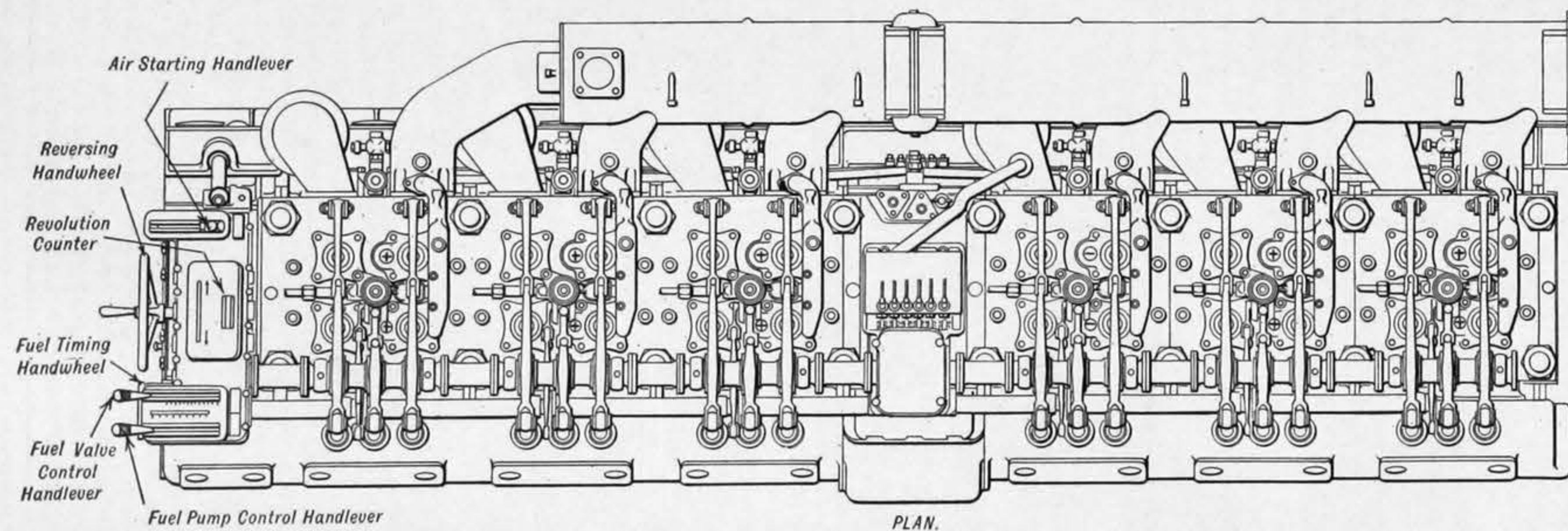
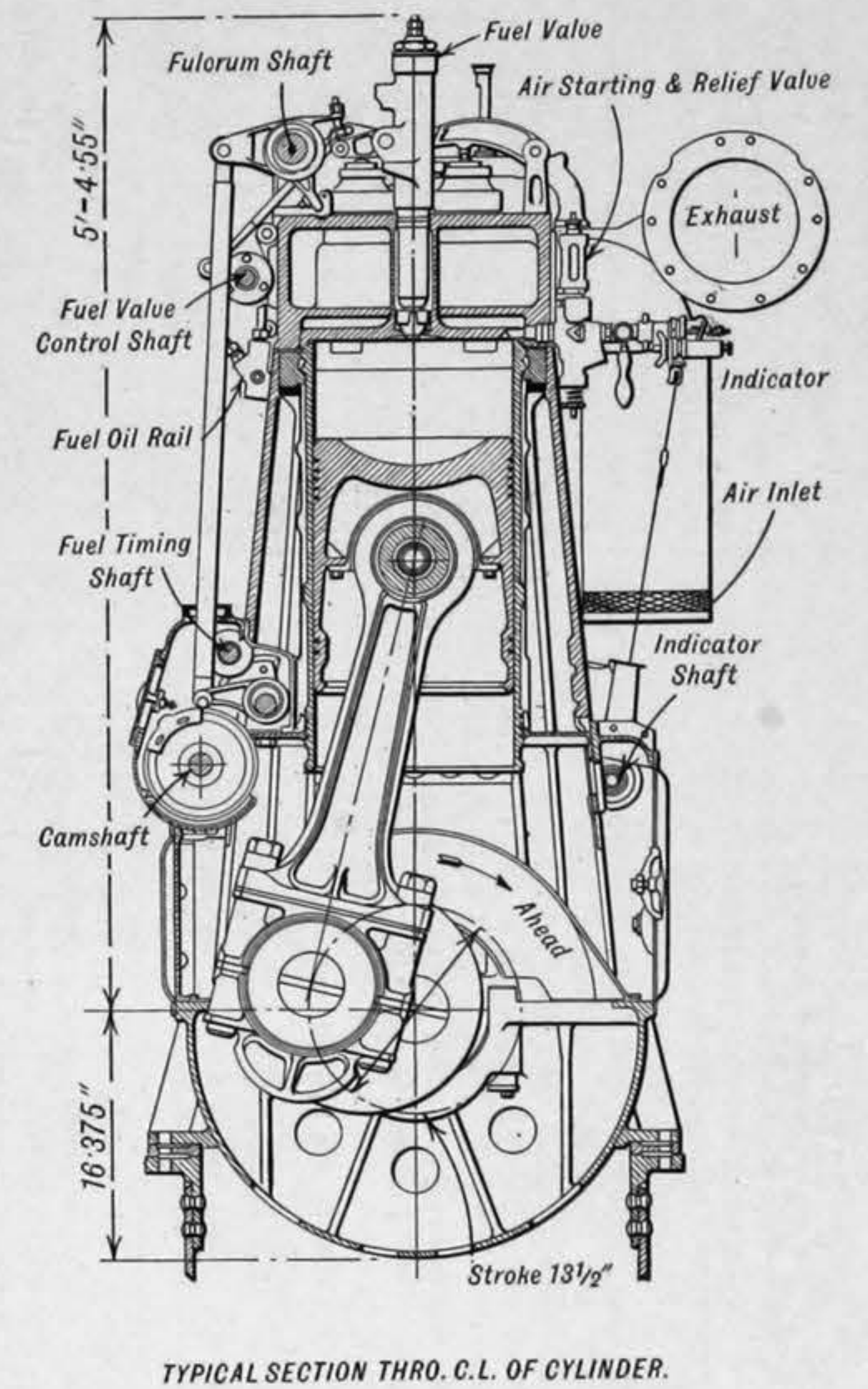
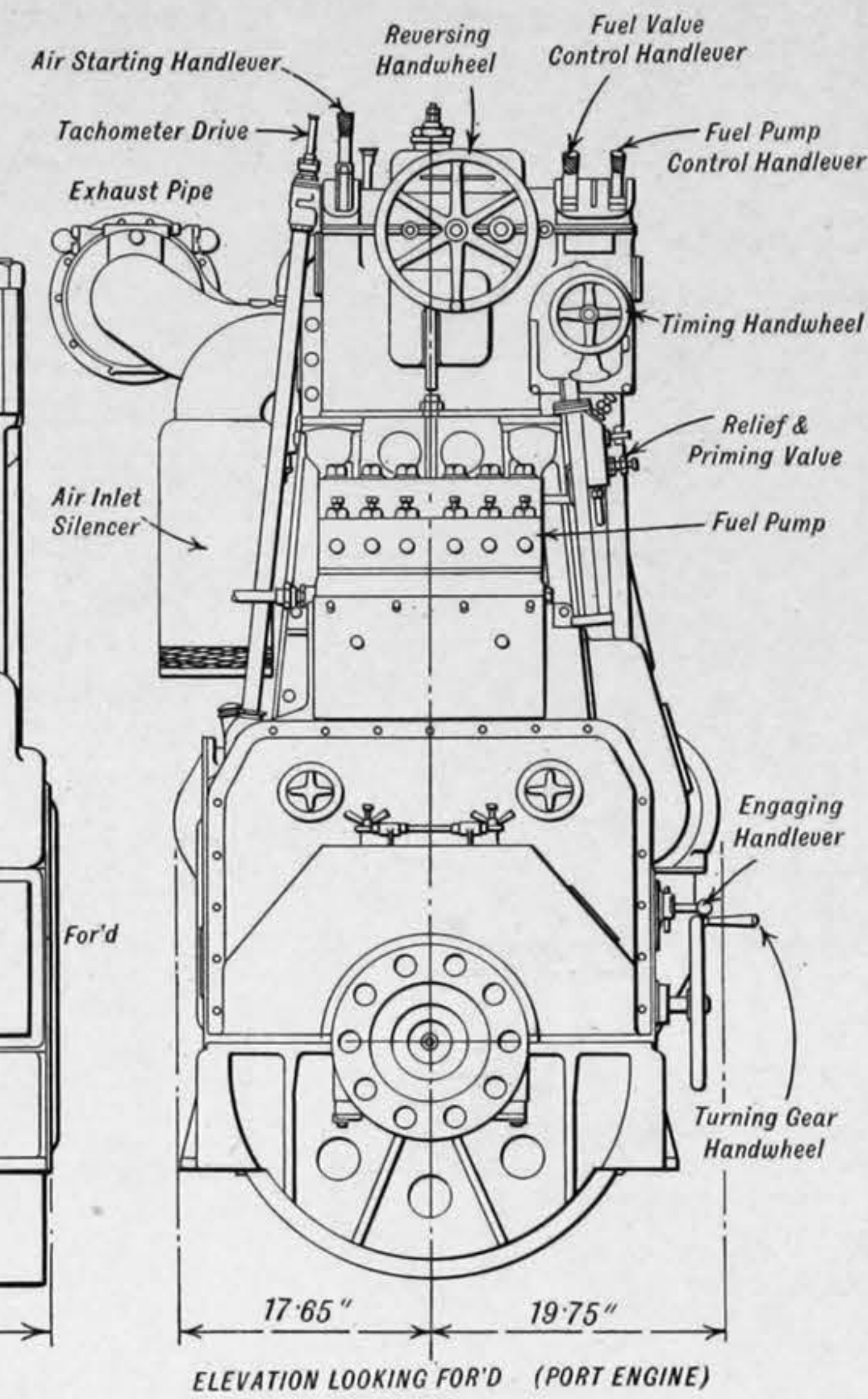
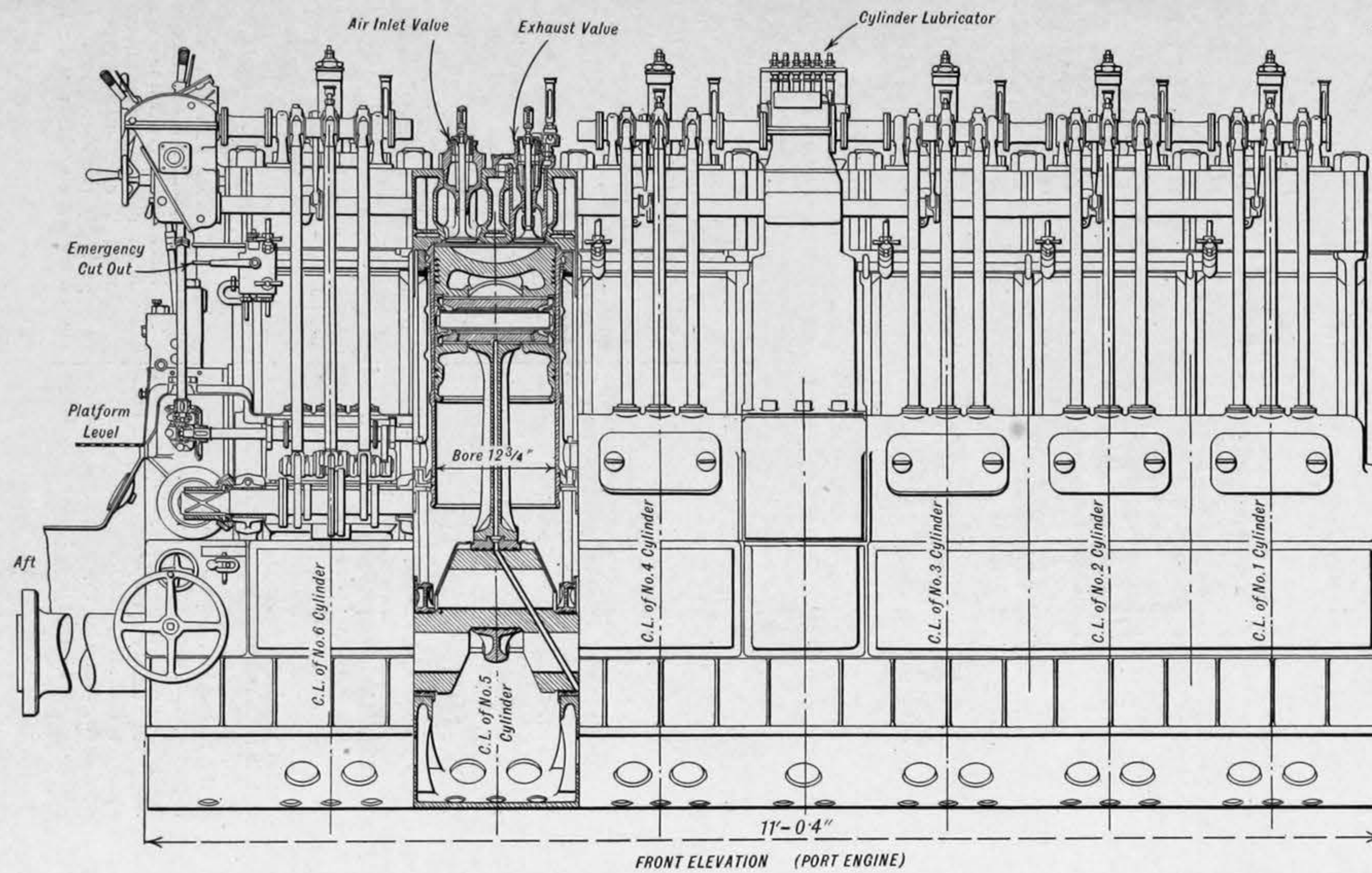
The larvicides in general use consist of either light fuel oils or solutions containing an oil extract of pyrethrum. The first-named group, in which paraffin oil is probably the best, provides a liquid larvicide. The oil chosen should be toxic to mosquito larvæ; the toxicity of a fuel oil is very nearly proportional to its volatility. Although oils can kill larvæ by suffocation, this will only occur provided that an unbroken

* "Mosquito Control Engineering." New York, *Engineering News-Record*, 1936. Price \$1.

600 B.H.P. LIGHT-WEIGHT OIL ENGINE FOR SUBMARINES

VICKERS-ARMSTRONGS, LTD., BARROW-IN-FURNESS, ENGINEERS

(For description see opposite page.)



film remains on the water surface for more than forty-eight hours. This condition is difficult to obtain in most cases, and therefore an oil such as paraffin, which has toxic properties, should be employed.

An oil solution of pyrethrum is frequently cheaper than fuel oils and the stock emulsion can be diluted with ten parts of water. The advantage gained by using a concentrated solution is that dilution can be carried out with water taken from the breeding area and therefore the operator need not carry so much larvicide as is necessary when using fuel oils. Fuel oils require an application of about 3 gallons to the acre and pyrethrum about 5 gallons to the acre, but the operator need only carry half a gallon of the concentrated solution for each acre to be treated.

A third form of larvicide is the arsenical dust larvicide—known as paris green—which frequently provides a more economical method of treatment. Paris green mixed with any diluting dust—preferably hydrated lime—can be liberated on the windward side of the breeding area when the wind conditions are suitable. Paris green can be distributed by any of the means named above in connection with oil larvicides, and in addition can be “dusted” from an aeroplane. A half to one pound of arsenical powder per acre is sufficient to destroy all larvæ on the surface of the water. In the quantity generally used it is not harmful to cattle, human beings, birds, or fish, nor does it harm water vegetation.

Permanent mosquito control work consists of draining water which is stagnant and liable to form breeding places. Such places are of various types, depending on the terrain, the rainfall, and whether inland or on the seaboard. The salt marsh mosquito lays its eggs in the mud at low tide and the eggs hatch when the highest tides reach them. Therefore the procedure for control is extensive drainage, ditch, and diking construction on salt marsh lands. Mosquitoes other than those found on salt marshes lay eggs on the ground, where water, such as pools caused by rain or melting snow, causes them eventually to hatch. In canal construction frequently the moist mud of fills dries and cracks in the dry season. The cracks form breeding places for mosquitoes when filled with rain. Permanent marshes do not necessarily form breeding places and in many cases fish may be depended upon for mosquito eradication in such marshes, especially if the central area in each pond be deepened and radial connecting channels be provided for other low spots, so that fish may easily gain access to them.

Constructional work of a permanent nature should proceed concurrently with the temporary measures and should be carried on as rapidly as possible. A salt marsh will only breed mosquitoes if it holds warm water, free from fish, long enough for the eggs to hatch. The drainage of such a marsh requires the ditching of the area so that surface water will fall below the marsh surface at low tide. Holes and ponds should be so connected that fish may readily enter them at all times. Ditches should be connected to natural creeks and outlets. If there are insufficient natural outlets wider main ditches will have to be constructed. Generally, a ditch 10in. wide and from 20in. to 30in. deep, with perpendicular smooth sides, will be found adequate. A parallel system of ditches for salt marshes is usually the most satisfactory, in which the area is divided into portions according to the natural outlets available, and each portion is crossed by parallel ditches. The ditches may be spaced about 300ft. apart and require to be cleaned every three years in large areas, or annually in smaller areas. When draining large areas it may be found more economical to use machines for ditching, such as the special machines used in New Jersey, which consist of a plough drawn by a tractor on wide caterpillar treads.

An enclosed marsh will require main dikes to be constructed, with automatic tide gates. This procedure will also be necessary where sewage polluted water—which generally stimulates breeding—empties into a marsh or where wind conditions hold the tidal water at a high level for several days. In other cases natural drainage has been interfered with by the construction of roads and railways, and a marsh may have sunk by as much as 3ft. or 4ft. In such circumstances an internal draining system with pumping equipment may be necessary and all tidal waters must be withheld.

Dike construction for excluding high tides should follow the installation of internal ditches. The dikes should generally be placed where they are not likely to be damaged by waves and storms and when calculating the height required an allowance for shrinkage of at least 25 per cent. should be made. In beginning the construction of the dike a trench is made along the centre line of the proposed structure and the excavated material is laid on each side of the trench with the grass ends outside. The width of the dike at the base may vary from 8ft. to 12ft., depending on the height of tide which must be excluded and the amount of storm action expected. The intervening space is packed with mud and then another layer of sod is built up in order to provide a slope on the sides of the dike. The construction is continued in this way until the width at the top is from 3ft. to 4ft., when the top is finished with mud filling.

Where automatic tide gates are necessary, the form of construction shown in an accompanying engraving may be employed. With this type, wooden flap gates

are built on the end of sluice boxes. A convenient size for the sluice box type has a 2½ft. by 2ft. opening. When additional cross-sectional area is required, they may be duplicated in the same bulkhead. When installing these gates timber must be used for shoring to support the box and to close the ditch at the sides and top of the box.

The disadvantage of using tide gates is that fish are excluded from the area and breeding of mosquitoes may take place in ditches which are not kept clean. This difficulty may be overcome by admitting a supply of unpolluted salt water, together with the fish contained therein, into the sides and back of the marsh during high tides. By this means a supply of water may be obtained for flushing the small internal ditches and for stocking them with fish.

The illustrations herewith also show the construction of an arrow-head outlet channel for a marsh ditch through a sandy shore. This type of outfall is used in the State of Delaware. It is claimed that the arrow head construction protects the outlet from silt. The wing walls on the shore are for the purpose of preventing erosion taking place.

In Delaware, air views are taken of the area which it is proposed to drain. These photographs are taken from an altitude of about 10,000ft., and enlarged to a scale of 800ft. to the inch. The views are then superimposed on a geological survey map to the same scale, from which information can be obtained for a general plan for a ditching system.

In New Mexico, an inland State, the population is grouped around rivers and irrigated valleys. Not a few of the mosquito-breeding sources exist because of the artificial expanses of water formed by engineering works in the shape of reservoirs, roads which interfere with the natural drainage, and reclamation works. When material is required for a road or canal embankment, it is usually “borrowed” from the nearest place. The borrow pits fill with water and form ideal breeding places.

In this State a narrow-bottomed ditch has been adopted, since this type increases the flow velocity and becomes more nearly self-cleaning. The banks

are made of a minimum slope of 1:1, though conditions sometimes make necessary more gentle slopes. A uniform gradient for the ditch is desirable, but not always possible to obtain. A maximum fall of 1 in 100 should not be exceeded, as erosion will probably occur. Where the natural slope is greater than 1 in 100, steps can be formed in the ditch to prevent the banks being washed away. In this connection it is helpful if the ditch is lined with rubble and stone, especially on curves or places where erosion is severe.

In many places the beds of the rivers are at a higher level than the surrounding valleys. Small marshes, which are below seepage level, must be filled, in the absence of any other form of drainage. If material is available, they can be filled level with the surrounding country, but if there is a scarcity of material, they need not be filled to a higher level than the seepage level. In either case a permanent eradication of the breeding place is obtained, without the necessity for maintenance work.

The successful completion of a programme for mosquito eradication results in several advantages, apart from the elimination of malaria and disease from a community. In regions where water is scarce, the water drained from swampy areas by means of ditches is available for irrigation. This water would have previously been lost by evaporation. Drainage ditches and filling operations reclaim much land for agricultural and other uses. In many places the drainage system serves as a flood relief measure and may save many acres of land from being inundated periodically. Provided the drainage is not severe, there is no reason why wild life should be affected. The drainage installed should only remove the surplus water. A good ditching system improves the circulation of water, lowers its temperature, and generally freshens the vegetation, besides allowing the existence of many fish which otherwise would not be present. Finally, the financial status of any community depends on the economic wealth of its surrounding territory, and a campaign to end fever will reflect itself in an increase in the wealth and development of the community.

A 600 B.H.P. Light-Weight Oil Engine.

ON a recent visit to the Naval Construction Works of Vickers-Armstrongs, Ltd., at Barrow-in-Furness, we inspected the drawings and designs of a new type of light-weight oil engine, which has been specially designed for small submarines in which weight and space must be economised. On page 10 and in the accompanying illustrations we illustrate a six-cylinder engine of this special type, which has been built and tested in the shops and at sea with very satisfactory results. In recent trials under nominal full power for submarine purposes an output of 600 B.H.P. at 500 r.p.m. has been maintained for long periods, and recent contracts have required a full-power trial of thirty-six hours' duration, the last two hours being run under overload conditions.

GENERAL DESIGN.

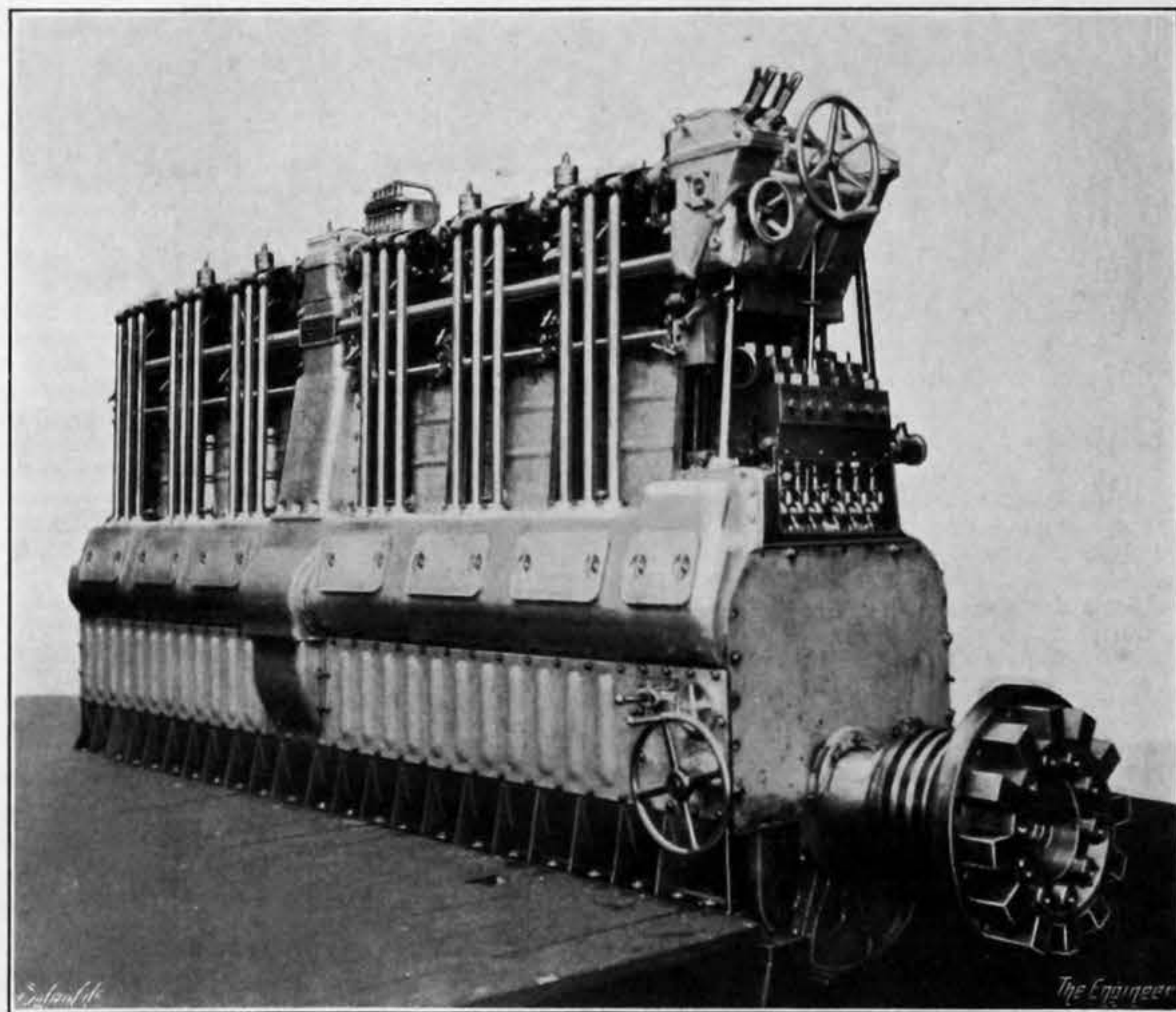
In designing this engine, an endeavour has been made to combine simplicity with rigidity, with the object of providing an engine which will be free from avoidable wear and any possible risk of derangement, while accessibility has been closely studied in order to render

periodical routine overalls an easy task. At the full speed chosen, namely, 500 r.p.m., the piston speed is low for high-duty service, and as the reciprocating parts are light this speed can be increased materially when the engine is used for yachts or for oil-engine driven generating sets.

The engine may be built as a six or eight-cylinder unit, and we illustrate herewith the six-cylinder engine. The cylinders have a bore of 12½in. with a stroke of 13½in., and operate on the four-stroke, single-acting cycle with the Vickers airless-injection system. The engine shown has a simple hand-operated type of reversing gear, but when not required this can be omitted. The lubricating oil pump and the water-circulating pump are both arranged for an independent drive, but, if so desired, can be engine driven.

DETAILS OF CONSTRUCTION.

As the sectioned drawings reproduced on page 10 clearly show, the bed-plate is of composite construction, the cast steel cross girders which support the crankshaft



FRONT VIEW OF SUBMARINE OIL ENGINE

bearings being welded into a steel plate trough to which the holding down flanges are in turn welded, these being supported by numerous stiffening ribs. The shells of the main bearings are of forged steel with bearing caps formed of two steel stampings welded together. Both the shells and the caps are white-metal lined, and each cap is secured to the cross girder of the bed-plate by four large bolts. The crankshaft, which is made of oil-toughened mild steel, is of large dimensions, and is hollowed out for lightness. Its rigidity is such as to enable most critical speeds to be harmless. It is made in two lengths joined with a coupling, on which is mounted the helical spur wheel for driving the cam shaft.

The column consists of two legs formed of steel stampings with cross plates welded between them, the unit so

bottom of which is welded a combustion plate of forged steel. They are bolted together and thereby form a continuous girder which rests on the top of the columns and is attached to them by large studs. As is shown by the drawings reproduced on page 10, each cover carries two inlet and two uncooled exhaust valves, which are housed in removable cages. The valves are made from special alloy steels. The neat arrangement of the valve-driving mechanism is clearly illustrated by the diagrammatic drawing at the bottom right-hand corner of page 10. The push-rods are hollow and carry large diameter rollers at their bottom ends. The cam shaft is driven by helical spur wheels, and the gears are force lubricated. The space around the cam shaft is in free communication with the crank case, but for additional lubrication an oil

that an efficient self-venting is obtained with the use of a minimum amount of piping.

The lubricating oil enters the crankshaft at the main bearings, and then passes up through the big ends and through the connecting-rods to the gudgeon-pin bearings. All the bearings and the wheels within the crank case are lubricated by direct-pressure leads. Most of the bearings for the levers and the valve motion are of the needle type, and where they are outside the crank case they are grease lubricated and require only attention at long intervals. A sight feed oiler placed at the centre of the engine lubricates the main pistons.

Other fittings calling for brief mention include the indicator gear arranged at the back of the engine and the turning gear. The main shaft of the indicating gear is so arranged that it can be readily disconnected once the engine has been adjusted, after which an occasional "pull" card, together with the exhaust thermometer readings, suffices to give all the data needed for efficient working.

The turning gear is at the after end of the engine and is of the combined worm and wheel pattern. Its hand wheel is situated close to the lever which engages the final spur wheel, an arrangement which is both neat and effective, and lends itself to the rapid turning of the engine when engaging a submarine clutch.

ENGINE PERFORMANCE.

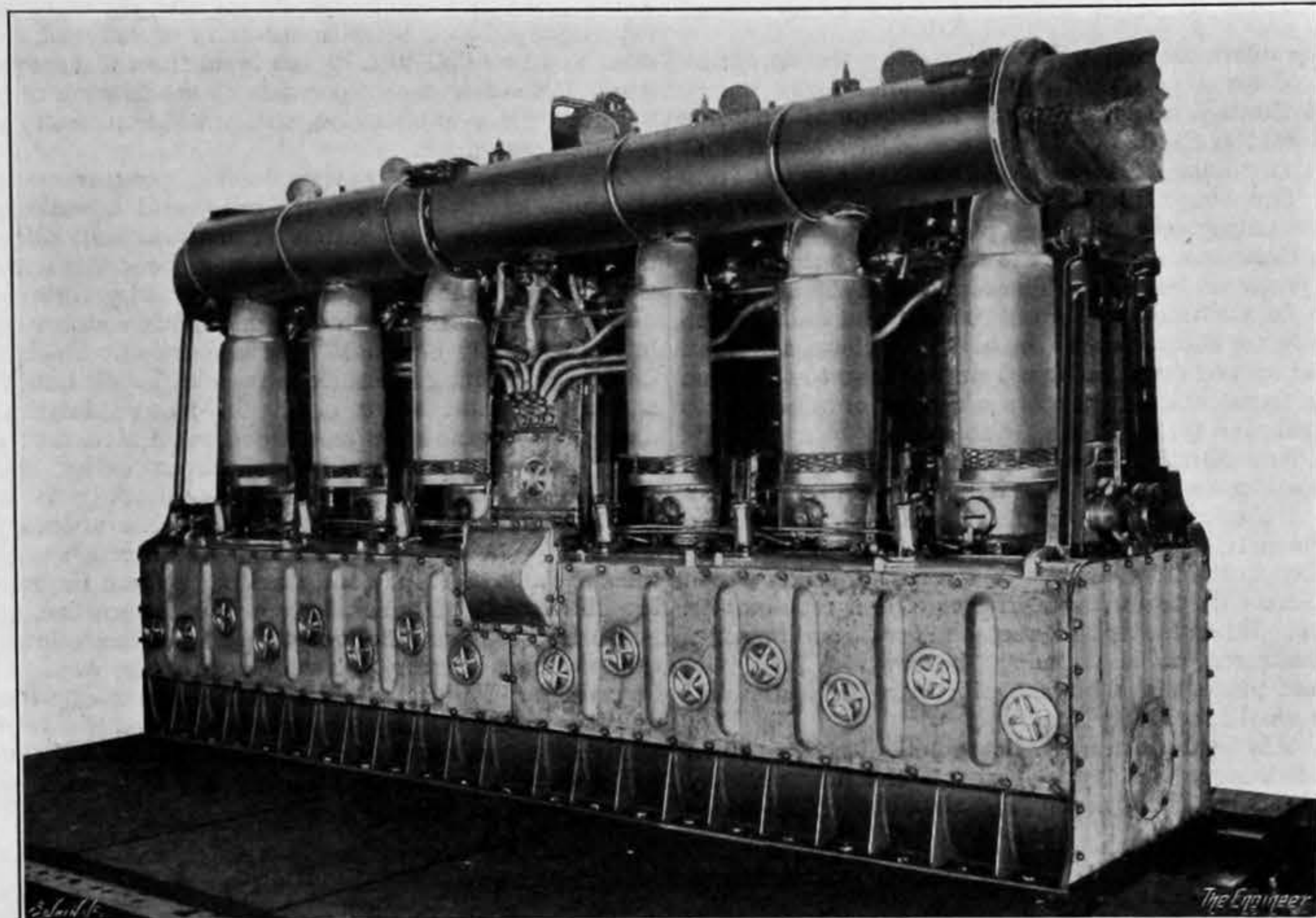
In the early part of this article we made reference to the general satisfactory performance of the engine. In the curves reproduced above we show the fuel consumption and the brake horse-power at various engine speeds. These figures are for a six-cylinder engine, and the fuel consumptions are an average of the trial results of a number of engines running under ship propulsion conditions as regards speed and power. The drawings reproduced show the overall sizes of the six-cylinder, 600 B.H.P. engine. The eight-cylinder engine, with a designed output of 800 B.H.P. when running at 500 r.p.m., has an overall length of 13ft. 11in., a width of 2ft. 10in., and a height of 6ft. 9in. These are small dimensions for engines of such power, and the weights are 8.2 tons and 10.5 tons for bare engines of the six and eight-cylinder sizes respectively.

SIXTY YEARS AGO.

A NOTE in our issue of July 6th 1877 stated that on May 8th of that year all the patents, with one minor exception, governing the manufacture of sewing machines had expired. Immense profits had been made in America out of the business. One company during the previous year had sold over 260,000 machines and had a sum of between ten and fifteen million dollars invested in its business. It was estimated that on each machine an overall profit, shared between the manufacturers, agents and canvassers, of 400 or 500 per cent. was made. The actual first cost of the machines sold by the leading companies at from 60 to 70 dollars was stated to be from 11 to 15 dollars. After paying royalties and commissions to agents and canvassers the manufacturers retained about 80 per cent. of the profits but out of that sum they had to meet the expense of maintaining their factories, paying taxes and meeting the immense costs of the litigation which had marked the early days of the sewing machine industry. Among the patents which had expired was the Batchelder continuous feed which substituted a cylinder for the ratchet and wheel feed of Howe's original machine. The continuous feed remained an essential feature of every sewing machine whatever its make. It was stated to have earned a profit of four million dollars for its inventor. The patent had been twice extended to the enormous advantage of the Singer, Wheeler and Wilson, Grover and Baker and Howe sewing machine companies. Outside this combination other companies had to pay royalties for the use of the invention of from one to three dollars on each machine. Following the expiration of the patents there was a great fall in the retail prices of sewing machines. The four combine companies announced that the cost of their 60 and 70-dollar machines would be reduced to 18 and 22 dollars respectively. Farther reductions would possibly be made owing to the dissolution of the combine and because of competition from Canada. It was anticipated that this reduction in price would not only benefit the public but by weeding out the weaker companies would establish the stronger concerns on a more profitable basis than ever. The sewing machine business in England, our note concluded, had not been thriving lately; indeed the trade had been "rather disastrous." A crisis had now been reached of which the issue at the moment was very doubtful. It was however suggested that from the extinction of the monopoly nothing but advantage would arise and that a greatly increased business would result.

"A VERY LARGE PLANING MACHINE."—We have been asked to state that the machine described under the above-named title in our issue of June 18th was supplied to the order of the Davy and United Engineering Company Ltd.—formerly Davy Brothers Ltd. of Sheffield—and that it is one of many large tools which the firm is installing in connection with the extensions to its Darnall plant.

THE LATE MR. JOHN W. MELDRUM.—It is with regret that we have to record the death of one of the oldest mechanical engineers in the country, Mr. John W. Meldrum, the joint managing director of Meldrums Ltd., of Timperley, near Manchester. He joined the firm in 1886, when the works were in City-road, Manchester. His brother, Mr. James Meldrum, had started the works, then manufacturing steam jet apparatus, such as acid elevators, compressors, ejectors, &c. The works were moved out to Timperley in 1902. The steam jet blower formed the basis of the "Meldrum" forced draught furnace. It was then applied to the burning of refuse in conjunction with the "Meldrum" continuous grate destructor, which was the basis of modern destructor practice. It is also applied with great success to mechanical stokers. Mr. Meldrum, who would have been eighty-seven on June 26th, was at the works, as usual, within a few days of his death, which took place whilst on holiday in Scotland.



REAR VIEW OF SUBMARINE OIL ENGINE

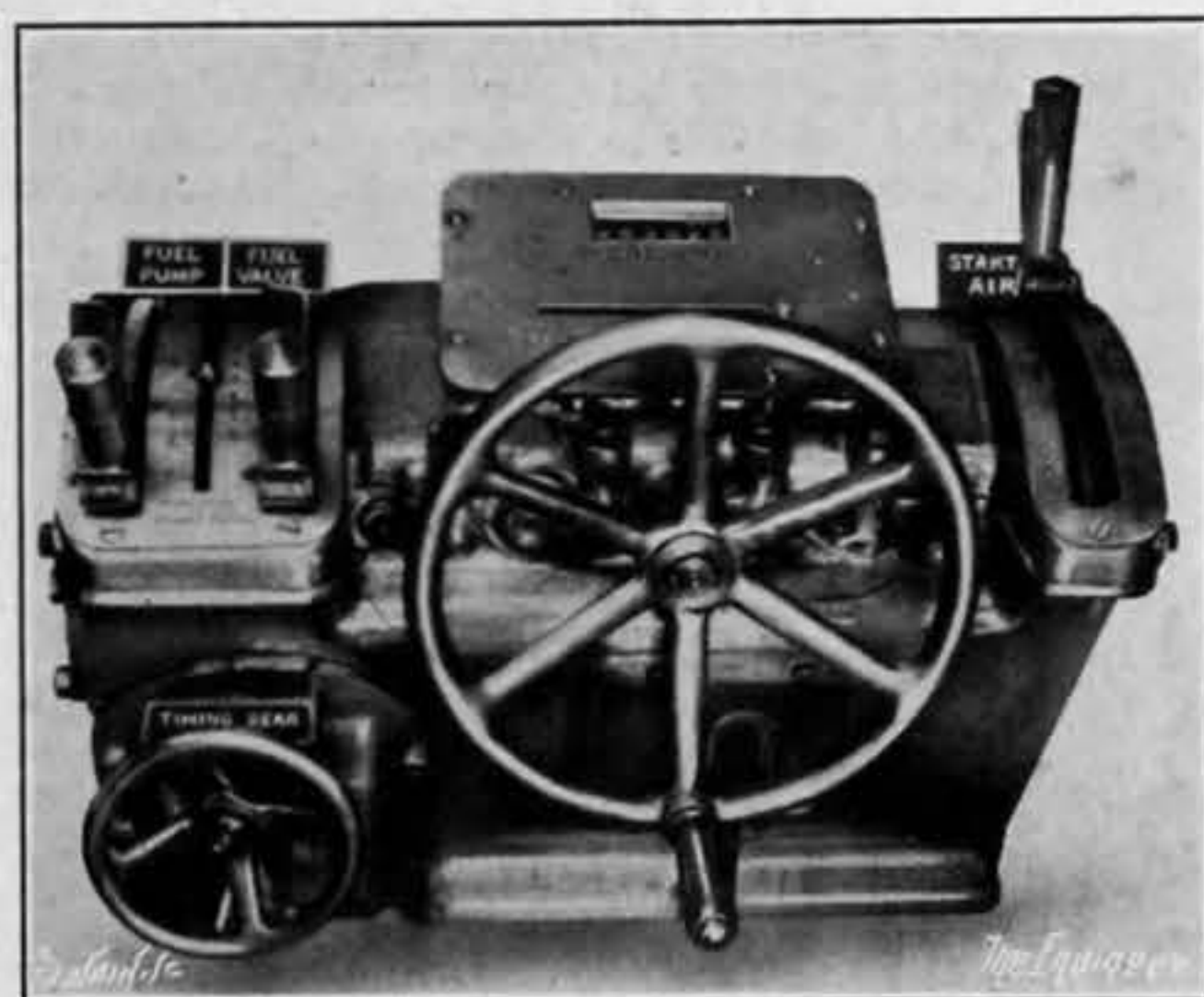
formed spanning the main bearings. The feet of the columns are bolted to the cross members of the bed-plate. This form of construction, while being both light and stiff, is so contrived that the combustion load does not pass through the welded portion of the structure. The cylinder liners are machined all over and are made of special steel. A departure from normal practice is the holding up of the liners to the under face of the cylinder cover by means of a forged steel ring of deep and stiff section to the underside of which the sheet steel water jacket is attached. By adopting this design it is possible to employ a liner of simple shape, having a well cooled top flange, which is not subjected to the holding-down load on the cover. The water joint is quite independent of the gas joint, and is so arranged that water cannot leak into the cylinder space. At the bottom the liner is guided by passing through the plate which forms part of the crank case. It may be noted that the

tray is fitted below the cam shaft, into which the cams dip.

The fuel pump, as will be seen from the above engraving, is mounted at the end of the engine, and is driven off the end of the cam shaft. There are six pump units housed in a single forged steel block, and the pumps deliver into a common fuel rail from which leads to the mechanically operated fuel valves are taken. The fuel valves work in stamped steel bodies; they are provided with ground guides, no soft packing being needed. At the lower end of the fuel valve is a very fine wire-wound Lolos filter, which renders the fuel nozzle practically free from the risk of choking, is fitted.

CONTROL ARRANGEMENTS.

The control gear, which is shown in the accompanying engravings, is mounted in one group at the end of the engine. It comprises the fuel pump, the starting air controls, and the reversing gear. The output of the fuel pump is regulated by the hand lever on the left of the control unit. The next lever controls the period of opening of the valves, the timing being automatically adjusted

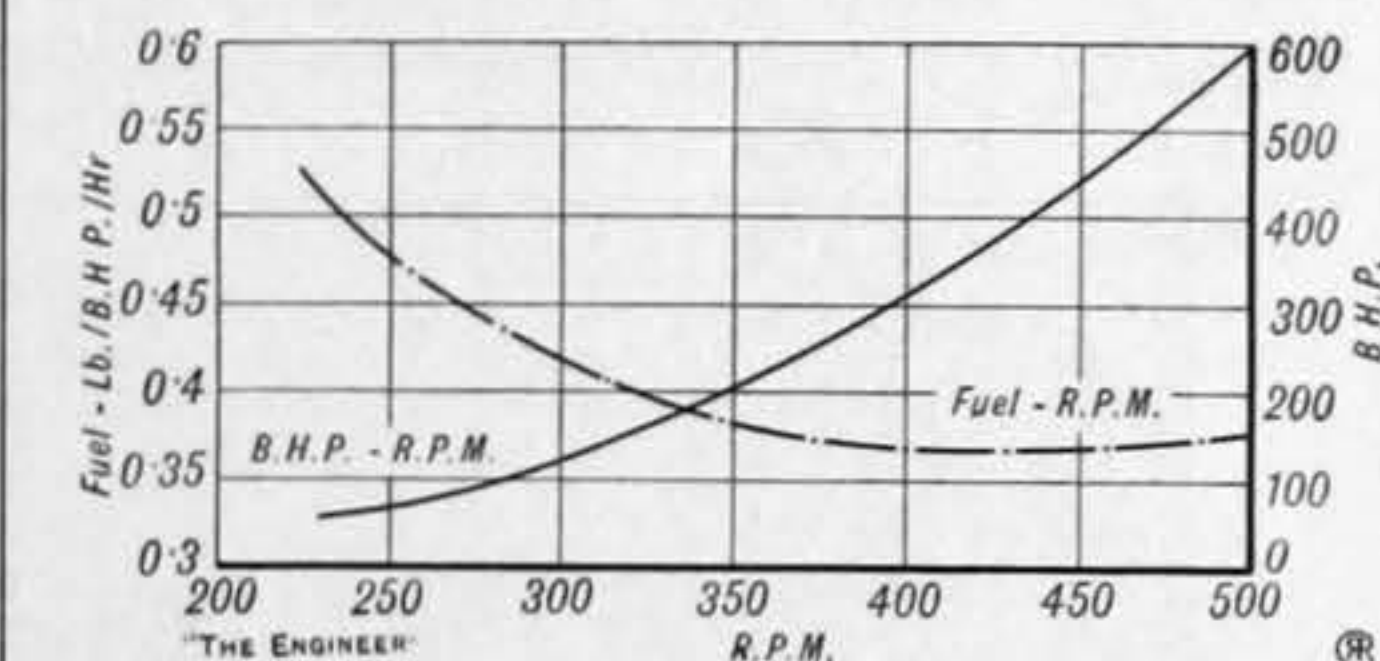


OIL ENGINE CONTROL GEAR

water joint is outside the crank case, thereby avoiding any possibility of contaminating the oil within the crank case by water leakage. The connecting-rods are of forged steel of approximately "H" section. They are machined on the profile, and are drilled for the passage of lubricating oil. The big-end bearings are formed of steel stampings and are particularly stiff in structure. They are attached to the palm of the connecting-rod by four bolts of large diameter. A hollow gudgeon pin is adopted, and it is of the floating type, being free to rotate in the chilled bronze bearings, which are pressed into the solid eyes of the connecting-rod and the piston bosses. Special care has been taken to prevent oil leakage at the ends of the gudgeon pins, while just over it there is an aluminium guard which prevents any oil from the crank case reaching the ribbed underside of the crown of the piston.

The piston is of the plain trunk pattern, and is a one-piece casting of special cast iron. It carries five narrow pressure rings, and two scraper rings, which are slightly wider and are positioned near the bottom of the piston skirt.

The cylinder covers consist of steel castings, into the



PERFORMANCE CURVES

to suit the duration of opening as set by the lever. The small hand wheel below the levers allows the fuel injection to be further advanced or retarded to meet special running conditions or when abnormal fuels are being used. The lever on the right of the group admits starting air to the engine. The distribution box is placed at the back of the engine. In it there are separate cam-operated valves for the cylinders, distributing the air in correct sequence to the non-return valves on the cylinder covers. On each non-return valve there is a cylinder relief valve and also an indicating or pressure release cock.

The large hand wheel on the control unit, which is interlocked with the control levers, reverses the engine by raising the push-rods, sliding the cam shaft along to bring the second set of cams under the push-rod rollers and then lowering the push-rods. This operation is carried out very rapidly by hand power alone.

LUBRICATING OIL AND CIRCULATING WATER.

The cooling water for the engine, which is supplied by a separate pump, enters the bottom of the cylinder jacket and passes up outside the liner to the hollow securing ring and through to the cylinder by four passages which are easily accessible. It then passes over the face of the combustion plate to the centre of the cylinder cover, where it rises and passes through the exhaust valve cages to the exhaust manifold. All the water passages are large, and the circulating water system is so designed

Rail and Road.

NEW AUSTRIAN ELECTRIC STOCK.—Two new designs of electric rail coach are being tried by the Austrian State Railways. One is an eight-wheeled high-speed passenger coach, the other a light parcels van. Two vehicles of each pattern are on test.

MANIFOLD VALLEY LINE: CORRECTION.—In our note on the Manifold Valley Line in this column last week, we said that it had been presented to the Staffordshire County Council by the London and North-Eastern Railway Company. This, of course, should have read the London, Midland and Scottish Railway Company.

PARIS-LE MANS ELECTRIFICATION.—The electrification of the 132½ mile section from Paris to Le Mans of the Paris-Brest line has now been completed. The current is supplied at 1500 volts as D.C. from thirteen automatic converting stations using mercury arc rectifiers. The stations receive current at 90,000 kV from an overhead supply running for the most part alongside the track. Two three-phase circuits of six conductors are carried on the masts.

DELAY ON PONDERS END LINE.—On Tuesday last, June 29th, a large dump of old rubber tires on the premises of the Lipton Tyre and Rubber Works, near the railway arch at the bottom of Broad-lane, Tottenham, caught fire. As a result trains on the L.N.E.R. line from Ponders End to Liverpool-street were delayed owing to the dense smoke. Up to 9.10 a.m. all trains were run past the store at caution, but after that time traffic had to be stopped for a period of nearly fifty minutes.

A ROAD SCHEME IN NORTHERN RHODESIA.—At the opening of the Legislative Council of Northern Rhodesia, on Saturday last, June 26th, the Governor, Sir Hubert Young, stated that a surplus of £500,000 was expected. He indicated that he was prepared to agree to provide funds for the construction and maintenance of a road linking Salisbury, the capital of Southern Rhodesia, with Lusaka, the new capital of Northern Rhodesia. The new road has been made possible by the proposed erection of a bridge over the Zambesi at Chirundu by the Beit Trustees, work on which will commence shortly.

NEW L.N.E.R. LOCOMOTIVE.—On Monday, June 28th, the new L.N.E.R. locomotive, "Union of South Africa," was named at King's Cross Station by Mr. C. T. de Water, High Commissioner for South Africa; the locomotive "Dominion of New Zealand" was named at the same time by Mr. W. J. Jordan, High Commissioner for New Zealand; and the locomotive "Empire of India" was named by Sir Firoz Khan, High Commissioner for India. A sister locomotive, the "Dominion of Canada," has been fitted with a Canadian type whistle. The "Union of South Africa" is also fitted with a whistle of Colonial type, the pattern used being that of the South African Railways. The other locomotives of this group of five, which includes the "Dominion of Australia," have standard L.N.E.R. pattern whistles.

"ALL-STEEL" COACHES IN ACCIDENTS.—We notice that at least one London newspaper has used the circumstances of the accident which occurred on the Southern Railway at Swanley last Sunday, June 27th, as an occasion for reviving the demand for "all-steel" coaches. It therefore seems appropriate to remark that in Colonel Mount's report on the Battersea Junction accident on April 2nd the company's chief mechanical engineer is quoted as having expressed the opinion that had the bodies of the two coaches which collided afforded greater resistance, as, for example, by being of all-steel construction, the increased rigidity might have resulted in derailment and the throwing about of the coaches in star formation. It was fortunate that there was no derailment for the collision took place on a viaduct. Colonel Mount himself contends that the right policy is to continue to direct available resources towards the prevention of accidents rather than towards minimising their effects.

NEW LOCOMOTIVES FOR INDIA.—Some new 4-6-2 "X.P." type locomotives are being built by the Vulcan Foundry, Ltd., for the Great Indian Peninsula Railway. A number of features new to this type of engine are being incorporated with a view to finding a design suitable for long mileages in express passenger work between overhauls. The new engines have two outside cylinders driving the middle pair of coupled wheels. One of the engines has been fitted with Timken and the other with S.K.F. roller bearings. The cylinders are 21½ in. diameter by 28 in., and other leading dimensions are: Driving wheels, 6ft. 2 in.; driving wheel base, 13ft. 2 in.; total wheel base, 36ft. 10 in.; overall length of engine and tender, 76ft. 8 in.; total heating surface with superheater, 2289 square feet; grate area, 45 square feet; boiler pressure, 210 lb. per square inch; weight of engine and tender in working order, 173 tons fitted with S.K.F. bearings, and 173 tons 2 cwt. 2 qrs. fitted with Timken bearings.

ACCIDENT TO THE IRISH MAIL.—A note in this column in our issue of April 30th last referred to the inquiry into the accident to the Irish Mail train at Crewe Station on April 14th. It will be recalled that in his evidence Mr. Spinks, of the London, Midland and Scottish Railway, said that he found the leading axle of the trailing bogie of the kitchen car broken off flush with the left-hand wheel and that he had subsequently found that there was a flaw in the axle. In the conclusion of his report on this accident, which was recently issued, Colonel A. C. Trench says: "This accident was caused by a broken axle, the fracture being due to a fatigue flaw which had grown till it extended over about 65 per cent. of the area; the flaw probably commenced with corrosion, or possibly a tool mark on the edge of the wheel seat, and the final fracture may have been due to the shock which occurs when traversing an abrupt diamond crossing. The flaw was in a position where it would be almost impossible to detect it in either running or shop examination, unless the wheels were pressed off. The metal of which the axle was constructed was of good quality and complied with the latest specification. The company are taking steps to reduce still further the liability of similar failures, which are already rare."

Miscellanea.

LONDON CHAMBER OF COMMERCE.—After three years' service as President of the London Chamber of Commerce, Sir Stephen Demetriadi has retired. At the annual meeting of the Chamber Sir Alexander Gibb was elected President.

EXPORT OF WELSH COAL.—Shipments of coal from ports in South Wales during the last week amounted to 468,000 tons, a figure 36,200 tons higher than that of the previous week and 168,669 higher than that of the corresponding week last year. This is the highest level recorded since the week ended January 22nd, 1932.

ELECTRICAL TUNING OF MUSICAL INSTRUMENTS.—It is reported that an electrical apparatus has been designed by O. N. Kasatkin and constructed by the Electro-Acoustics Department of the Institute of Research of the Soviet Musical Industry, operated on A.C. to tune by sight such instruments as harmoniums, accordions, &c., during manufacture.

THE INSTITUTION OF GAS ENGINEERS.—On Wednesday, last, June 30th, Mr. J. R. W. Alexander relinquished the secretaryship of the Institution of Gas Engineers to take up the appointments of general manager of Associated Gas and Water Undertakings, Ltd., and general manager of the East Surrey Gas Company. He will be succeeded by Dr. W. T. K. Braunholz.

SOUTH AFRICAN MINING.—Since the setting up in 1913 of the Prevention of Accidents Committee in South Africa the figures for deaths in mines, recently published for the period 1912 to the present time, are almost half that of previous similar periods. These figures are the more significant in view of the increased depth of mining and of the many inexperienced employees engaged during the period of expansion.

YORKSHIRE COAST ELECTRICITY SUPPLY.—A report from Messrs. Preece, Cardew and Rider and Mr. A. Collins on the possibilities of closer union between the electricity undertakings of Scarborough, Bridlington, and Whitby, in accordance with the recommendations of the McGowan Report, has been received by the councils concerned. It was agreed to form a joint board for the distribution of electricity within the areas of the undertakings concerned or in any other area considered advisable and agreed to by the Electricity Commissioners.

A NEW RUSTPROOF PAINT.—A new rustproof paint for which a number of advantages are claimed has recently been put on the market by Thos. Parsons and Sons, Ltd. The new paint is formulated on a chlorinated rubber base and is known as "Rust Eater." When applying the paint it is not necessary to clean off all the rust on a metal, but merely to clean off loose scale and grease, and when the paint is applied it reacts on the rust and transforms it into an essential part of the protective coating. It is applied either by spraying or with a brush and sets in twenty minutes.

A ROYAL VISIT TO JARROW.—It is announced that on July 12th the Duke of Kent will visit Jarrow and Hebburn to inspect the social service centres, as part of a tour of social centres in County Durham. The Duke will inspect the occupational centre now in course of erection at the Hebburn power-house. At Jarrow he will pass the site of the £1,000,000 steel works project, which has been derelict since the closing of Palmer's steel works. He will be received at the Jarrow centre by the Mayor, Alderman J. W. Thompson, and it is hoped that Sir John Jarvis will be present. In the various departments the work will be explained to him by the unemployed men in charge of the various sections.

LOW TEMPERATURE CARBONISATION, LTD.—In the course of his address at the annual general meeting of Low Temperature Carbonisation, Ltd., Col. W. A. Bristow said that, following upon the success that has attended the preparation and marketing of the products from the first plant at Barugh, it has been decided to construct a second plant in Derbyshire, at a cost of approximately £200,000. A third plant will be included in the general scheme in South Wales. Contracts have already been placed for the main items for the Derbyshire plant and most of the products have been sold up to the year 1940. By the middle of next year the company will have over a thousand retorts at work, not including those at Greenwich, which are owned by the South Metropolitan Gas Company.

THE VIBRATIONS INDUCED BY BLASTING.—In order to study the nature of the vibrations of earth and air caused by blasting in quarries and mines, the U.S. Bureau of Mines assembled a portable research plant in a specially constructed vehicle equipped with seismographs and recording apparatus to study the amplitude, frequency, and rate of propagation of vibratory waves, both fundamentally and in relation to the transmitting media. The instruments measure amplitudes in ten thousandths of an inch. Observations during 1936 were taken in nineteen different quarries of shots varying from 42 lb. to 20,000 lb. of explosive per shot. As a result a considerable amount of information has been obtained concerning the characteristics of earth vibrations caused by blasting operations and the influence upon them of structural changes in the ground and of field technique.

LONDON'S GAS MAINS.—Recently a length of gas main laid down at King's-avenue, Woodford, brought the total mileage of the Gas Light and Coke Company's mains up to 6000, a figure surpassing that of any other gas company in the world. Each year during the past five years this company has laid over 200 miles of mains, 1800 men being employed continually on main laying and repairs. The system now consists of 2,650,000 pipes from 2 in. to 4 feet in diameter, with a total weight of 560,000 tons. Statistics show that the company serves an area of 540 square miles and supplies 1½ million consumers. It carbonises 3,000,000 tons of coal each year and the gas is distributed from 100 gasholders. Its highest daily output of gas is 250 million cubic feet, as against a few thousand 125 years ago. Last year the company installed 750,000 new appliances. The ten London gas companies in the Greater London area, including the Gas Light and Coke Company, work 12,000 miles of mains.

Air and Water.

INTERNATIONAL AERONAUTICAL FEDERATION.—At the conclusion of the International Aeronautical Federation Conference in London, Prince Georges Bibesco (Rumania) was for the eighth successive year elected President of the Federation.

AERIAL ROAD INSPECTION.—The possibilities of an aerial inspection for the trunk roads transferred to the care of the Ministry of Transport from the local highways authorities are being considered by the Minister of Transport, Dr. Burgin.

INTERNATIONAL AVIATION MEETING.—The Fourth International Aviation Meeting will be held at Zurich from July 23rd to August 1st. It is expected that it will be even more successful than the previous meeting, held in 1932, since already more than twice as many competitors have entered from fourteen different countries.

A NEW HIGH-SPEED MOTOR BOAT.—A series of experiments are to be made by Sir Malcolm Campbell on Loch Lomond with a new high-speed motor boat. The boat has been named "Bluebird," and if the experiments are successful Sir Malcolm intends to install the engine of his racing motor car in the boat and attempt to set up a new world speed record for water.

A NEW WORLD'S HEIGHT RECORD.—The world's height record recently made by Squadron Leader F. R. D. Swain was broken on May 7th last by Lieutenant-Colonel Mario Pezzi in a Caproni 161 biplane with a Piaggio "PX1RC72" engine. Lieut.-Col. Pezzi reached a height of 15,655 m. The figures, however, have not yet been homologated by the Fédération Aéronautique Internationale.

LIVERPOOL-AMSTERDAM AIR ROUTE.—On July 1st the daily air service from Liverpool and Doncaster direct to Amsterdam, operated by the K.L.M. Royal Dutch Air Lines, will be resumed. The route will be operated entirely by Douglas "DC2" machines. On the same date the North-Eastern Airways will also open new air routes from Doncaster to Manchester, Hull, and Grimsby.

UNION CASTLE SHIP LOST.—On Saturday last, June 26th, the s.s. "Sandgate Castle," a vessel of 7634 tons, owned by the Union Castle Mail Steamship Company, was abandoned on fire some 400 miles north-west of Bermuda. The crew of forty was rescued by the American liner "President Pierce," which responded to an S.O.S. when about 180 miles away, and taken to New York. The "Sandgate Castle" was completely destroyed.

EMPIRE AIR MAILS.—The Imperial Airways flying boat "Centurion" inaugurated the new Empire air mail services on Tuesday, June 29th, when she left Southampton Water on the first stage of her 7260-mile journey to South Africa. She carried 112,000 letters, and the mail included a letter from the King to the Governor-General of South Africa. The flying boat's departure was delayed for half-an-hour by trouble with one of her four engines, but the lost time was soon made up.

A NEW QUAY AT NORTH SHIELDS.—Sir Arthur Sutherland, Chairman of the Tyne Improvement Commission, formally opened a new quay at the Albert Edward Dock entrance, North Shields, on Tuesday last, June 29th. The new quay marks the completion of schemes costing £500,000 carried out by the Commission to facilitate trade with Norway. It is designed to accommodate passengers and cargo between the Tyne and Oslo, and as a result of its construction Fred. Olsen and Co., Ltd., has intimated an extension of its services with this country.

MARINE ELECTRIC PROPULSION.—A recent report on the running and operation of the two 18,000-ton liners, "Scharnhorst" and "Potsdam," during the past twelve months indicates that a saving in fuel consumed per voyage amounting to about 8 per cent. has been shown over the costs for fuel of a similar vessel propelled by geared turbines. This saving is credited to the turbo-electric installation on the two vessels and is attributed to the avoidance of propeller racing in rough weather and the ease with which one turbo-alternator set can be run alone, when the vessel is operating at cruising speed.

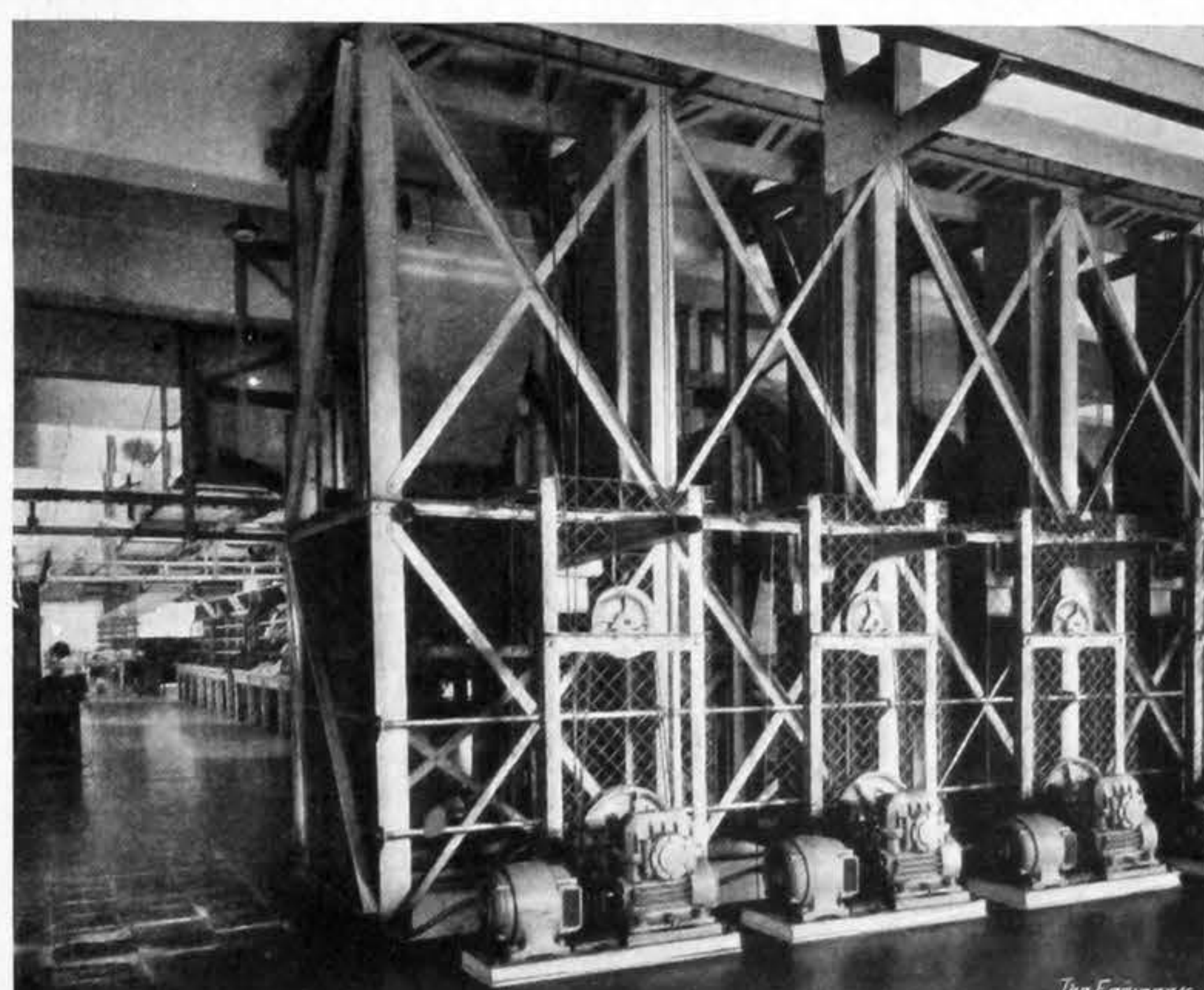
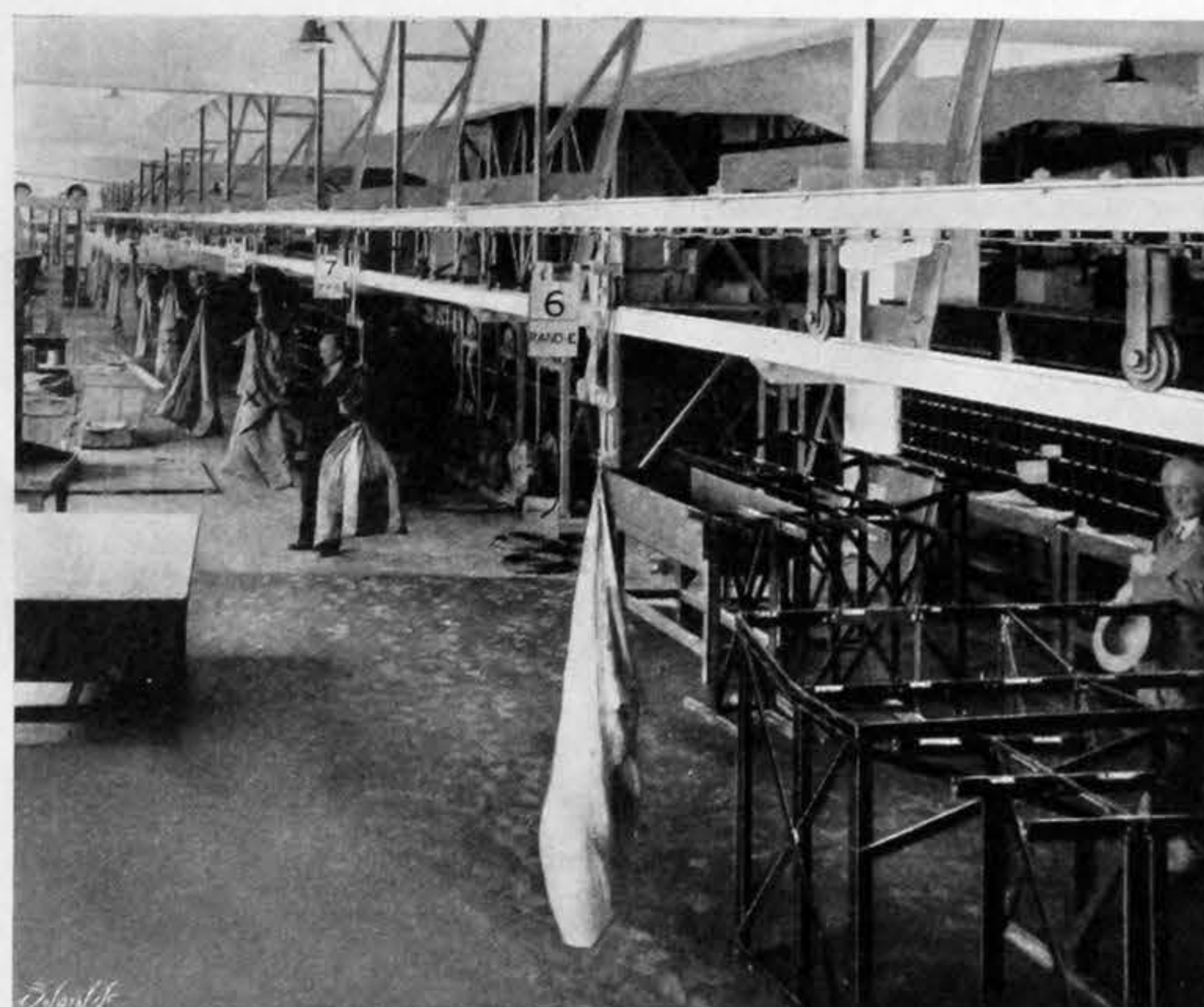
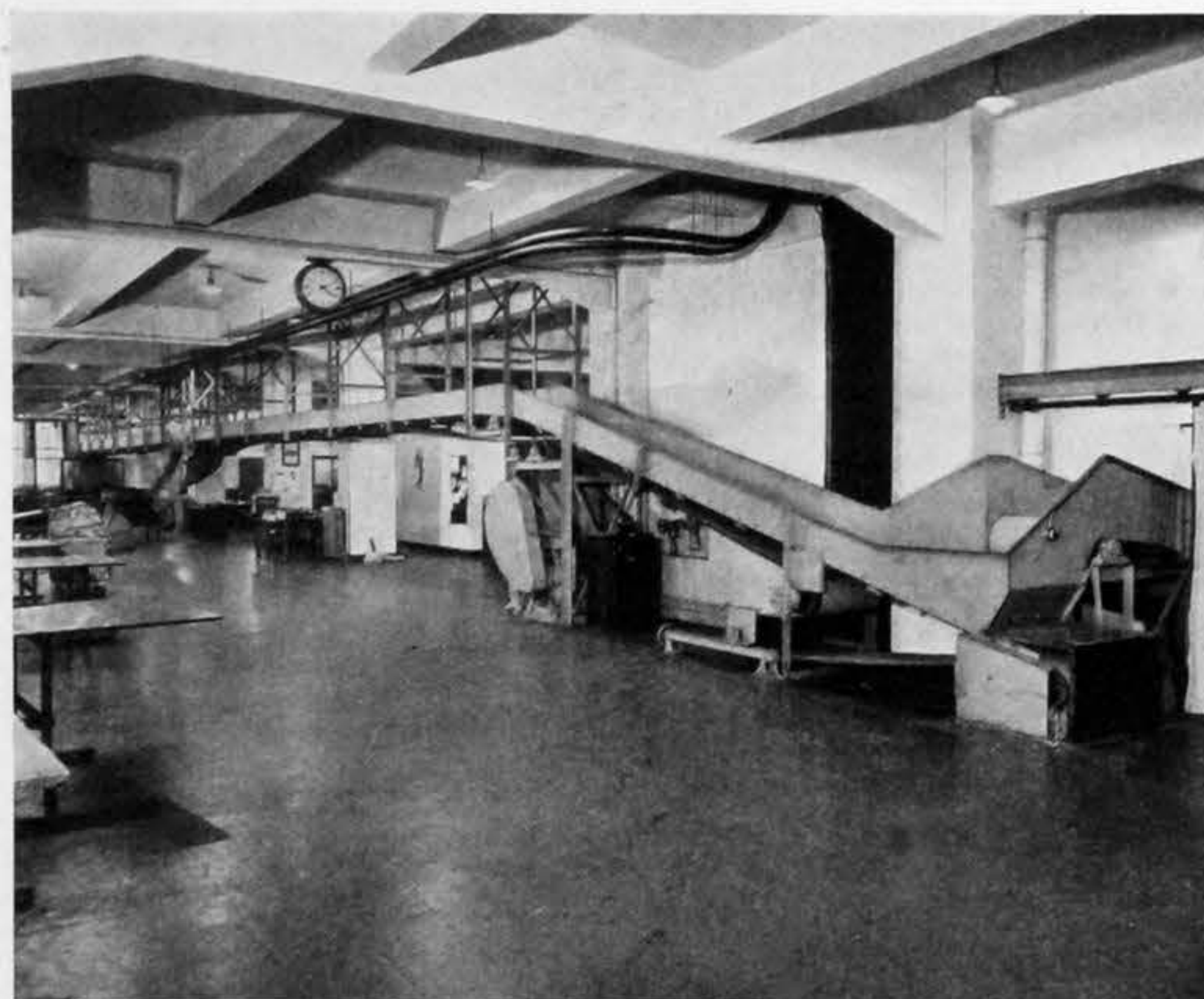
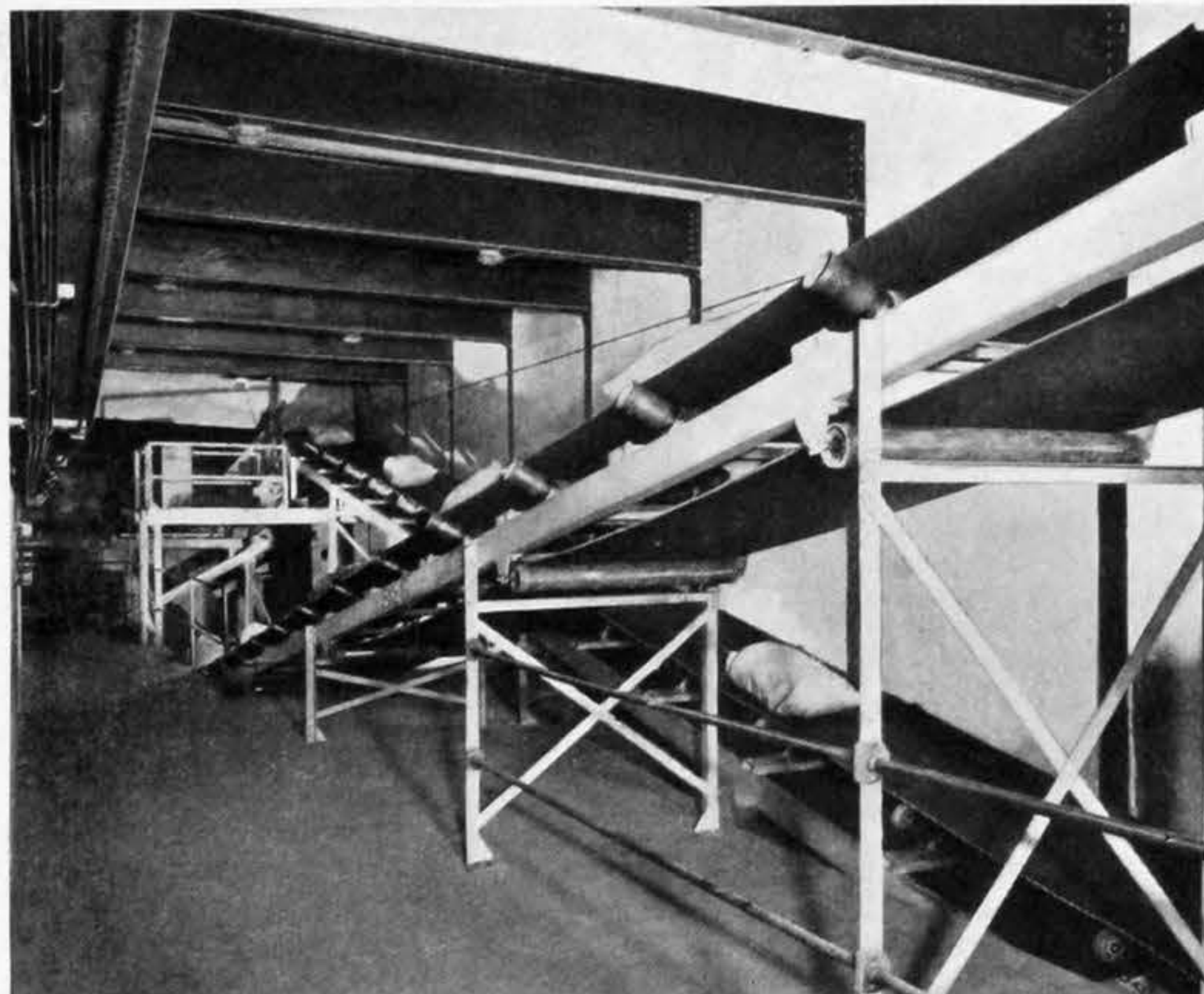
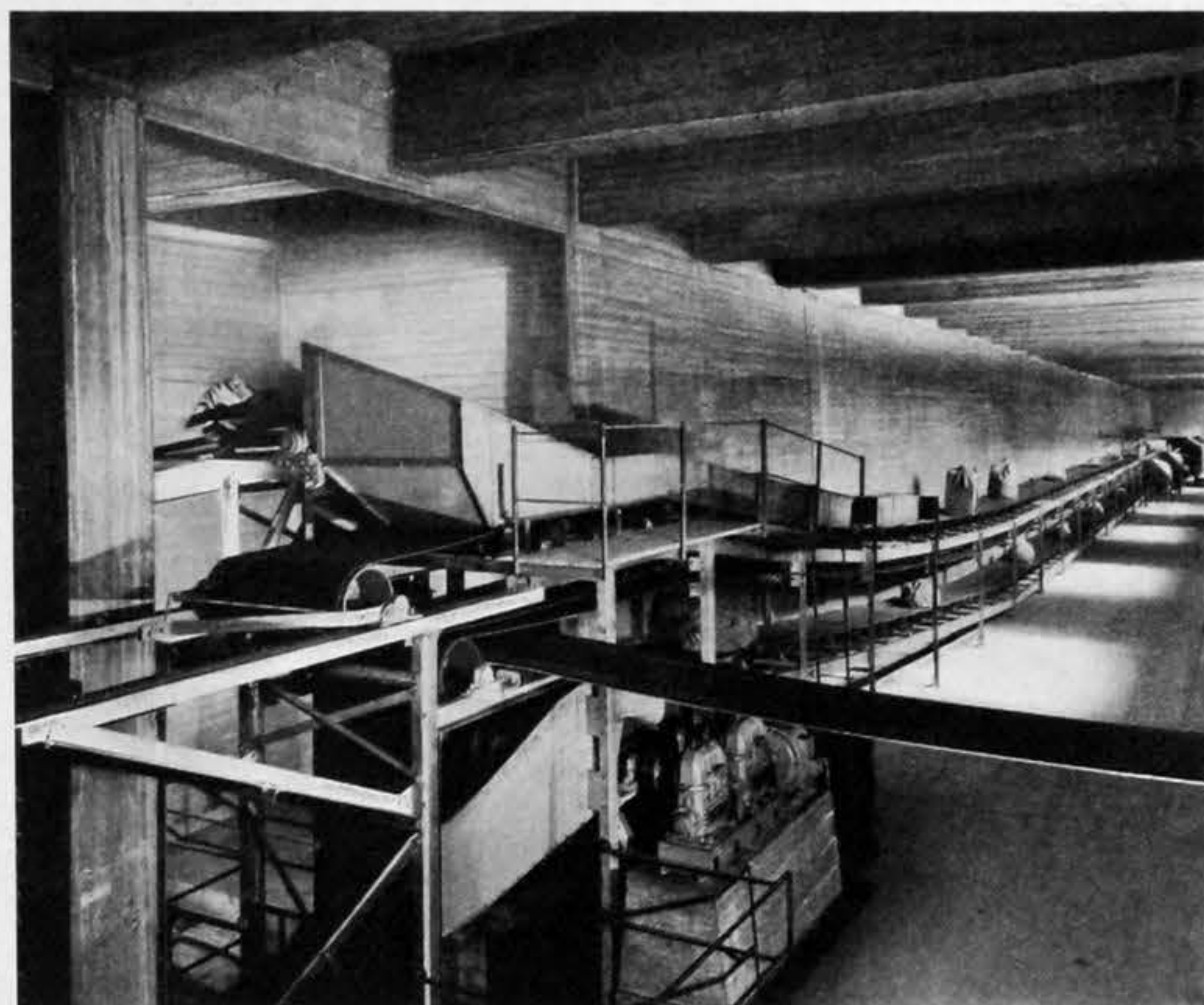
BEIRA PORT EXTENSION.—In the annual report of the directors of Beira Works, mention is made of the increased traffic, amounting to 25 per cent. last year, at the port of Beira. Owing to satisfactory trade conditions in both Southern and Northern Rhodesia, imports rose by 13 per cent., while exports were 32 per cent. higher. Under the circumstances arrangements have been made to extend the port facilities at an estimated cost of £475,000. The improvements include the construction of an additional deep-water berth and equipment, two large transit sheds, an extension of the electric power station, and the reclamation of land behind the existing wharves.

THE LATE SQUADRON COMMANDER COLMORE.—We have to record the death of Squadron Commander G. C. Colmore, at the early age of fifty-two. He was one of the pioneers of flying in this country, and was a successful competitor in the early competitions for British-built engines. On the outbreak of war he joined the Royal Naval Air Service and was posted to the airships branch. He was commander of the Luce Bay Airship Station and at a later date he was made commander of the Wormwood Scrubs Naval Airship Constructing Station. He was looked upon as an authority on airship design and construction and made many trips on both British and Continental airships.

GENOA AIRPORT.—It has recently been decided by the Italian Council of Ministers to grant 18,000,000 lire towards the construction of an airport at Genoa. Difficulty has been experienced as the town is placed on a narrow strip of land between the sea and encircling mountains. In consequence aircraft have had to choose between the seaplane base and the emergency landing ground of the local aero club. It is now proposed by the engineer in charge of the scheme, Signor Albertazzi, to make the necessary space by enclosing a portion of the sea and building a platform over it to act as a landing ground. The project is estimated to cost about 22,000,000 lire and involves clearing the coast to the west of the Polcevera around Castello Raggio and enclosing a strip of sea in the shape of a trapezium in front of this coast.

NEW JOHANNESBURG POST OFFICE

SPENCER (MELKSHAM), LTD., MELKSHAM, ENGINEERS

(For description see page 19.)

JUNCTION OF TUNNEL AND STATION CONVEYORS
CONVEYOR "K" BRINGING PARCELS FROM COUNTER
BAG CARRIER AND DISTRIBUTOR

CROSS-OVER CONVEYOR, "O" AND "P" AT BREE STREET
BAG CARRIER CONVEYOR, CIRCULATION FLOOR
POSTING SKIPS "A," "B," "C," "D," AND DRIVING UNITS

The Engineer

JULY 2, 1937.

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NOTICES TO READERS.

- * If any Subscriber abroad should receive THE ENGINEER in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.
- * For Subscription rates, see page 2 of Advertisements.
- * All letters intended for insertion in THE ENGINEER or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.
- * No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

CHANGES OF ADDRESS.

- * Will subscribers please note that in all advices regarding changes of address it is necessary to have both the old and new addresses, as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.

OF STRIKES.

At the moment no grave strikes are disturbing the even course of British industry. The busmen's strike came to its inglorious end several weeks ago, and the mining strike never matured, either because the people concerned were moved by Mr. Baldwin's appeal, or because, as some qualified observers hold, there is little or no discontent amongst the miners. In this state of peace it should be possible to study strikes with a philosophical detachment which is unattainable at a time when a general statement is certain to be applied instantly to a particular case. Before a war or after a war one may debate the means of preventing wars, but during the war particulars engross the attention to the exclusion of generalities, whilst the mental—or, must we say, psychical?—condition of all concerned is unfitted for logical thought.

Concentrating our attention solely on genuine industrial strikes, the first fact that occurs to us is that they are anachronisms. By the genuine strike we mean one that is directed by labour against the particular conditions of its employment. It is a conflict between a specific employer and his employees—say, to take an example, between the railway companies and their men on the question of hours and wages. Strikes like that threatened in the northern coalfield because two unions were at loggerheads we do not regard as genuine. We must exclude also all strikes which are fostered for a political purpose even though that purpose is the improvement of labour conditions. It is impossible to regard a mass rebellion of the working classes against the national

constitution as a strike, for it is something apart from industry; something with which industry cannot deal. We regard also as not genuine all strikes which are not aimed against the employer, for something he has done or has not done in connection with his workpeople; but to force him to do something which it is not his real business to do, as, for example, to discharge a man against whom labour has directed its rancour. Omitting such cases as we have outlined, we insist that the strike is an anachronism because, in the course of years, efficient machinery has been built up for the settlement of labour questions in all organised industries. We may cite as examples the excellent way in which the Engineering Employers' Federation and the A.E.U. have settled their differences for many years past; or the peaceful conditions which have reigned in the steel industry for an even longer period. The railway tradition is not quite so good, but there exists now in the railways such a complete organisation for the adjustment of all questions affecting the particular conditions of railway employees that a strike should rightly be regarded as unjustifiable. In the old days men struck against a hard or inconsiderate employer or group of employers. But under the conditions which now prevail in all save very small concerns, the bad employer cannot exist; the other members of the Federation to which he belongs would not tolerate the existence of conditions which might upset them all. These federations enter into binding agreements with the trades unions and with rare exception abide faithfully by those agreements. Since no human arrangement can be 100 per cent. perfect, there are lapses from time to time, but they are generally adjusted within the employers' federations, and the cause of offence is removed. But if the employers are occasionally at fault it must be admitted that labour is not invariably as conscientious in the observance of its contracts as it should be. In justice it must be said, however, that of late the troubles have been brewed by groups within the unions and not by the union executives.

In view of all the machinery which exists for the settlement of questions concerned with employment between employers and employed, the strike has become an antiquated weapon only wielded when labour determines to force industry to do something which the committees or courts set up for arbitration and conciliation have decided it should not be called upon to do. Such strikes, when they do occur, are not infrequently tinged with politics and inflict hardships on the community. A strike, for example, which was directed against capitalism could not be classed as a trades dispute. It would be not a quarrel with the industry, *qua* industry, in which the men were engaged, but against the conditions of the State. It was laid down in the Trades Dispute and Trade Unions Act of 1927 that any strike is illegal if it (1) "has any object other than or in addition to the furtherance of a trade dispute within the trade or industry in which the strikers are engaged; and (2) is a strike designed or calculated to coerce the Government either directly or by inflicting hardship upon the community." It is, we think, desirable that this clear definition should be borne in mind at the present time. We have to recognise that labour would be shrewd enough to give an industrial appearance to its actions and so bring them within the law, but it should not pass the wit of man to decide in the case of any dispute whether it was fundamentally industrial or political. That would be no small advantage, for even though the means, formulated in the Act, for dealing with the strike which is outside the law leave much to be desired, it would be a satisfaction to know when it was not the machinery for the settlement of labour questions that was at fault, but that the matter was one which no form of industrial conciliation could ever hope to satisfy.

Standardisation of Locomotive Failures.

Of all the troubles likely to afflict the engineer responsible for the running of locomotives, the failure of an engine to proceed with its train is one of the most trying. It is bound to upset immediate routine, and later on to appear against the owning shed in the shape of reduction of the average of sound mileage, although the cause may be, and often is, beyond the control of the shed authorities. Most failures can be traced to one of five main causes—plain carelessness in lubrication, which on most railways appears to be the principal source of trouble; shortage of steam, which may

be due to the mismanagement of the engine or the fire or to poor quality of the coal; overloading, an error on the part of the traffic department; failure of material, which cannot be foreseen; and inherent weakness of some particular part or detail, inducing either liability to repeated breakage or to such indifferent running that the slightest lack of special attention may prove fatal. Carelessness in lubrication and mismanagement of the engine or fire are causes open to improvement by educative methods, and poor quality of coal can be remedied by closer supervision of the sources of supply, but an allegation of weakness in some detail requires a lot of proof, and can only be determined satisfactorily by statistics over a reasonable period of time. In spite of sometimes strenuous denial, such defects do at times exist, and can cause a lot of trouble before they are finally scotched. Excepting delays alleged to be due to minor cases of overloading, which are often really an excuse for mismanagement, it does not seem to be fair to blame the engine for another department's mistakes, and we would, in consequence, suggest that failures of this nature should not rank, and that this should include all cases of trains delayed by severe weather conditions or by the presence on the line of huge bodies of insects, such as locusts and caterpillars—a not uncommon occurrence in tropical countries.

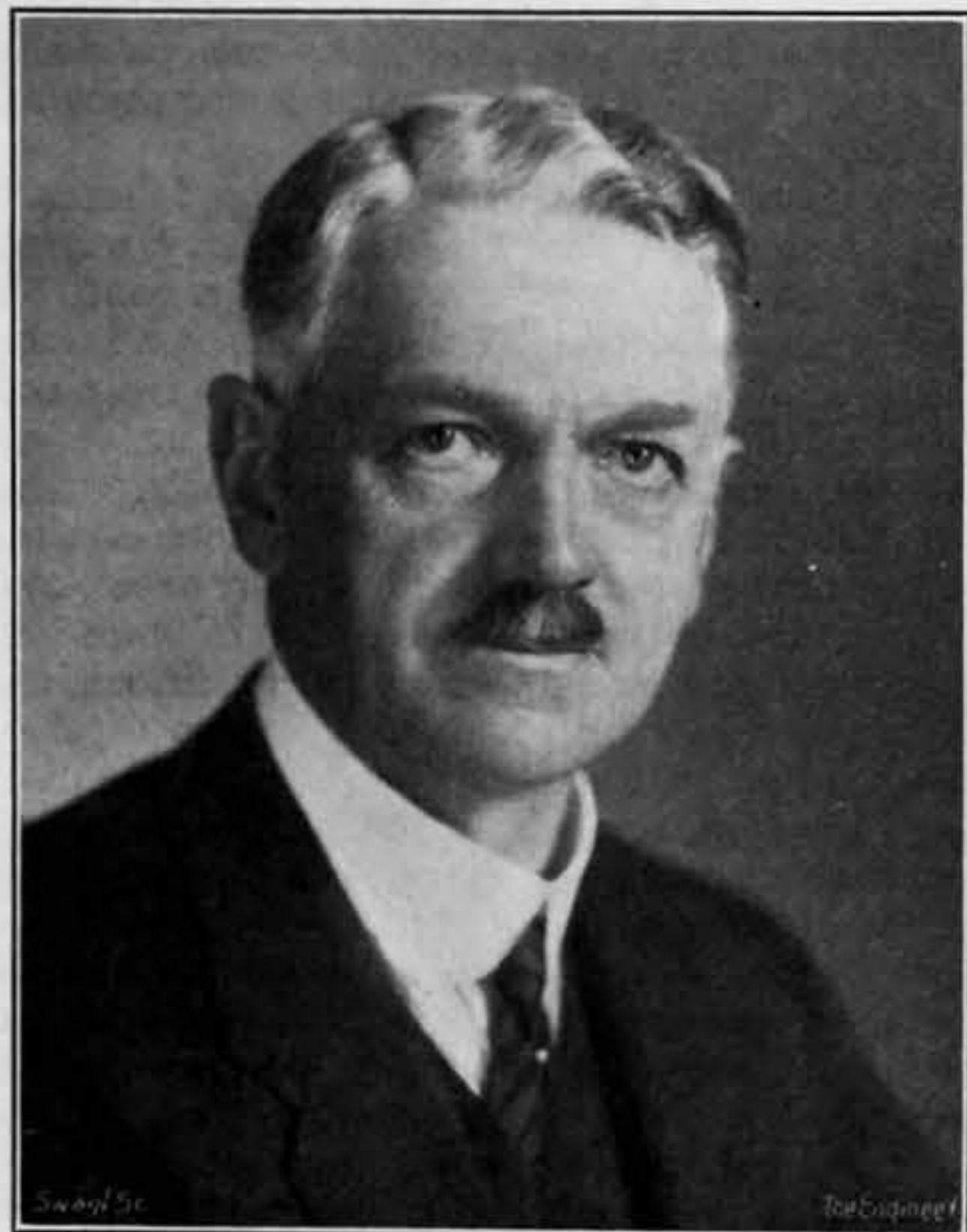
It is usual practice when assessing failures to group them under the headings already referred to, but what we think would also be a good, but is not perhaps so general a practice, is a further grading on the basis of time lost to the train concerned. Following this up, the gravest case would be the total inability of an engine to proceed with its train, followed in turn by a limit of loss of time, which might be assessed at one hour, any excess over this period being rated as a total failure; the succeeding limits being possibly thirty, fifteen, and five minutes in each grade, any excess of these figures again putting the failure into the next class. Division into passenger and freight groups is not recommended, on account of the increasing number of freight trains running at almost passenger service speeds, and also on account of the growing practice of working trains of both classes by the same engine, often during the same turn of duty. The suggested grading would give a standard basis for comparison which might be universally applied throughout British-owned railways, and which would answer the question of what precisely constitutes a locomotive failure. An examination of the official standards of various railways would show a wide divergence of opinion in this respect, beginning with the somewhat rigid inclusion of inability to work its booked train when once the fire has been lit for that purpose, even though the engine may not have left the shed and no delay to the traffic has been caused. At the other extreme is the definition of a failure as a total delay over any one trip of more than fifty-nine minutes, caused by mismanagement of the engine or by mechanical failure. The first of these standards strikes us as unnecessarily strict, and likely to lead to evasion, as engines are easily changed over in a large shed during the process of steam raising without authority being any the wiser and often with authority's connivance, nobody being anxious to earn the shed a black mark. The second definition seems altogether too lenient for modern operating conditions. These standards are quoted as showing the wide differences at present existing, but which must be adjusted before comparison is in any way possible.

Were British standards adopted, the circulation of the details of failures would become a valuable, if a novel practice, even on a confidential basis between the principal officers concerned. But it is submitted that nothing is to be gained by official reticence in this respect, whereas we venture to think that much could be learned by C.M.E.s and traffic managers from an examination of each other's troubles, and that, further, the comparative mileages run per failure would act as a stimulus to every locomotive department, in exactly the same way as does the domestic publication to the districts of an individual railway. It would seem that all British-owned or operated railways in other parts of the world might join in with advantage, although their conditions may be widely different, the argument being that such difference is often more apparent than real, as it is compensated in many ways. There also is the likelihood that parallel conditions do exist somewhere else in the British Empire. We should learn from our mistakes, but before we learn we must have knowledge of them, and the greater the knowledge, the greater should be the advancement.

Obituary.

HENRY HOMAN JEFFCOTT.

It is with the deepest regret that we have to record the death at his home at Walton-on-Thames, Surrey, on the morning of Tuesday, June 29th, after a long illness, of Dr. Henry Homan Jeffcott, the Secretary of the Institution of Civil Engineers. Dr. Jeffcott was the second son of William Jeffcott, Justice of the Peace, and was born in County Donegal on February 6th, 1877. From 1895 to 1899 he was educated at Trinity College, Dublin, and then proceeded for three years to the Engineering School at Trinity College, Dublin, where he gained high academic honours, the degrees of B.A., B.A.I. (Bachelor of Engineering, Dublin), and Sc.D. being conferred upon him. From 1902 to 1904 he was trained as an assistant with Siemens Brothers and Co., Ltd., at Woolwich and Stafford, being engaged on the design of dynamos, motors, transformers, &c., in addition to workshop experience. From 1904 to 1905 Dr. Jeffcott was at the Openshaw works of Sir W. G. Armstrong, Whitworth and Co., and was there engaged in gauge making, screw-cutting, general turning and fitting, &c. After leaving Manchester, he became the head



HENRY HOMAN JEFFCOTT

of the Metrology Department of the National Physical Laboratory, London, and was occupied with the experimental work connected with screw threads, pipe flanges, bolt heads, standardisation of engineers' gauges, verification of surveying apparatus for base-line measurements, and the design, erection, and the testing of measuring machines. In 1910 he was appointed Professor of Engineering in the Royal College of Science for Ireland, Dublin, and held that post until 1922. During the last eight years of this period he was also Dean of the Faculty of the College. During the war he was responsible for the manufacture of munitions in the college workshops, which involved the design and construction of turret lathes and the adaptation of existing lathes by novel methods. He held from 1918 to 1921 the post of Secretary of the Water Power Resources of Ireland Sub-Committee, and was also Examiner in Mechanical Engineering in the University of Belfast and in the National University of Ireland. At this period he was associated with Sir John P. Griffith, M. Inst. C.E., in the preparation of a hydro-electric scheme for the river Liffey.

Dr. Jeffcott wrote many papers on engineering and scientific subjects for the "Transactions" of learned societies upon such highly technical matters as the whirling of shafts, vibration of beams, elastic deformation, screws and threads, electrical transmission lines, hydro-electric investigations, heat engines, surveying instruments, &c., and, in addition, he was the patentee of several inventions, the best known of which is his direct-reading tachometer. In 1922 he was appointed Secretary of the Institution of Civil Engineers, which position he held until his death. During his secretaryship, the Institution celebrated its Charter Centenary in 1928. Dr. Jeffcott always placed himself with unfailing readiness and courtesy at the disposal of members and visitors to the Institution, and his death will be keenly felt by all those with whom he came in contact. He was a member of the Institution of Civil Engineers, the Institution of Mechanical Engineers, and the Royal Irish Academy.

CONGRESS OF THE INSTITUTE OF TRANSPORT, 1938.—Arrangements are in progress for the holding of the 1938 Congress of the Institute of Transport at Edinburgh from Wednesday, May 18th, to Saturday, May 21st, 1938, inclusive.

Literature.

Modern Works Management. By G. S. MASON, B.Sc., M.I. Chem. E. London: Sir Isaac Pitman and Sons, Ltd. 1937. Pages 201. Price 8s. 6d. net.

THIS book may be described as suggestive rather than comprehensive, for in its relatively small compass it gives a general outline of the various phases of management, and it should help to enable a manager who has hitherto been content to rely on haphazard and uncertain methods to replace them by systems involving the control of raw materials, labour, workmanship, &c. The author has endeavoured to treat his subject in a broad way, so that it may be applied with equal effect to an engineering works as to a factory manufacturing textiles, chemicals or any other product.

Chapter I deals with general principles, and six main principles, which may almost be regarded as axiomatic, are enunciated; but although they are easy to state, their application often requires an infinity of patience, coupled with intelligent zeal. It is simple to affirm that "each person must have a specific task, clearly defined and easily understood," yet most industrialists will appreciate the many difficulties that arise, especially when functional organisation is undertaken. We cordially endorse Mr. Mason's statement that "to give more work to do than is possible to be done is involving not only criticism, but trouble." A harassed official is always inefficient.

Chapters II to VI are concerned with the successful control of various items, of which the first is the important one of raw materials. Unless adequate safeguards are introduced serious loss will result, and this is duly emphasised by the author. We should like him to have stressed the importance of two things: first, the necessity for limiting stocks, particularly as most storeholders are prone to err on the side of lavish provision; and secondly, the great value of having in addition to the ordinary determined maximum and minimum quantities, a further predetermined "ordering level." It is obvious that if the storekeeper is satisfied to work by minimum, stocks may be seriously depleted between the time of ordering and the delivery of the requisite goods.

Chapter III considers the control of labour, and the various incentives adopted to obtain a maximum output. The value of promotion is rightly stressed, for it is felt that the introduction of an outsider should only be resorted to when a suitable individual cannot be found inside the organisation—in itself a reflection on the administration. The fatigue curve given shows that the greater the output, the greater the rate of increase of fatigue. While the author sketches the different methods of remuneration, he does not express an individual preference, although we judge he inclines to the "efficiency system," in that it should tend to bring employee and employer nearer together. We fully agree that "the closer the sympathy between master and man, and the deeper the knowledge of each other, the better it will be for the ultimate good of the organisation as a whole." We do not, however, agree that bad workmanship, irregular attendance, &c., may be punished by fining in the form of a deduction from the weekly wage. In no circumstances should that be done.

Chapter IV discusses the control of workmanship by means of examination at various stages and by testing, and it emphasises the necessity for providing efficient machinery, ensuring well-lighted shops, and not ignoring the very important part cleanliness plays in the workshop.

Chapter V treats in a general and somewhat elementary manner with cost control, a subject to which engineering managers have not paid sufficient attention, partly because the cost accountant has not worked in close co-operation with the works staff. We should like to have found this strongly advocated by Mr. Mason, more particularly with reference to the relation between the estimating department and the cost accountant. While he states that "estimating is a matter of considerable importance," he does not point out the way in which close collaboration can be effected, although we are glad to notice that he draws attention to the value of comparison between actual costs and those estimated. We should like to mention the value of occasional and thorough "inquests" into serious discrepancies. The method on which overhead costs are recovered is so vital a consideration that we should have welcomed Mr. Mason's views on the subject, and a statement as to the advantages to be obtained from the machine-hour rate.

Chapter VI describes problems that arise in administrative control, and emphasises the necessity for managers to have at their disposal all details for determining the true position at any moment. For this purpose charts and diagrams are invaluable, and the different types likely to be of use are explained, the Gantt chart being given a degree of prominence. The change of scale encountered is, however, a disadvantage. All the proposals in this chapter are worthy of close attention.

Chapter VII concludes an interesting book with reflections, past and present, and furnishes much food for thought in such subjects as the increasing tendency towards special purpose machines, towards

individual drive, towards the reduction of hours, and the author advocates the need for closer co-operation between the machine builder and the machine user. This has not received from engineers generally any-thing like the attention it deserves.

This book can be recommended to those who desire to manage their works on logical and modern lines, as well as to the student who would know something of the general principles underlying management. "Modern Works Management" is well illustrated with charts and diagrams, but it would be a definite improvement if these were numbered for more readily linking with the text. In a work of this nature it is inevitable that no section can be treated exhaustively, and accordingly it would be a distinct help if a comprehensive bibliography could be added to future editions.

BOOKS RECEIVED.

Men of Mathematics. By E. T. Bell. London: Victor Gollancz, Ltd., 14, Henrietta-street, W.C.2. Price 12s. 6d. net.

Public Library Lighting. Vol. I. By R. D. Hilton Smith. Gravesend: Alex. J. Philip, "Lodgewood." Price 5s. net.

The Coal Seams of North Staffordshire. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C.1. Price 1s. 6d. net.

Examples in Practical Mathematics. By Leonard Turner. London: Edward Arnold and Co., 41, Maddox-street, W.1. Price 2s. net.

A Survey of the Development of the Automobile Radiator. By J. Coltman, M.A. Manchester: John Coltman, 7, Mirfield-drive, Monton. Price 4s. net.

Standard Weight Table of Black Bolts and Nuts, &c. Prepared by the Black Bolt and Nut Association of Great Britain. Birmingham: E. L. Heathcote, F.C.A., 25, Bennetts-hill.

Proceedings of the First Annual Conference of the Combustion Appliance Makers' Association (Solid Fuel). London: Combustion Appliance Makers' Association (Solid Fuel), 54, Victoria-street, S.W.1. Price 2s. 6d. net.

Thorpe's Dictionary of Applied Chemistry. Fourth edition. Vol. I, A-Bi. By J. F. Thorpe, C.B.E., D.Sc., and M. A. Whiteley, O.B.E., F.I.C. London: Longmans, Green and Co., Ltd., 39, Paternoster-row, E.C.4. Price 63s. net.

Letters to the Editor.

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

THE THEORY OF DIMENSIONS.

SIR,—When you favoured me by publishing at full length in your issue of June 11th my reply to Mr. R. C. Porter's letter which appeared in a previous issue (May 21st), I promised that I would refrain from taking any further part in the discussion, allowing Mr. Porter the last word. But now that a letter from Professor Cramp has appeared (June 25th) in support of Mr. Porter, I think I am entitled to trespass a little further on your space. I will be as brief as possible.

Professor Cramp gives us a kindly lecture on the principles on which the construction of a balance is based. In this he is, to the best of my knowledge, perfectly accurate; in fact, without disrespect to Professor Cramp, all that he says was quite familiar to me when a student at the Royal College of Science some fifty years ago. But the principles on which an instrument acts and what the instrument does, namely, its object or function, are two totally different things. When a chemist makes use of a balance, either to weigh a certain residue or precipitate for example, or to weigh out, say, a gramme of some reagent, he does not need to know the local value of g ; the operation will give the same result exactly wherever he may be situated, from the Equator to the Pole. But ask him what force he is measuring (according to Mr. Porter), or what is the torque, or what the bending moment on the beam at the pivot point (according to Cramp), and the instrument gives no indication whatever. Even if asked to calculate the force or the torque, he will first need to be informed of the local value of g (in most cases unknown); if satisfied on this point, he will be able to express the force in dynes by multiplying by g the figure representing the number of grammes. Then, to give the torque about the central knife edge, he will need to dismantle his instrument and measure the distance between knife edge centres, which he must multiply by the force as calculated above. If Professor Cramp likes to use a balance in this way there is nothing to prevent him doing so, but it is not the manner in which a chemical balance or a pair of scales is used, nor the purpose for which that instrument is designed.

Birmingham, June 26th. F. W. LANCHESTER.

TRACK RECONSTRUCTION ON THE L.M.S.—With a view to increasing the comfort of passengers in the new high-speed trains between London and Glasgow, the London, Midland and Scottish Railway Company has carried out an extensive curve reconstruction scheme. More than a hundred curves with an aggregate mileage of about 60 have been recanted or realigned. Another improvement is the reconstruction of the viaduct carrying the line over the river Clyde at Lamington, in Lanarkshire, so that trains are now able to cross this viaduct at considerably higher speeds than hitherto.

The Southern Railway's Electrified Extension to Portsmouth.

THE opening to the public of the Southern Railway's latest electrified extensions from Hampton Court Junction to Portsmouth, *via* Woking, and from Woking to Alton, takes place on Sunday, July 4th. Although the density of traffic on the Portsmouth route is not so great on the average as it is on the Brighton system, the relief afforded by conversion is, if anything, greater, for the two banks in each direction between Guildford and Havant, with gradients as steep as 1 in 80, have always proved limiting factors to the weight, timing, and punctuality of the steam trains. For the fast trains, a four-car vestibuled set is the basic unit, from which are built up eight and twelve-car trains, according to the time of day and the requirements of the traffic. One of the four-car sets in all these trains contains a kitchen car, so that every express train has a

three complete sub-station equipments were unloaded per month. During the period between December, 1935, and November, 1936, 188 cable trains were employed in laying 309 miles of single-core, 33-kV cable, and 218 miles of pilot cable.

For the operation of the electric services, the power is obtained from the Central Electricity Board's grid sub-stations at Byfleet and Portsmouth, and from the company's own generating station at Durnsford-road, where a 5000-kW set has been replaced by a 12,500-kW machine. The increased traction supplies in the western suburban area have been provided by an additional rotary converter sub-station at Durnsford-road. Power from the grid is distributed by a 33-kV ring main to unattended sub-stations (Fig. 1) containing mercury arc rectifiers, which supply 660-volt D.C. to the track. These sub-stations are operated by supervisory control gear from central points.

As usual, the H.T. and pilot cables are run in wooden

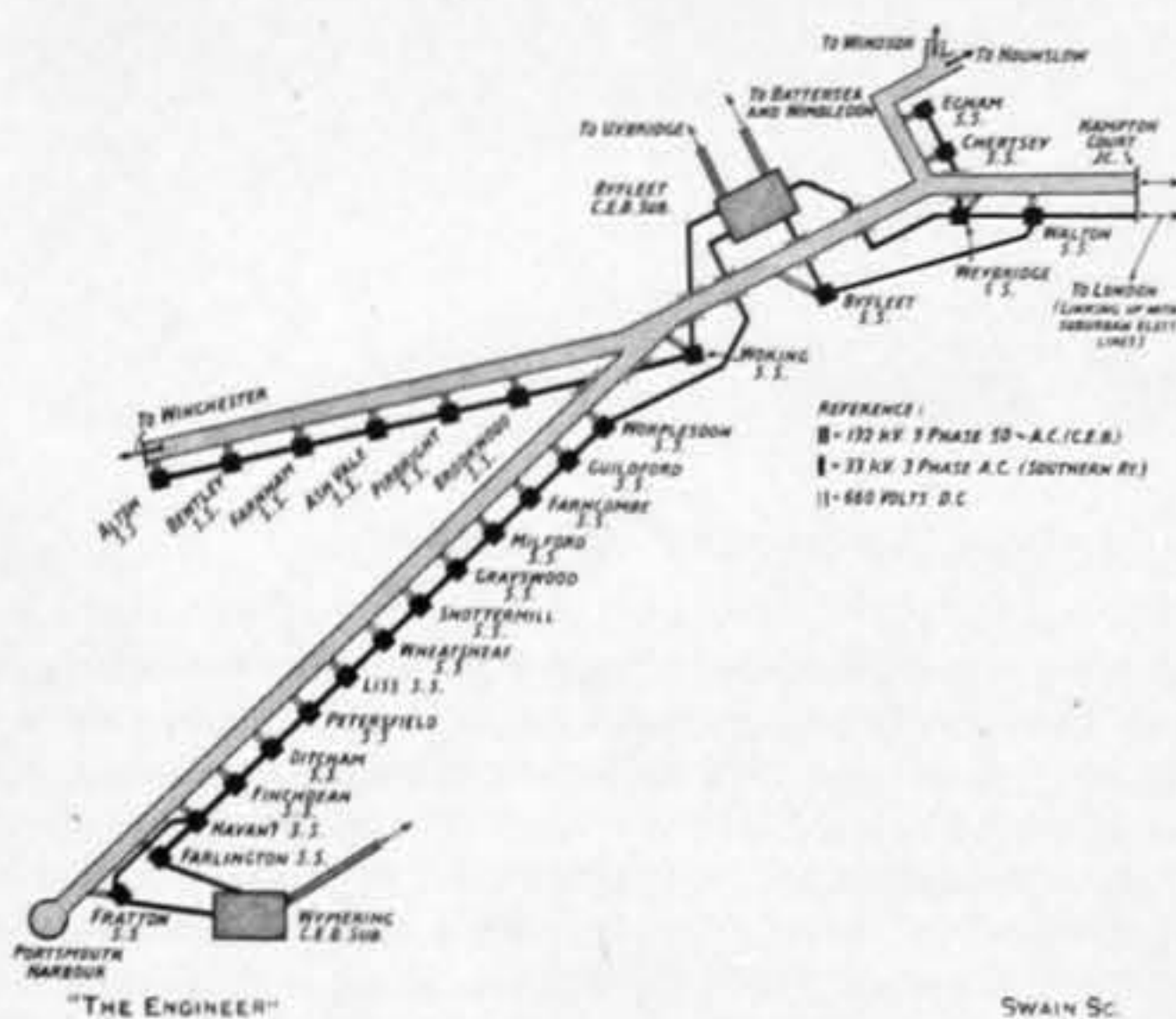


FIG. 1—DISTRIBUTION SYSTEM

refreshment or restaurant service. The stopping trains are composed of one or more two-car units of the corridor non-vestibuled type.

A standardised time-table has been introduced to give increased up and down regular services in all categories, and the total electric train mileage of 4,188,168 a year has replaced 2,235,464 steam train miles, an increase of 88 per cent. compared with 68 per cent. increase on the Eastbourne and Hastings line, electrified in 1935. The standard basis of the new time-tables is one fast train an hour between Waterloo and Portsmouth Harbour in each direction, calling at Guildford, Haslemere, Portsmouth, and Southsea; two stopping trains an hour in each direction, running non-stop between Waterloo and Surbiton, and then calling at all stations between

troughs supported on concrete posts, except where local conditions necessitate the use of concrete ducts, as at level crossings and stations. The 33-kV power cables consist of three single paper-insulated, lead-covered cables, compounded and served, and are laid in the troughing in triangular formation, transposed at regular intervals, but the last sections of the cables which lead into the sub-stations are three-core armoured cables.

A dry core paper insulated lead-covered and armoured pilot cable is laid with the power cables, together with a four-core impregnated paper cable for the E.H.T. feeder protective system (Fig. 2), which is a combination of the circulating current and

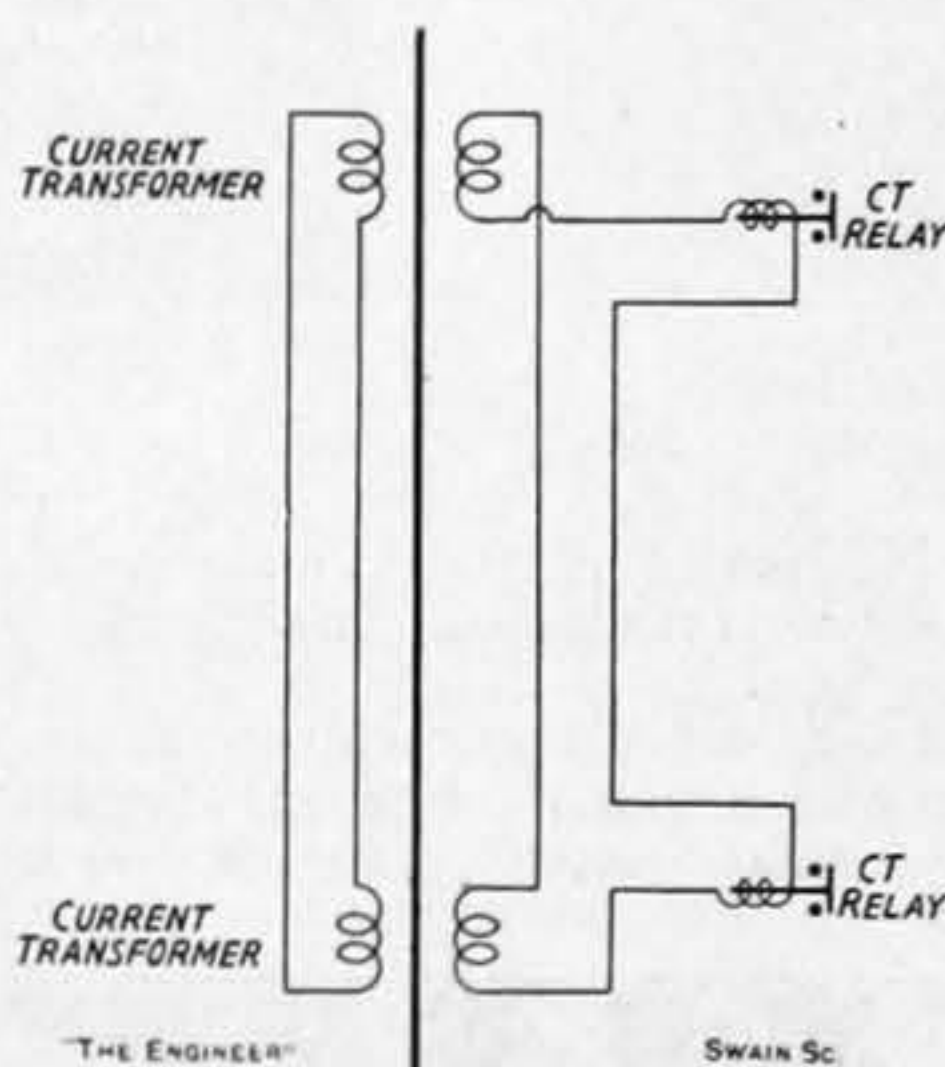


FIG. 2—PROTECTIVE SYSTEM

and very small circulating currents, resulting in a pilot cable of small section.

In all there are twenty-six sub-stations and eighteen track paralleling huts remotely controlled from two control rooms at Woking and Havant. The Woking control room controls the area north of Liss, while the sub-stations south of that point are controlled from the Havant control room shown in Figs. 3 and 4. The sub-stations are of identical design to those on previous extensions and consist of two sections: an E.H.T. switchgear outdoor structure section, and a rectifier and L.T. switchgear building. Apart from those places where special conditions require the addition or omission of an E.H.T. feeder as at Weybridge, Pirbright, Chertsey, Egham, Guildford, Havant, and Ash Vale, or where an additional rectifier has been installed, as at Fratton, the sub-stations are all identical.

The E.H.T. switchgear, Fig. 5, is erected on reinforced concrete structures screened from unauthorised access by an unclimbable fence. Normally there are three oil circuit breakers, each of 500,000 kVA rupturing capacity. Two are for the sectionalising and selective protection of the ring main, and one for controlling the supply to the rectifier transformer. Adequate facilities are provided for local isolation and sectionalising by the isolating switches supported on the concrete cross beams, which also support a bus-bar system which links up the two incoming feeders. From this bus-bar a tee-off connection is taken through the rectifier transformer oil switch to the unit in question. This transformer stands against the end wall of the sub-station building and its purpose is to step down the 33-kV three-phase supply to a double six-phase supply at the voltage required by the rectifier anodes.

Auxiliary supplies are provided by single-phase 20-kVA transformers connected through switch fuses from each of the two incoming feeders, and a three-phase 30-kVA transformer similarly connected to the bus-bars. The single-phase transformers provide the current for signalling, oil switch operation, lighting, and other auxiliary purposes. Duplicate transformers ensure continuity of supply in the event of failure of either feeder, and also serve as potential transformers for synchronising the two feeders. The 30-kVA three-phase transformer provides the auxiliary supply for the mercury arc rectifier, sub-station heating, and lighting, &c.

The sub-station buildings house the mercury arc rectifying plant, the D.C. high-speed circuit breakers which control the D.C. energy to the track feeders, and other auxiliary equipment. The steel tank rectifiers are duplicates of those installed on the Sevenoaks-Eastbourne and Hastings schemes. The continuous rating is 2500 kW, corresponding to 3790 amperes at 660 volts on the D.C. side. Higher currents can be provided for shorter periods up to a momentary maximum of 12,000 amperes. A thermostatically controlled closed circuit water-cooling system is housed in an annexe built on to the back of the sub-station building.

All the rectifiers are completely automatic in their operation through the medium of a master controller

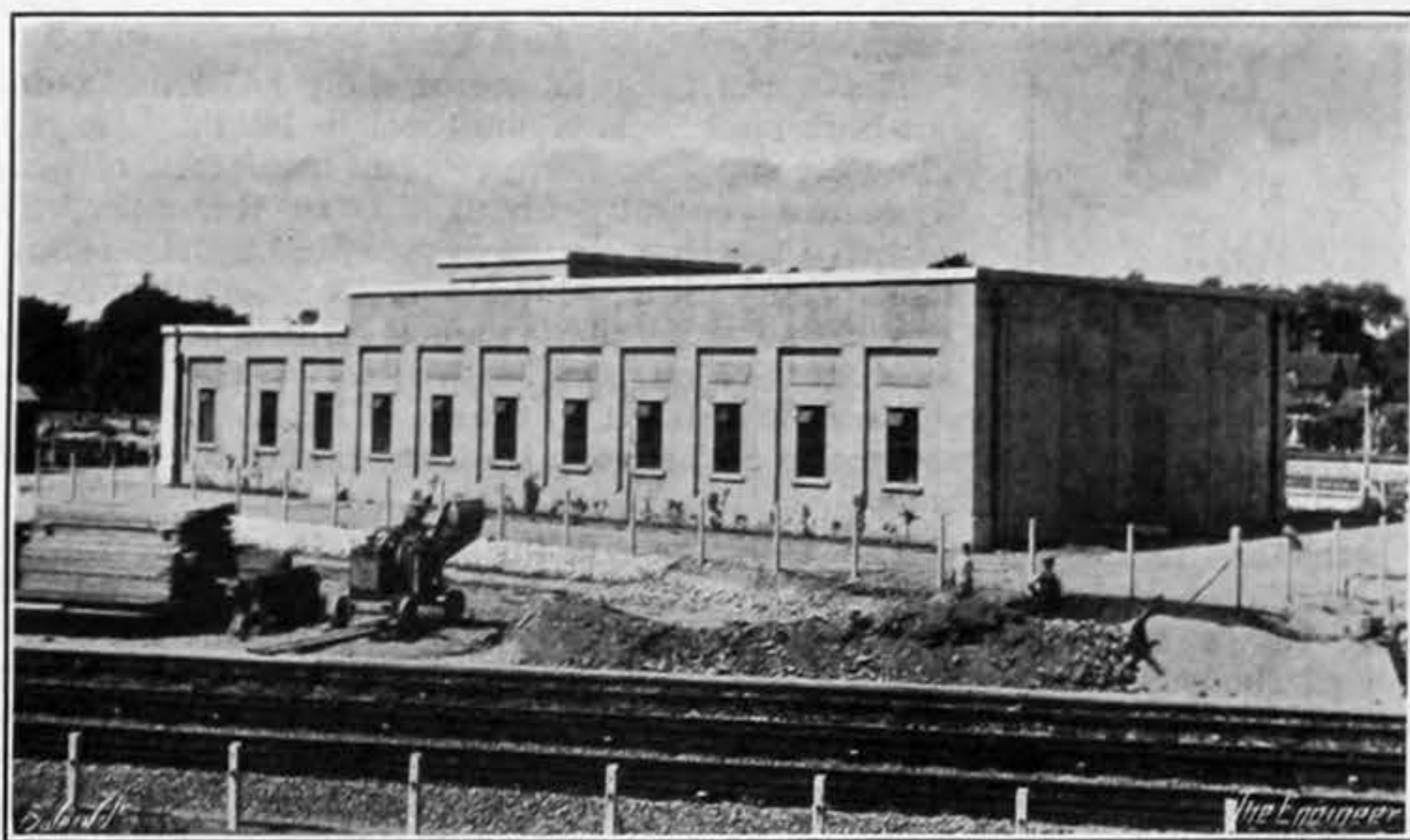


FIG. 3—HAVANT CONTROL ROOM

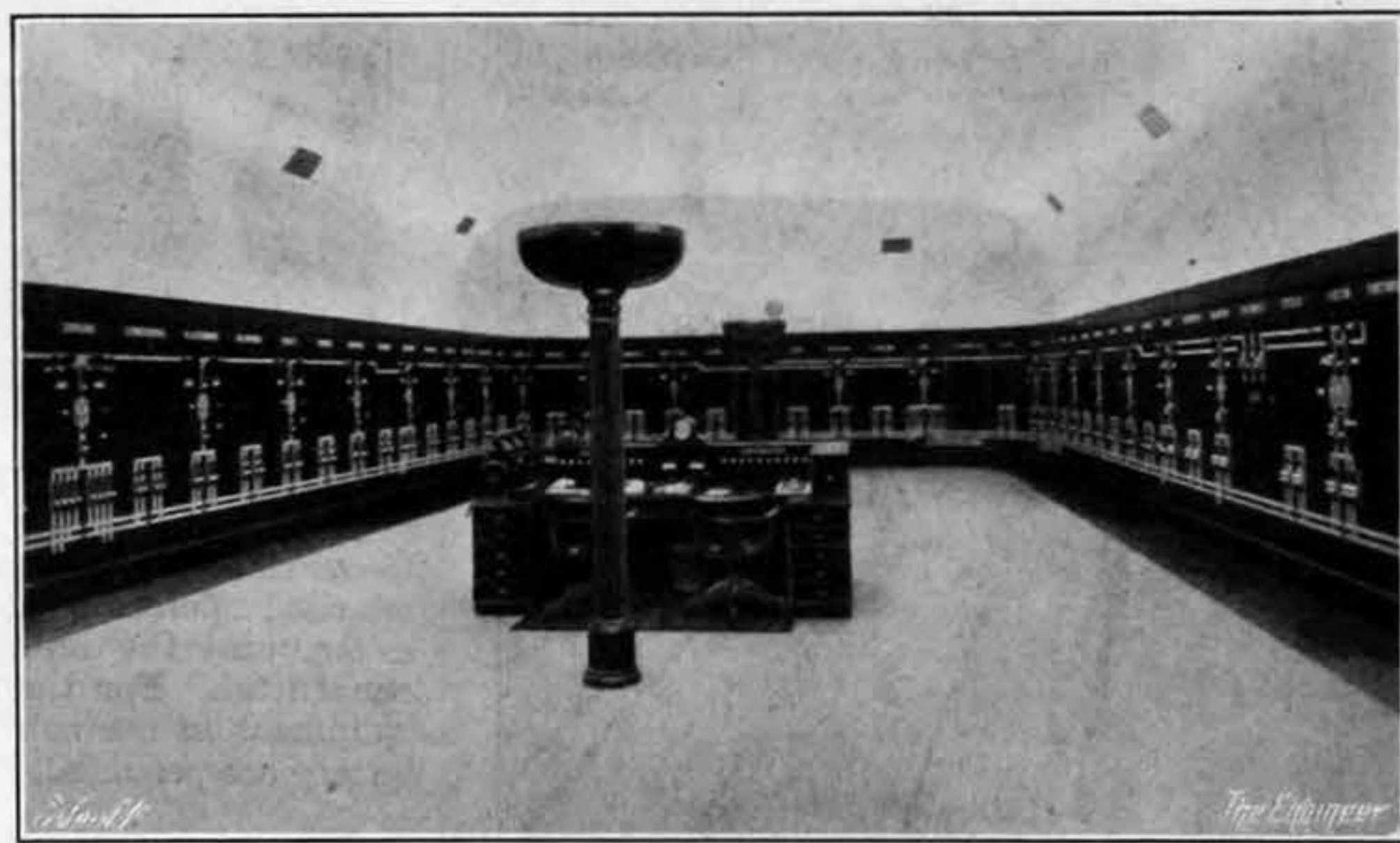


FIG. 4—INTERIOR OF CONTROL ROOM

Surbiton, Portsmouth and Southsea. These trains, are made up in two sections, one of which is detached or attached at Woking to serve all stations on the Aldershot, Farnham, Alton line. The Weybridge, Virginia Water, and Staines trains are regarded as part of the western section suburban services, although the tracks were electrified as part of the Portsmouth scheme. On Saturdays in the summer the standard service over the Portsmouth direct line is increased by three fast trains an hour in each direction.

The rapidity with which the work was carried out speaks well for the organisation of those responsible for it. Starting on June 27th, 1935, twenty-six sub-stations were built and equipped and 242 track miles were electrified in just over twenty months. Electric trial trains began to run to Portsmouth on May 8th, 1937. Each sub-station equipment was carried on a train (Fig. 6) composed of eighteen wagons, with a 36-ton breakdown steam crane and brake van, and

balanced voltage systems, giving the advantages of both and employing the simplest devices. From Fig. 2 it will be seen that each current transformer has two secondary windings interconnected to form a balanced current system in one case and a balanced voltage system in the other. The protective relays are connected into the balanced voltage circuit in such a way as to operate as balanced voltage relays. The action of the remaining set of windings, through which the current circulates, prevents the high-voltage experienced with the balanced voltage system, and troubles due to capacity currents in the pilots are removed. Ring type current transformers of simple design and capable of meeting heavy short-circuit conditions can be employed. No special balancing of the current transformers is necessary, and the usual air gaps, which are sensitive to location, are eliminated. Other advantages claimed for the system are increased stability without sacrifice of sensitivity

which comes into service when the rectifier transformer oil circuit breaker is closed. A complete sub-station can be, however, changed over to local operation if desired. The control gear in this case is centralised in a three-panel switchboard, which also houses various auxiliary transformer equipment associated with the rectifier itself. The three panels control the E.H.T. switchgear, the rectifier, and the auxiliary services respectively, and give visual indication should any failure occur.

The positive connection from the cathode of each mercury arc rectifier is taken along a trench in the floor to a D.C. circuit breaker room. Here it is taken through a main 4000-ampere high-speed circuit breaker, and thence to a bus-bar, from which connection is made to the track feeders through smaller 2500-ampere high-speed circuit breakers. The negative feeders connected to the track rails return the current to the negative bus-bar situated near the main

transformer to the neutral point of which it is connected through absorption coils.

Similar in design to the Swanley and Ore control rooms on the Brighton line, the new Woking and Havant control rooms contain switchboards arranged along a curved wall, on which are diagrams of the

other by A.C. obtained by the high-tension supply. Two 120-volt storage batteries, and a switch-board serve to supply and distribute operating current for the main control board, transmitter cubicles, and control desk. The batteries are kept automatically charged by the motor generator sets

impulses between the control room and the sub-stations. Each selector requires four conductors and one common return, and two sub-stations are operated on each selector.

By means of the main control boards it is possible to select any switch it is desired to operate. This is

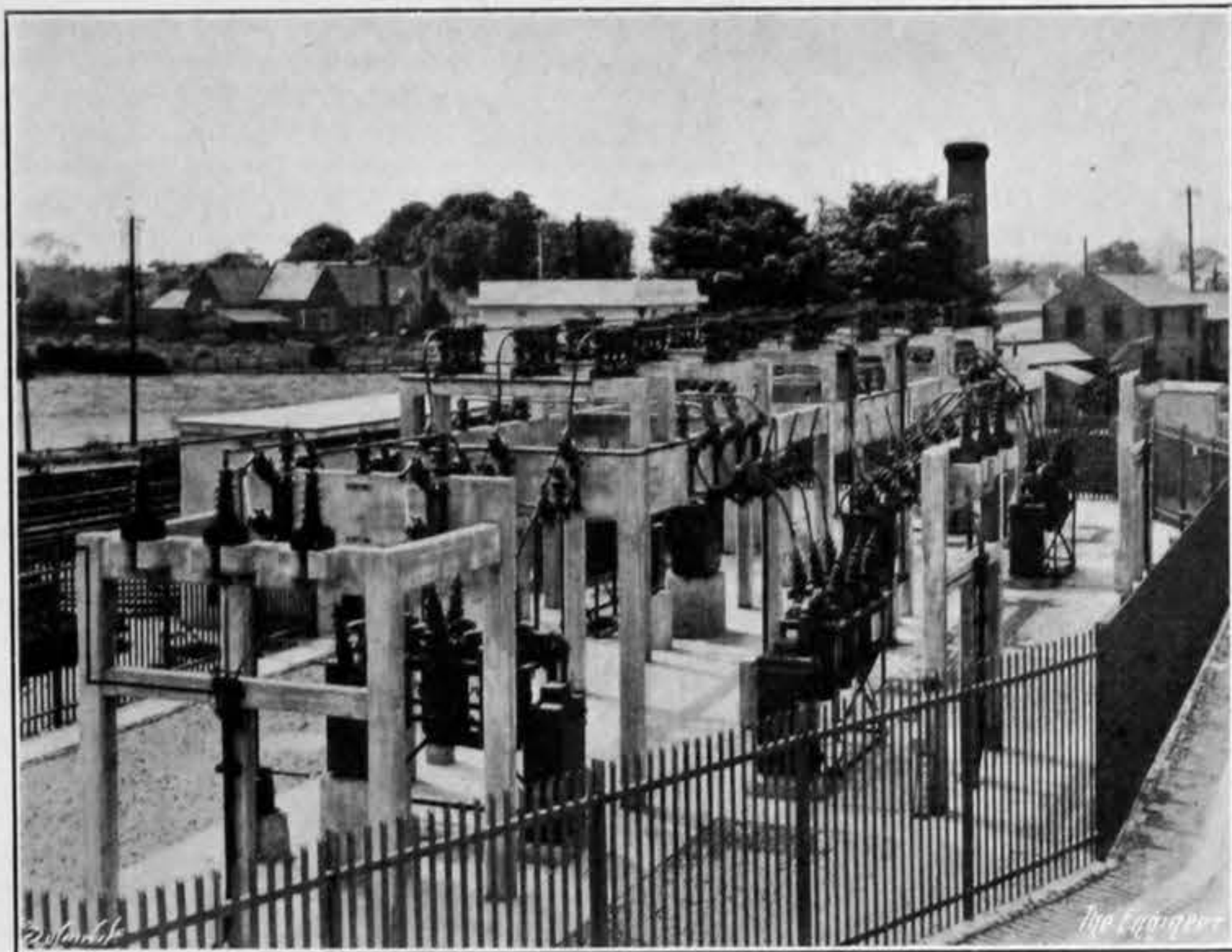


FIG. 5—HAVANT SUB-STATION



FIG. 6—SUB-STATION EQUIPMENT ON TRAIN

whole of the main power circuits for the supply of energy to the conductor rails, made up of mimic bus-bars and switch units. Each panel represents a sub-station, track paralleling hut, or C.E.B. supply sub-station. There are forty panels at Woking and fourteen at Havant. The Woking control room will also eventually control the Reading extension, and Havant room the Leatherhead to Portsmouth, *via* Horsham, extension, when additional panels will be installed in both control rooms. The most important operations carried out in these control rooms are:—(1) Operating and indicating the H.T. oil switches and D.C. high-speed circuit breakers; (2) remote metering of the D.C. current and voltage; (3) fault signalling when the position of any switch does not agree with the indication of the switch at the control room; and (4) telephonic communication between all sub-

and in the event of both motor generator sets failing the two batteries are consecutively connected to the bus-bars.

The receiver cubicles in each sub-station form the selective link between the supervisory pilots and the apparatus under control. In these cubicles are

done by operating a calling key on the switch unit, and a white lamp incorporated in the mimic switch lights up when the selector switch reaches the corresponding position to that of the key depressed. The operation of this switch can now be performed by a second key on the switch unit, which is mounted between a red and a green indicating lamp. Correct operation is indicated by the lighting of these lamps, depending upon whether the switch is closed or open. For the operation of the E.H.T. feeder oil switches an additional lamp is provided to indicate synchronism or otherwise between the two respective supplies.

When a circuit breaker trips owing to a fault the fact is signalled to the control room by the ringing of a bell and the flashing of a clear lamp at the top of the panel belonging to the particular sub-station. At the same time, a coloured shutter is exhibited at the control desk. These conditions continue until the control room attendant has operated a resetting key. To discover which of the switches has automatically operated, a checking key is operated on the sub-station panel in question, which causes the selector arm to rotate once round the face-plate and connect in succession each one of the switches in the sub-station to its particular unit in the control room. When the selector arm passes over the contacts corresponding to the switch that has tripped the indication on the control panel changes from red to green.

The conductor rails are of the Southern standard flat-bottomed section and weigh 100 lb. per yard. They are supported on porcelain insulators, of which there are generally about 620 to the mile. The negative traction circuit is provided by the running rails, each joint of which is bonded together by two bonds, one protected type bond inside the fish-plate, and one welded bond. Sections of the conductor rail can be isolated by means of hook switches which are provided between the feeders and the conductor rails.

The track paralleling huts are placed midway between sub-stations and contain groups of high-speed circuit breakers depending on the number of tracks. They are automatic in operation and their purpose is to parallel the tracks to take advantage of all the cross-sectional area of the conductor



FIG. 7—FAST CORRIDOR EXPRESS



FIG. 8—ELECTRIC KITCHEN

mounted the receiver with its attendant relays, the polarised operating relays, &c., for the execution of orders, and the fault indicating relays and fault transmitter. For the operation of the supervisory equipment in the sub-stations a metal rectifier and battery are provided. Multi-core cables transmit the

stations and control rooms. While the main control boards are the chief operating medium, there are other essential features of the supervisory control equipment, each forming an important link in the complete system.

The control desk is centrally placed in the control room and contains a telephone exchange, indicating relays and alarm bells for fault signalling, and meters for reading sub-station battery voltages, as well as for detecting defects in the supervisory pilot cables.

The transmitter cubicles house the transmitter with its auxiliary relays, polarised relays, &c., and all apparatus for the transmission of orders, as well as the reception of indicating impulses between the control room and the remote controlled sub-stations. Each transmitter cubicle controls two sub-stations. The control room auxiliaries comprise two motor generator sets with automatic starters, one driven by a 660-volt motor from the track and the

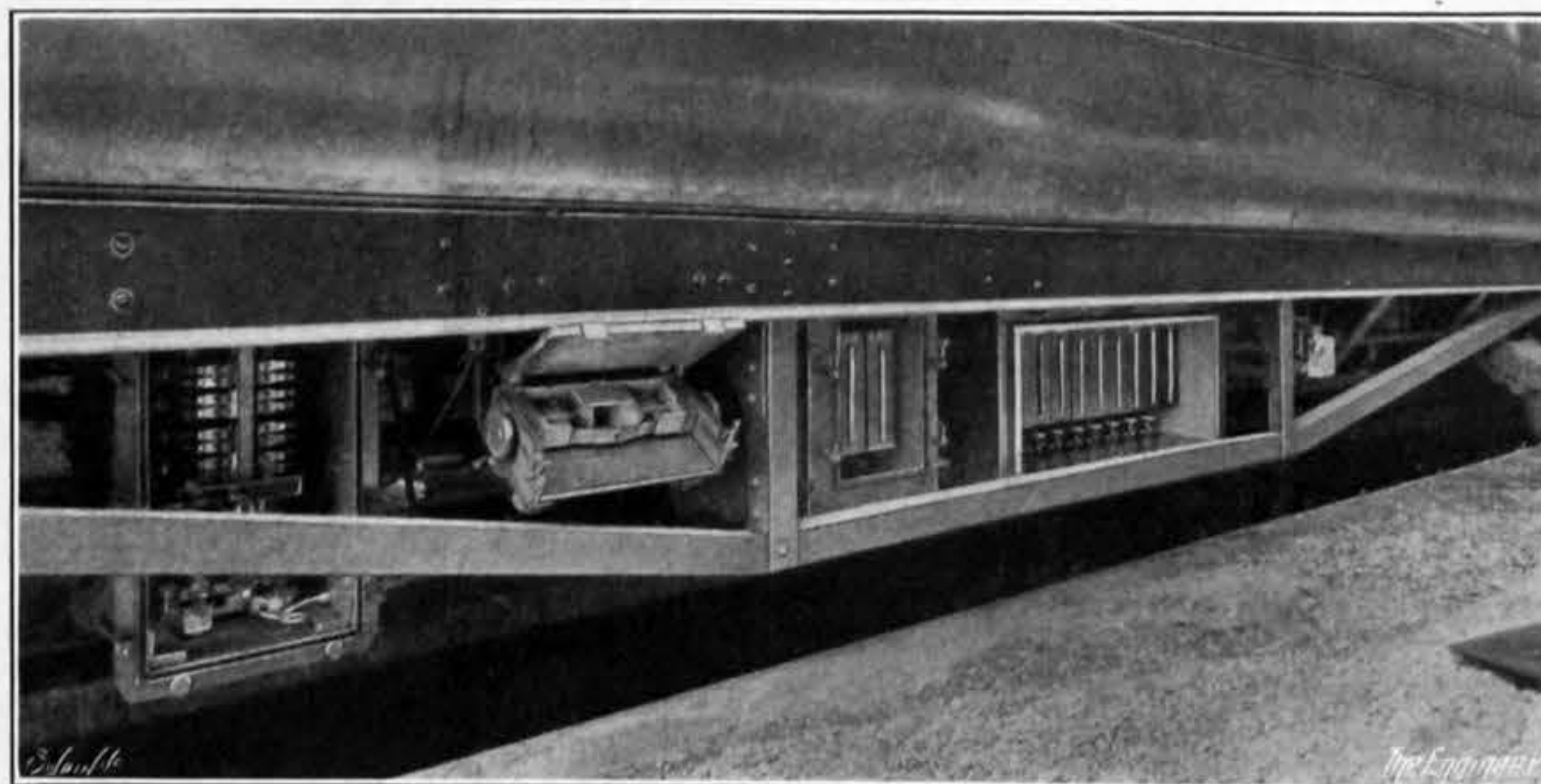


FIG. 9—MOTOR COACH ELECTRICAL EQUIPMENT

rails and thus reduce voltage drop to a minimum. The total amount of additional electric passenger rolling stock ordered for these extensions is :—

	No. of sets.	No. of coaches.
(a) Two-coach trailer sets	5	10
(b) Three-coach motor sets	6	18
(c) Two-coach motor sets	8	16
(d) Two-coach motor lavatory sets	38	76
(e) Four-coach corridor motor sets	29	116
(f) Four-coach kitchen corridor motor sets	19	76

Total number of coaches ... 312

Items (a), (b), and (c) were provided by the conversion of existing steam coaches mounted on new underframes and bogies; while items (d), (e), and (f) are new stock throughout. The two-coach trailer sets, three-coach motor sets, and two-coach motor sets are required to cover the extension of existing suburban services which will serve certain parts of the newly electrified lines. The two-coach motor lavatory sets will form the main line stopping services, and the four-coach corridor motor units will form the express services.

The two-coach trailer sets, three-coach motor sets, and two-coach motor sets are generally similar as regards coachwork to other sets provided for earlier extensions. The two-coach motor lavatory sets resemble the ten two-coach motor lavatory sets provided for the Eastbourne extension; and this unit has now been adopted as the standard unit for handling main line stopping services.

The express stock consists of four-coach units, comprising two third-class brake saloon motor coaches between which are coupled two trailer coaches. In twenty-nine standard units the trailer coaches are a third-class coach and a composite, while in nineteen kitchen units the trailers are a restaurant car and a first-class coach. Besides corridor connection throughout each unit, the units are provided with vestibule connections giving access from one unit to another when coupled, a feature not previously adopted on Southern Railway electric stock. The normal busy-hour train of express stock will consist of twelve cars formed of two standard units and one kitchen unit coupled. Two of the four-car non-restaurant

switch. All the 660-volt cooking circuits are remotely controlled by contactors mounted in a box on the underframe. The control circuits are fed from the low-tension side of the dynamotor, and the operating switches are mounted on a panel fixed above the cooking range. Circuits working at 200 volts are directly controlled.

In addition to normal ventilation the kitchen has two electric exhaust fans mounted in the roof and fed from the lighting supply. The refrigerator motor and compressor are supported in a case hung from the underframe. The third-class restaurant kitchen car and its fellow trailer car in the same unit, and a first-class car with dining saloon, are provided with air ventilating and heating equipment. A heating unit is mounted in a case suspended from the underframe, and consists of an electrically driven fan which blows the air over banks of heating resistances and thence through ducts which distribute the air through the coach. The 600-volt energy supply to the heating resistances is controlled by thermostats operating 70-volt control circuits of four contactors,

which, together with fuses and a main switch, are mounted in a separate case hung from the underframe. An additional hand-operated switch in the fan motor circuit can be used in extremely cold weather to insert resistances in this circuit and reduce the speed of the fan. In warm weather the fan can be run to provide ventilating air to the coach without the heating resistances being in circuit.

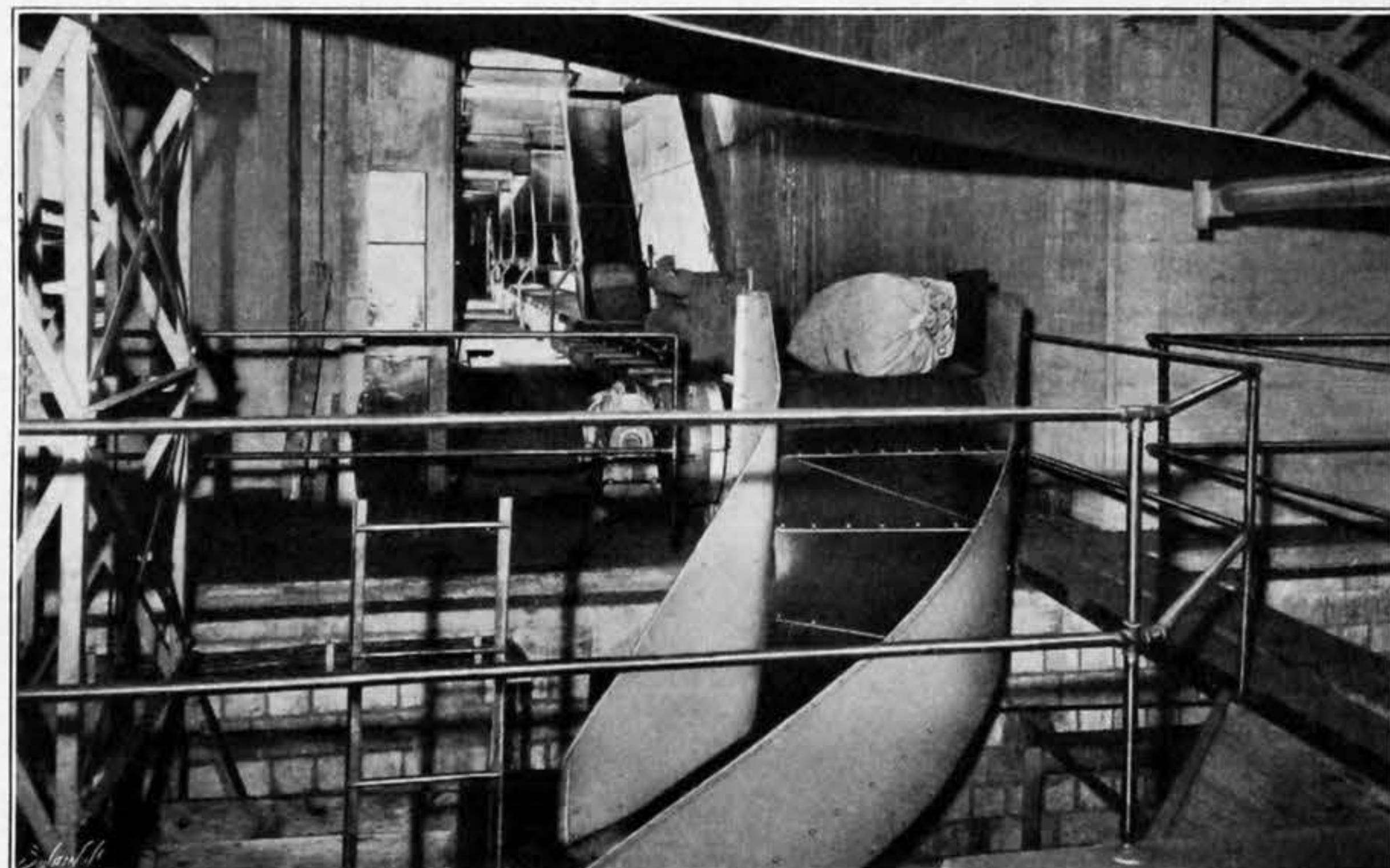
The electrical contractors were :—Asea Electric, Ltd.; British Insulated Cables, Ltd.; British Thomson-Houston Company, Ltd.; Bruce Peebles and Co., Ltd.; Chloride Electrical Storage Company, Ltd.; English Electric Company, Ltd.; Estler Bros., Ltd.; Pirelli-General Cable Works, Ltd.; Taylor, Tunnicliff and Co., Ltd.; Henley's Telegraph Works Company, Ltd.; Simplex Conduit Company, Ltd.; Johnson and Phillips, Ltd.; Docker Bros., Ltd.; General Electric Company, Ltd.; Veronese, Ltd.; Edmondson's Electricity Corporation, Ltd.; Elliot Bros., Ltd.; Parminter, Hope and Sugden, Ltd.; W. T. Glover and Co., Ltd.; Siemens Electric Lamps and Supplies, Ltd.

The New Johannesburg Post Office.

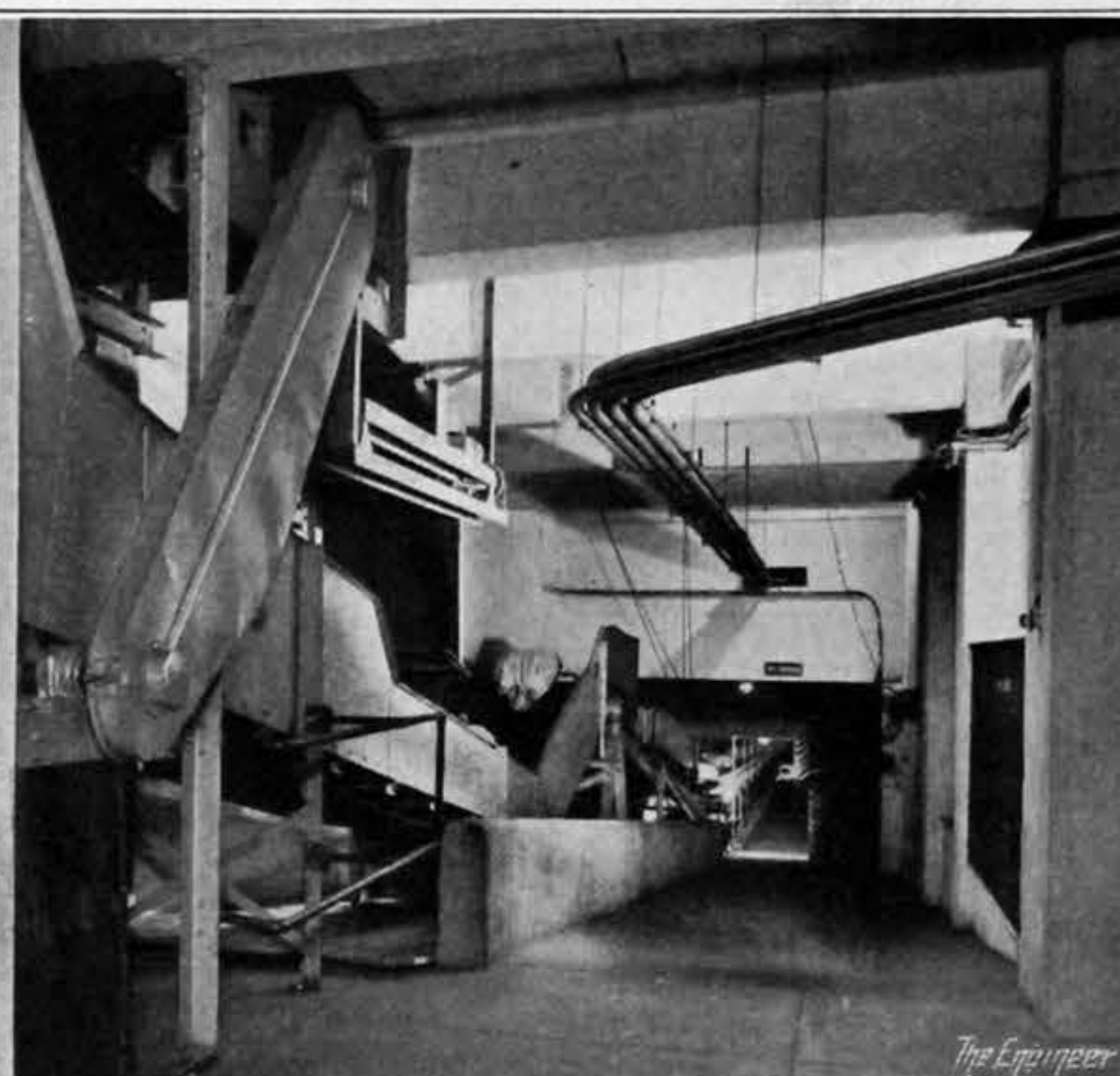
THE postal officials at Johannesburg, South Africa, are fortunate in two ways—a very large part of the sorting of the mail is done before it comes into their hands, and they have the most modern equipment for handling it when it arrives. The first condition is explained by the fact that the English mail is roughly sorted before it leaves London, although other countries are not so considerate, so that whole bags can be dispatched directly to the outlying districts immediately they arrive at the railway station. It is, however, with the mechanical handling plant at the Johannesburg Post Office with which we are here concerned. We reproduce a number of photographs herewith and on page 14, together with an elevation showing the general arrangement (page 21) and a

the railway station platform, and receives mail bags dropped directly on to it through holes in the platform; it feeds to the above-mentioned conveyor Q for delivery to the Post Office. The total distance from the railway platform to the Post Office is about $\frac{1}{4}$ mile, and it is carried in eight minutes.

There is also a conveyor V receiving from the conveyor R, for distributing mail bags by means of three ploughs to the mail chamber, or by chute, to the long conveyor, S and T, which conveys the bags a distance of 1250ft. to or from another mail chamber, also connected with Park Station. This conveyor runs under Noord-street from its junction with Wanderers-street right along to Rissik-street.



CHUTES AT STATION END DELIVERING TO TUNNEL CONVEYORS



ELEVATOR "Y"

sets in service on the Portsmouth main line are shown in Fig. 7.

The stopping service stock is provided with the standard motor equipment for suburban stock, viz., two totally enclosed motors of 275 H.P. each at the one-hour rating per motor coach. The motors are totally enclosed nose-suspended series interpole machines with solid yoke, sleeve armature bearings, and split sleeve axle suspension bearings. For the express stock a special traction motor was designed in 1931 for the extension of the Southern Railway electrification to Brighton, and is being employed on this new extension.

As the result of the experience gained with the electro-pneumatic control equipments of the Brighton extension, it was decided to standardise this type of control equipment for future work for all types of units, express and suburban, and the new equipments for the Portsmouth extension are practically identical for express and suburban stock. In Fig. 9 is shown the electrical equipment beneath a motor coach comprising from right to left the reversing switch, the main fuse line contactor, and resistance contactors.

An all-electric kitchen, Fig. 8, is provided for the third-class kitchen cars. Part of the supply for cooking is taken from the 660-volt traction supply, and the remainder from the L.T. side of a 660/200-volt dynamotor with a continuous rating of 15 kW. The total 660-volt connected load is 25.5 kW, and the 200-volt load 20 kW. The only 660-volt circuit under the control of the kitchen staff is a protected quick-break rotary switch for the dynamotor starting

sketch map. The whole of this plant has been supplied by Spencer (Melksham), Ltd., Melksham, Wilts., with Laurence Scott and Electromotors as sub-contractors for the electric motors. This side of the contract may be gauged from the fact that the system involves twenty motors of an aggregate of 120 H.P.

The machinery falls into two general classes, viz., conveyance in both directions between the Post Office and the Railway Station, and conveyance inside the Post Office building itself. Regarding the former, belt conveyors have been erected in tunnels under the streets. The arrangement is roughly as follows, and can be followed in the sketch map on page 20.

At right angles to Jeppe-street, where the new Post Office is situated, lies Kruis-street, and parallel, but not in line with Kruis-street, is Wanderers-street; there is a short diagonal tunnel connecting the tunnels under Kruis-street and Wanderers-street, this tunnel being known as the Bree-street cross-over.

The belt conveyors carry on the top and bottom strands, and, for the sake of clarity, each strand is given a distinguishing letter. Thus, the nearest conveyor to the Post Office is called N on the upper strand, and M on the lower. N is the "inwards" conveyor, which delivers to the inclined bag elevator Y—see general arrangement. M is the outwards conveyor receiving bags from the spiral chute 5.

In the Bree-street cross-over are the conveyors O and P. O receives from the lower strand conveyor M and delivers to the top strand conveyor R in the tunnel under Wanderers-street. In similar manner conveyor P delivers to the top strand conveyor N, but receives from the bottom strand conveyor Q under Wanderers-street.

At the end of Wanderers-street, Park Station is reached, and, at this point there is a large mail chamber. In it there are situated a number of conveyors running at right angles to Wanderers-street. Conveyor U is under

Taking the conveying plant inside the Post Office, the inclined conveyor Y, which receives the mails from the tunnel system, carries the bags up to the third floor and delivers them into a triple spiral chute on the left, which lowers bags containing letters and newspapers to the second floor, and parcel bags to the hinged table on the ground floor. The third spiral of this chute is used for sending parcel bags from the second floor down to the compartment for private boxes on the first floor. Local inwards mail bags are placed in a vertical elevator denoted X, only the centre line of which is shown on the drawing; this elevator delivers to a belt conveyor E fixed under the ceiling of the second floor and delivering to this floor by means of a short spiral chute.

Parcels are dropped straight from the receiving counter on to a conveyor system I, J, K, and delivered on to a table at the ground floor. There is a separate counter for receiving parcels from natives from which delivery is made by a conveyor to the parcels table on the ground floor. Letters and packets are posted by the general public in four posting boxes situated in the main vestibule of the building and are deposited into the skips marked A, B, C, D by means of the tipping chutes shown.

The four skip hoists are entirely automatic in action, being operated by time relays, and as each skip rises it tips up the chute thereby closing the posting box until the skip again returns to the loading position. At the top of their travel the skips tip and deliver their contents to one or other of the 36in. belt conveyors A, B, C, or D, fixed just below the ceiling of the second floor; these belts deliver by chutes to "facing-up tables" where the letters are turned the right way up for stamping.

Further belts and chutes for the internal working of the Post Office are :

The belt conveyor F under the second floor, receiving from a bag opening table and delivering to the conveyor

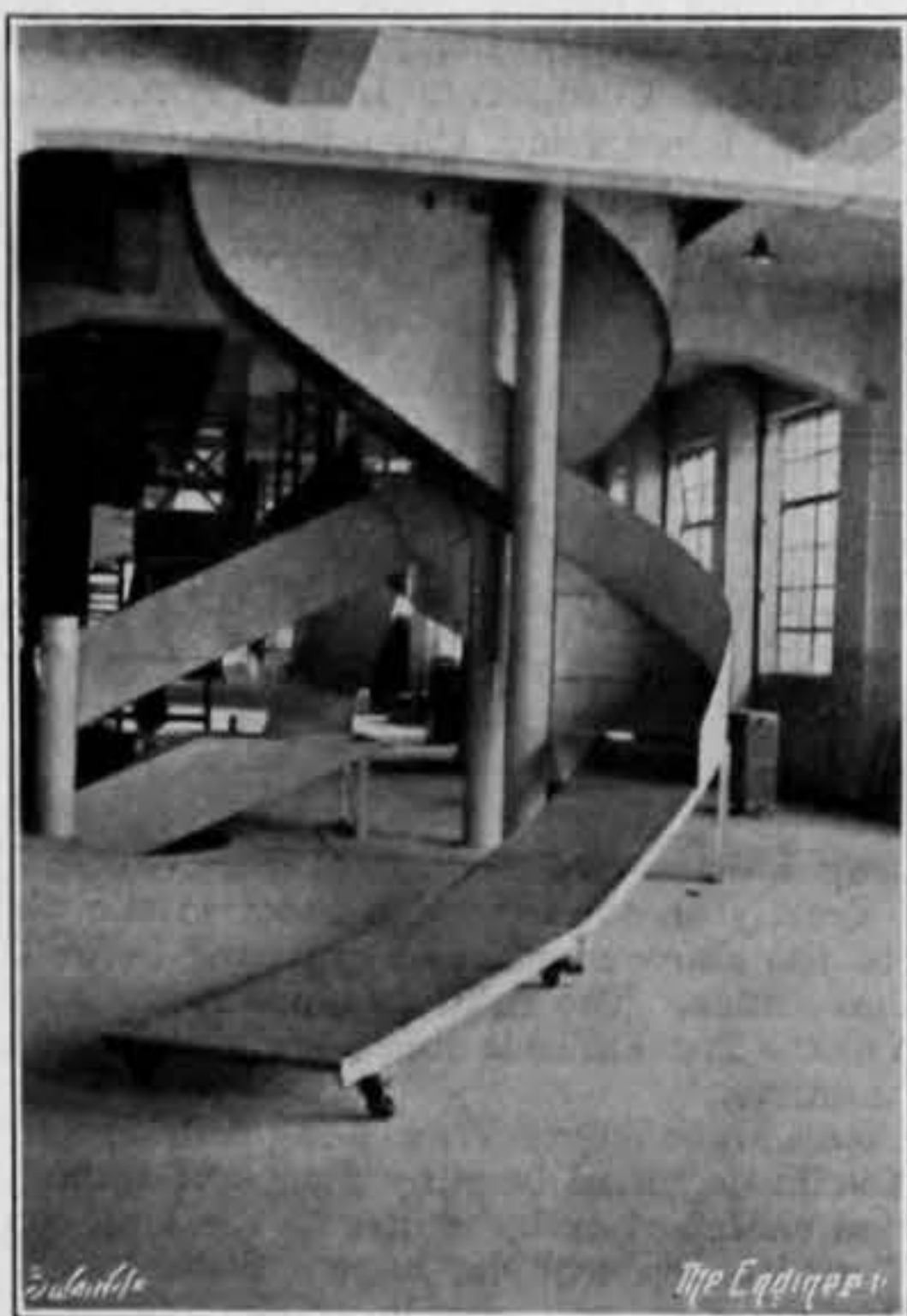
G. Conveyor G rises to a position just under the third floor and letters are ploughed off it for delivery to sub-sorting tables.

The return side of G is called conveyor H; it receives from the second floor and delivers to a sorting table in the "private box" compartment.

There are a number of other chutes for various purposes, including two for sending empty bags down to the bag-cleaning room in the basement.

The following particulars of some of the units of the plant have been extracted from the maker's specification:

There are, for instance, within the Post Office building six conveyors each 36in. wide, ranging from 10ft. to 117ft. long, together with six 30in. conveyors of from 30ft. to 152ft. length. These conveyors run at about 150ft. per minute and are of solid woven cotton $\frac{1}{4}$ in. thick. They



SPIRAL CHUTE FROM ELEVATOR "Y"

run on idlers, spaced at 3ft. centres, made of 3in. steel tube running on ball bearings. The sides of the conveyors are of No. 10 B.W.G. mild steel plating, ranging from 12in. to 18in. deep, according to their length, stiffened by the angle guides on which the edges of the belt run. The driving pulleys are driven through chain and worm reduction gear, each from its own motor, and the tension in the belt is maintained by cast iron weights in the usual manner.

In the case of the elevator Y, which is of 84ft. centres by 30in. wide, the belt is of four-ply canvas with a $\frac{1}{8}$ in. cover of rubber on the working face. Its idlers are pitched at 4ft. centres and the casing is No. 12 B.W.G. steel plating. The head pulley is 3ft. in diameter and the boot pulley 2ft. In this case an overriding belt of three-

buckets are of No. 12 B.W.G. steel plating and bolted to a pair of cross bars which are fitted with ball-bearing rollers bearing on angle iron guides. The belt is of three-ply canvas and rubber. There is a spot-light indicator which warns the attendant at the bottom of the arrival of a bucket.

The spiral chutes need little description. Most of them are 6ft. 10in. in diameter by 12ft. pitch, with a 9in. central tubular column and are made with 10 B.W.G. bottoms and 12 B.W.G. sides. There are, however, two chutes of 3ft. diameter by 5ft. pitch, and of 22in. diameter, respectively.

Iron and Steel Statistics.

THE British Iron and Steel Federation has published an advance edition of its annual statistical year book, comprising fifty-five pages, compared with 300 pages in the complete volume. The advance copy deals exclusively with statistics of the British iron and steel industries and contains a large number of interesting tables. Figures of production, imports and exports of iron and steel, coal, coke, and iron ore are included. In the notes issued with the volume it is pointed out that owing to the expansion of completely integrated plants combining blast and steel furnaces, steel makers' consumption of their own pig iron and scrap metal increased from 51.6 per cent. to 53.2 per cent. (comparing 1935 and 1936), and the use of pig iron and scrap bought from outside firms declined correspondingly. The total internal consumption of steel-making materials rose by 1,225,000 tons, and outside purchases increased by only 778,000 tons.

The statistics show that an important change took place during 1936 in the relations of blast-furnace metal to scrap in the steel furnace burden as a result of the increasing scarcity of steel scrap from midsummer onwards. In 1935 the average 10-ton ingot contained 5.92 tons of scrap and 4.66 tons of pig iron and/or hot metal. In 1936 these proportions had altered to 5.87 tons and 4.72 tons. The change resulted from a rise in scrap prices during 1936 of about 10 per cent. Some 40 per cent. of the scrap content is automatically produced within makers' works.

The correspondingly higher pressure on blast-furnace production gave rise to interesting economies in actual performance, but caused serious problems as to coke and iron ore supplies. Only 55.81 cwt. of burden, against 56.33 cwt. in 1935, were required per ton of pig iron. Progress in fuel efficiency is reflected in the fall from 33.58 cwt. to 33.16 cwt. of coal equivalent burned, due largely to more modern coke oven practice. High freights and the difficulty of quickly enlarging foreign sources of supply, however, threw the brunt of this load on to domestic ironstone mines. The additional 1,297,000 tons of pig iron smelted in 1936 required 2,786,000 more tons of iron ore. Of this need British quarries satisfied roughly $\frac{1}{4}$ million tons, and foreign mines one million. Supplies of iron ore from Newfoundland, the Labrador Coast, and Sierra Leone have tripled in the last two years alone. In this country rapid expansion is taking place in the Oxfordshire and Northants fields. Of the 1,800,000 tons higher output of home mines in 1936, these districts contributed nearly half. At the same time, the comparatively low iron content of those ores necessitated a higher consumption of coke in the blast-furnace and tended to aggravate the coke shortage.

Interesting figures relating to the supplies of semi-finished steel, the shortage of which has given rise to considerable complaints, are contained in the statistics. The production of billets, blooms, and slabs amounted to 7,317,900 tons last year, compared with 5,018,400 tons in 1929, which is generally regarded as the last ante-duties boom year. The quantities "despatched" presumably to re-rolling works amounted to 1,841,400 tons in 1936, against 1,022,200 tons in 1929. If we add to the quantities despatched, the imports, it will be found that the re-rolling works received 2,293,219 tons of billets, blooms, and slabs in 1936, compared with 1,594,705 tons in 1929, a balance in favour of last year of 698,514 tons. In the case of sheet and tin-plate bars, however, the comparison is not so satisfactory. Last year the British production was 2,387,700 tons, of which 1,380,800 tons was described as "despatched," which means presumably that they were sent to independent sheet makers. In 1929 the production was 2,223,700 tons and the quantity despatched 1,159,200 tons. The imports in 1929 totalled 418,838 tons and in 1936 95,140 tons. It will be seen, therefore, that the independent firms received last year 1,475,940 tons, compared with 1,578,038 tons in 1929.

One of the features of the statistics for 1936 is the remarkable increase in the production of finished steel, which rose from 7,101,800 tons in 1935 to 8,548,600 tons in 1936. In 1929 the production was 7,624,700 tons. The largest items were boiler plates, and plates $\frac{1}{4}$ in. thick and over, the output of which amounted to 1,431,200 tons; squares, angles, channels, and tees, 1,050,600 tons; and rounds, squares, flats, and hexagons, 1,315,900 tons.

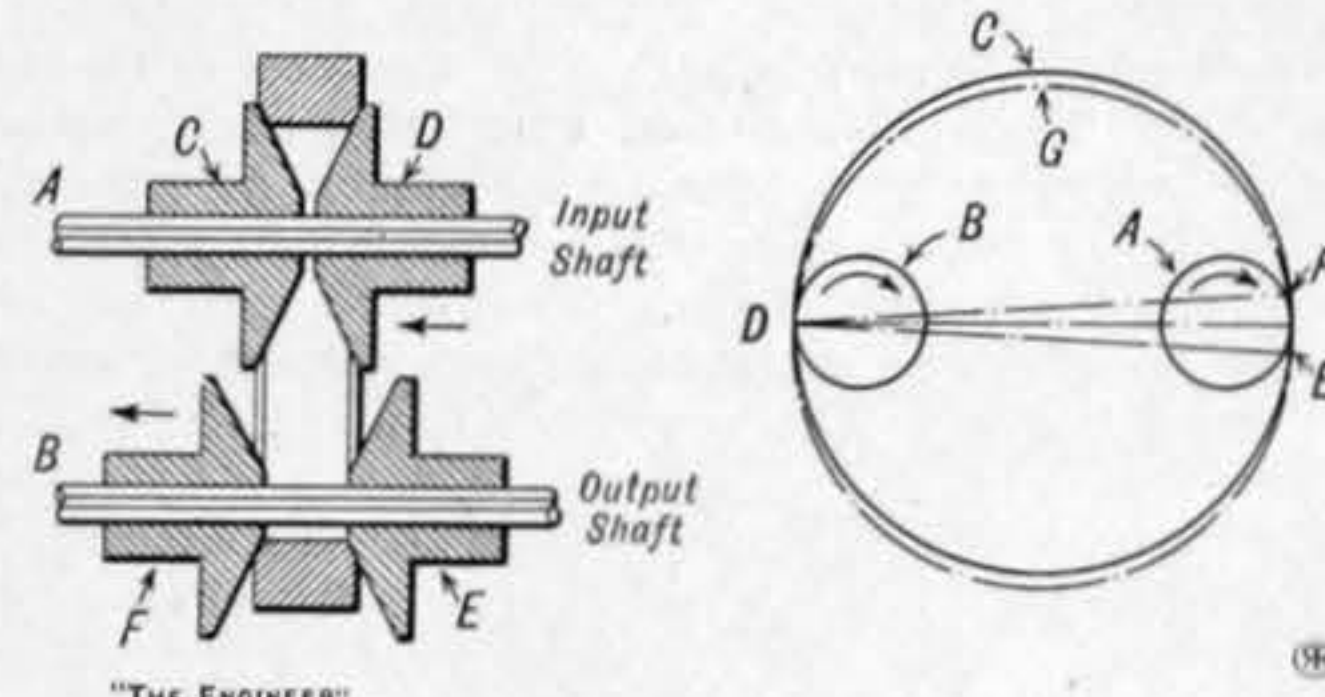
Valuable and interesting as these statistics are, they would be much more so if comprehensive figures of the consumption of iron and steel by the principal industries were included. It might not be easy to obtain these particulars, but with the resources at its disposal the British Iron and Steel Federation should be able to give reliable figures for the most important industries, such as shipbuilding and the chief branches of the engineering trades.

A Variable Speed Gear.

In an article which appeared in our issue for December 18th, 1936, we described the Newall jig borer, which has incorporated in it a variable-speed gear to give stepless variations of the spindle speeds. This mechanism, known as the "H" gear, is now available in a number of forms suitable for incorporation in many machine tools and for other engineering purposes, in units which are capable of

transmitting up to 10 H.P. We have recently inspected these gears and obtained particulars of their construction and operation from E. H. Jones (Machine Tools), Ltd., Edgware-road, The Hyde, London, N.W.9.

The accompanying line engraving, Fig. 1, shows the construction of the "H" gear. The input and output shafts, A and B, of the mechanism are splined and have mounted on them two pairs of hardened and ground cones, C, D, E, and F. Power transmission between the shafts and cones is effected by means of a hardened and ground steel connecting ring. The cones C and E are fixed to their respective shafts, but cones D and F can slide along their shafts, together with their bearings and bushes. The operating mechanism controls the motion of the movable cones D and F, so that when the distance separat-



FIGS. 1 AND 2-ARRANGEMENT OF "H" GEAR

ing cones C and D is increased, the distance separating the other pair of cones is correspondingly decreased, and vice versa. By means of this motion the relative position of the ring alters and the ratio of the peripheral velocities of the respective lines of contact can be varied, thus varying the relative speeds of the shafts.

Each cone is supported by a ball bearing in the housing which encloses the mechanism and operating gear. It is claimed that this method of mounting relieves the shafts of all stresses except the driving stresses. The illustration, Fig. 2, shows how the contact pressure between the ring and the cones is automatically increased in proportion to the power transmitted. It is stated that slip is completely eliminated, and that since no preloading device is used, the idling losses are considerably reduced. When running under no-load conditions the ring C makes contact

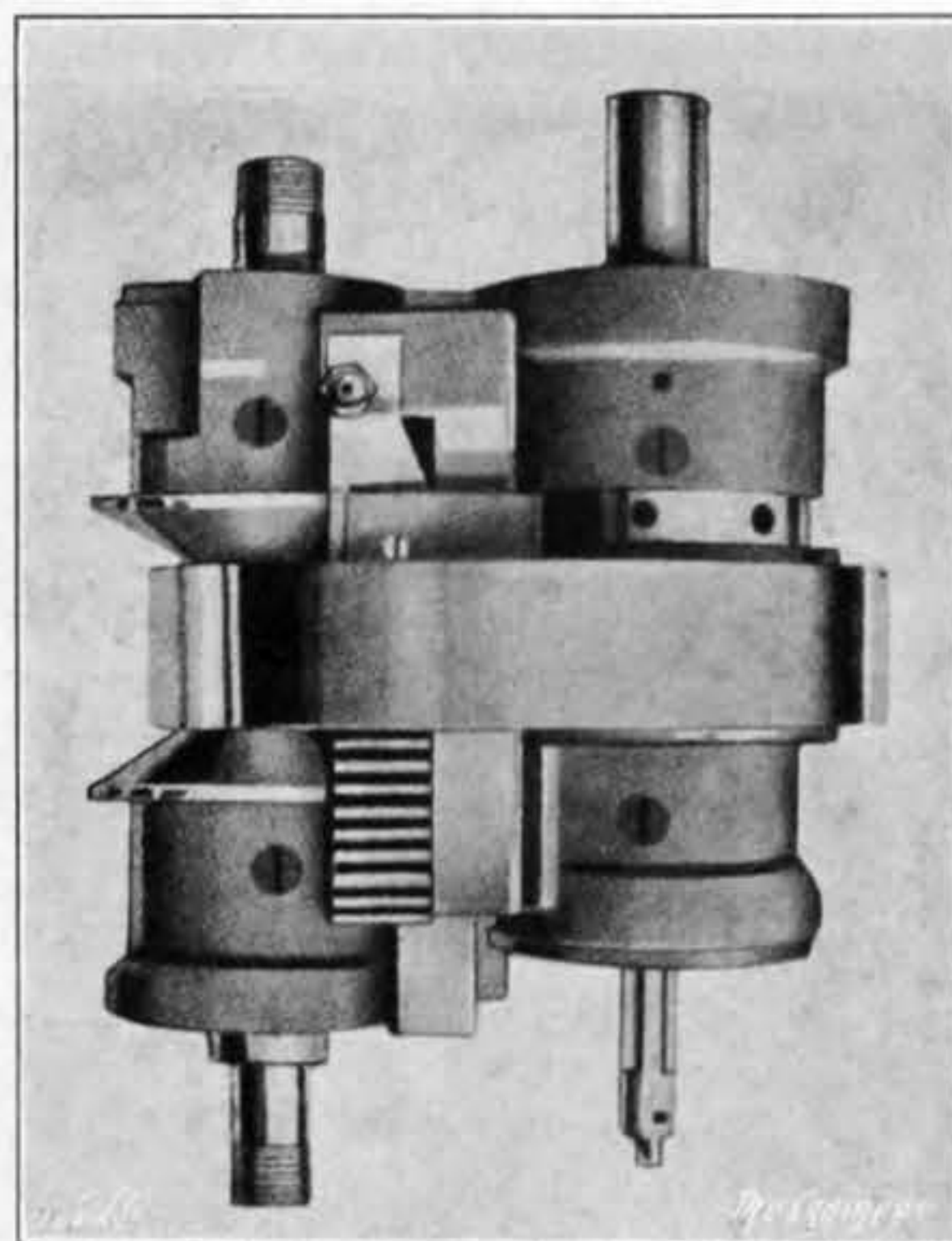


FIG. 3-ASSEMBLY OF GEAR

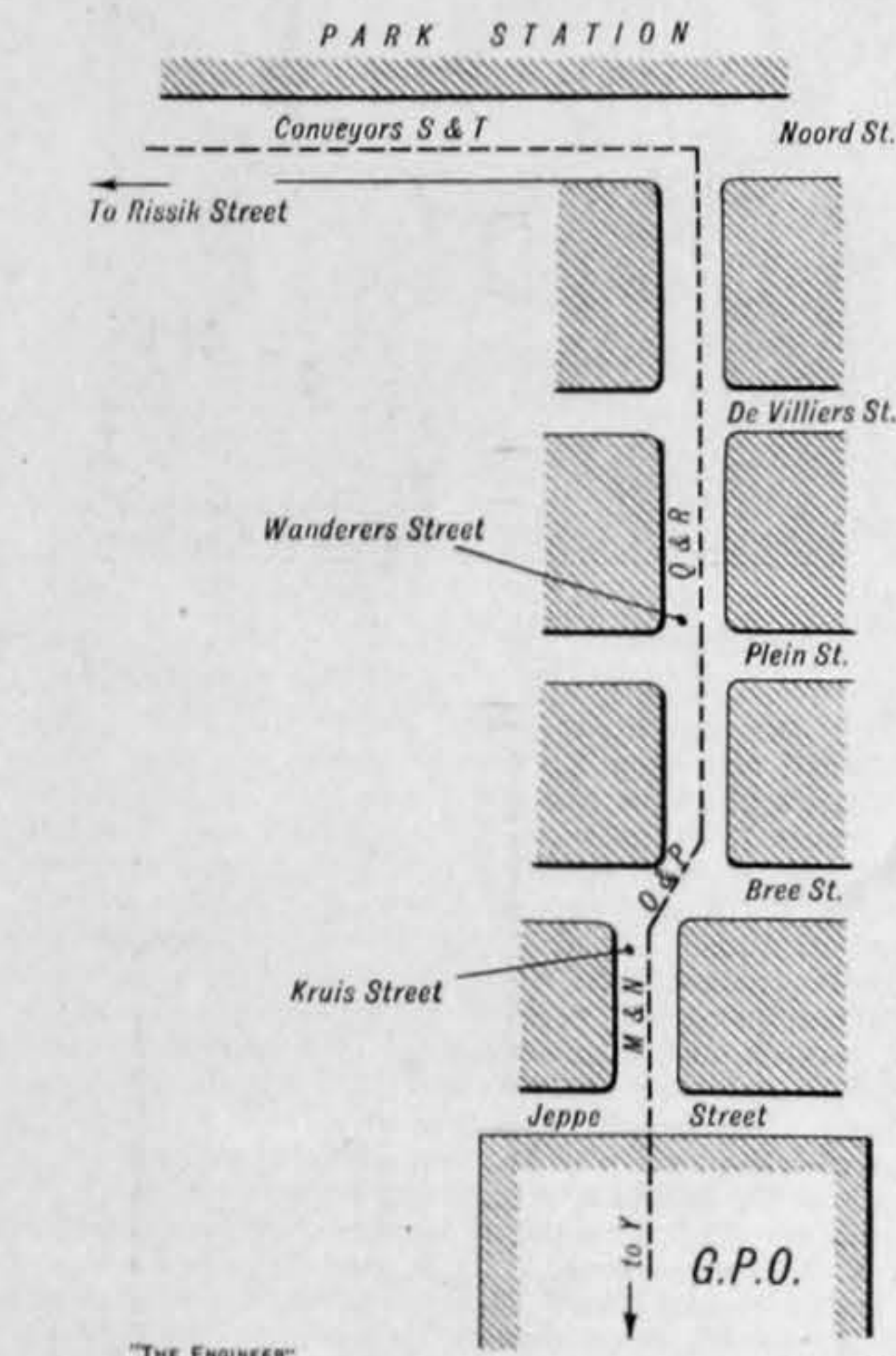
with the cones A and B at points D and E. An application of load produces a reaction which tends to move the ring into a position, such as shown at G. The point of contact of the cone A is therefore shifted away from the diameter D E to a new position, such as F. The distance D F is less than the distance D E, and therefore a type of wedging action will occur, the amount of which, it is claimed, is proportional to the power being transmitted.

A complete "H" gear, without the housing, is shown in Fig. 3. Another type of unit is fitted with a self-contained differential, whereby any ratio from the maximum to zero may be obtained in each direction of rotation. When working at low speeds the teeth of the differential gear cannot be made sufficiently robust to enable the full power to be transmitted, and therefore the reversing type of gear is limited to a constant torque transmission, although the torque is equivalent to the nominal H.P. capacity at the maximum speed. All "H" gear units run in an oil bath and are claimed to transmit the nominal H.P. capacity without slip occurring.

New 10-Ton Chassis.

In order to provide a chassis with a payload capacity midway between that of the two-axle vehicle, with its limit of 7 $\frac{1}{2}$ to 8 tons, and that of the three-axle type, with a limit of 13 to 13 $\frac{1}{2}$ tons, the Associated Equipment Company, Ltd., Southall, is introducing a six-wheel chassis with a payload capacity of 10 tons.

Known as the "Mammoth Minor," the new chassis, shown in the accompanying engraving, is fitted as standard with the A.E.C.-Ricardo six-cylinder, 7.7 litre oil engine, and weighs 4 tons 4 cwt. 2 qrs. for licensing purposes. If a six-cylinder, 7.4 litre petrol engine is fitted, the net



CONVEYOR SYSTEM BETWEEN G.P.O. AND STATION

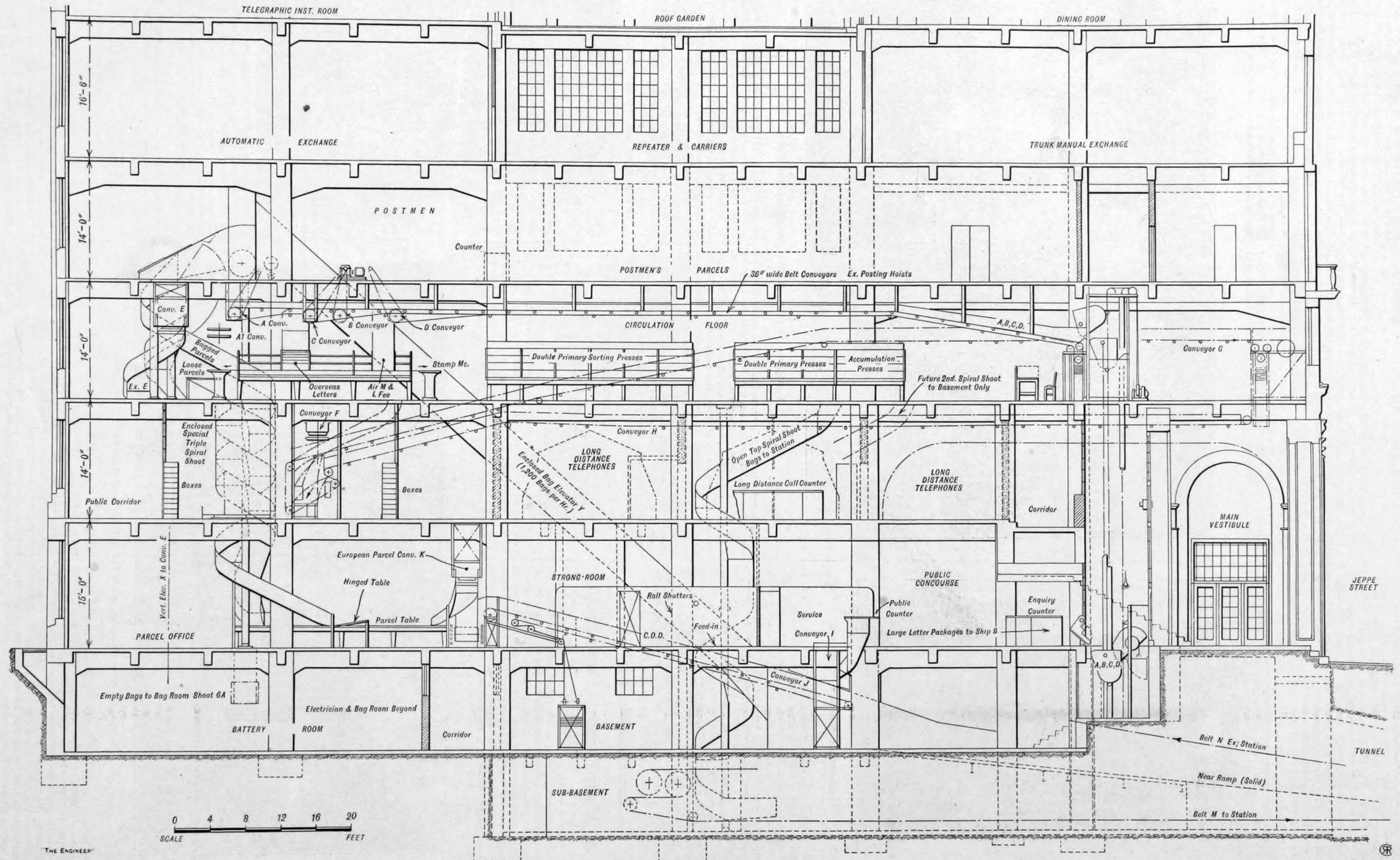
ply with a $\frac{1}{32}$ in. covering is allowed to rest on the tops of the mail bags and prevent them from sliding down again. This belt is driven at its lower end by a chain from the bottom shaft of the elevator. This elevator Y is fed by a short conveyor of 27ft. centres, which receives the bags from the conveyor N.

The conveyors from the Post Office to the station are all 42in. wide and of four-ply canvas with $\frac{1}{8}$ in. rubber covering. They range in length from 82ft. to 1195ft. and run on 5in. diameter idlers spaced at 4ft. centres. The driving pulleys are 30in. in diameter and are lagged with three-ply rubber.

The elevator X in the Post Office is of the vertical chain and bucket type, and has the buckets spaced at 6ft. 9in. centres. It runs at a speed of about 54ft. per minute, and delivers some eight bags a minute. The

CROSS-SECTION THROUGH NEW JOHANNESBURG POST OFFICE

(For description see page 19.)



licensing weight is 3 tons 18 cwt. 3 qrs. The wheel base is 15ft. 6½in. and 20ft. of body space is provided.

The six-cylinder oil engine has overhead valves operated by push-rods from the camshaft, which is carried in the cylinder block. The cylinder block is fitted with hardened iron liners and the seven-bearing crankshaft is provided with forced lubrication. The engine develops 108 B.H.P. at the governed speed of 2000 r.p.m. The single-plate type clutch is totally enclosed in the gear-box bell housing; the gear-box is mounted as a unit with the engine. Four forward speeds and reverse are provided, with constant-



"MAMMOTH MINOR" CHASSIS

mesh gears for the third speed. The ratios are 4.38, 2.69, 1.59, and 1 to 1, with a reverse gear of 5.33 to 1.

The rear driving axle incorporates a double-reduction bevel gear with a standard ratio of 6.25 to 1. An alternative rear axle ratio is 7.9 to 1. The foot brake actuates internally expanding shoes in drums on all six wheels, operated by a servo-assisted hydraulic system. The hand brake operates on all four rear wheels. The fuel tank has a capacity of 40 gallons. The electrical equipment, of the 24-volt type, includes a dynamo with an output of 470 watts; a 106-ampere-hour capacity battery, and an axial type starting motor. As additional equipment, a power take-off can be mounted on the gear-box to provide a power drive for pumps or other appliances, as well as a mechanically operated tire pump.

A Multi-Purpose Commercial Vehicle.

A COMMERCIAL vehicle, designed and marketed by J. H. Sparshatt, Portsmouth, in conjunction with Dodge Brothers (Britain), Ltd., Kew Gardens, Surrey, is shown in the engraving herewith. The vehicle is constructed for ordinary use as a flat-platform lorry, but can be quickly converted into a fire-fighting machine. The platform can be raised, as shown, to disclose a canvas container,



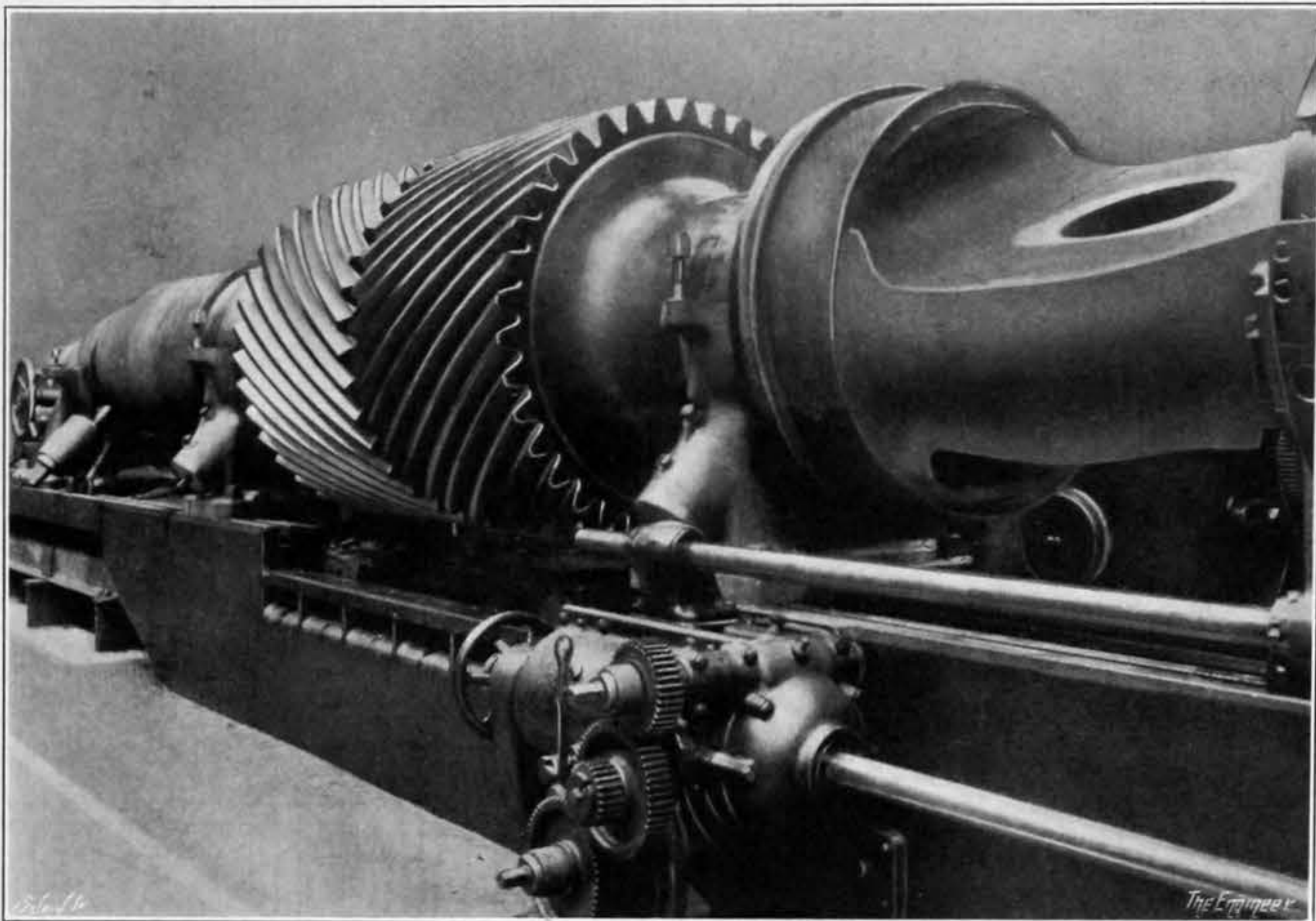
COMMERCIAL AND FIRE-FIGHTING LORRY

capable of holding 600 gallons of liquid, which, it is claimed, is sufficient to extinguish an ordinary fire. The container can be filled either from a hydrant or from a pond. The vehicle is fitted with a pump capable of delivering 100 gallons per minute at a pressure of nearly 100 lb. per square inch, and producing a 90ft. jet. The illustration shows the equipment at work with a decontamination jet.

30-Ton Rolling Mill Pinion.

THE engraving herewith illustrates the operation of cutting the teeth on one of two rolling mill pinions for a large plate mill. The machining of these pinions was carried out in the works of David Brown and Sons (Hudd.), Ltd., Huddersfield. Made of nickel-chrome steel, each pinion has thirty-eight double-helical teeth of 3½in. circular pitch; the width of the working face is 71in., while the shaft is nearly 23ft. long. The pinion is integral with the shaft and weighs about 30 tons.

Because of the load imposed on the bearing necks during the cutting operation by the weight of the pinion, the



CUTTING TEETH ON 30-TON ROLLING MILL PINION

journals were not finish ground until the teeth had been cut, after which operation the impression left in the track of the roller steadies was removed. The machine bed was extended by the addition of an auxiliary fabricated structure in order to support the pinion shaft at its far end. By this means three massive roller steadies were employed. The pinion shaft and pinion were rotated by means of a chuck at the coupling end and a centre at the other end. Although the pinions are not required to operate at a very high speed in service, the teeth must be accurately machined in order to eliminate "end slogger" of the main driving gears.

American Engineering News.

River Control Lock.

Since the reversal of flow in the Chicago River to cause its water and sewage to flow from Lake Michigan to the Mississippi River, by way of the drainage canal and Illinois River, there have been occasional periods after heavy rain storms when the flow is again into Lake

Calumet River, in the south part of Chicago, when this river also was connected to the main drainage canal by a new cut. They have been used also for the control of canals opening out of Lake Okeechobee, in Florida. The Calumet lock is 50ft. by 400ft., with two sets of sector gates, which can be operated against a head. All control of flow is obtained by varying the width of opening between the gates. The flow in the drainage canal is about 80 per cent. from the Chicago River and 20 per cent. from the Calumet River.

Earthquakes and Elevated Tanks.

In view of the extensive use of water tanks on high steel towers for water supply of American cities, towns, and public institutions, and the damage to such structures in earthquake shocks, studies of the design of quake-resistant structures have been made, assisted by tests of models. In a report to the American Society of Civil Engineers, the conclusion is that the common static method of design against earthquakes cannot be applied safely to elevated tank structures, but a modified design is suggested with a higher factor of safety under stress. Dangerous stresses are not avoided by designing against a static horizontal force of one-tenth the weight of tank and contents, since the ordinary structures lack damping action and ability to withstand large deflections. Moderate strengthening cannot improve the resistance materially, although the safe deflection of an ordinary water tower may be increased as much as 50 per cent. by strengthening the bracing in proportion to the loads, instead of using the same size of brace rods in several panels. Experiments were made with model tank towers in which the diagonal braces were connected to the gussets or connection plates through the medium of stiff springs, with sufficient damping to give a higher safety factor than the ordinary rigid tower. It would not be practicable to provide sufficient safe deflection by using springs without damping, but the amount of damping is small enough to be provided in practical design. The introduction of the spring elements does not affect the normal stability of the tower structure. To provide against torsional or twisting effects due to differences in action between elements on opposite sides of the tower, horizontal bracing of light steel rods at the level of the horizontal struts would equalise the action in case some of the damping devices should fail to act properly. With an initial compression for a horizontal force equal to one-fifth of the weight of tank and water, a deflection of 15in. in the tower may occur with safety.

SOUTH AFRICAN RAILWAY EXPENDITURE.—On the South African Railways during the current financial year expenditure on capital and improvement works is estimated at nearly £7,353,000. Of this amount over £1,105,000 will be spent on rolling stock. For the doubling of lines £27,000 will be spent on the Dunsward-Witbank section, £89,177 on the Germiston-Pretoria line, £25,000 on the Jupiter-Canada Junction line, and £20,000 on the Midway-Orlando line. The Reef electrification, for which £316,827 has already been voted, will require an additional £51,000. Provision has also been made towards the cost of 145 new main line saloon coaches. There is also a sum of £100,000 on the estimates for fitting recording speedometers on passenger trains.

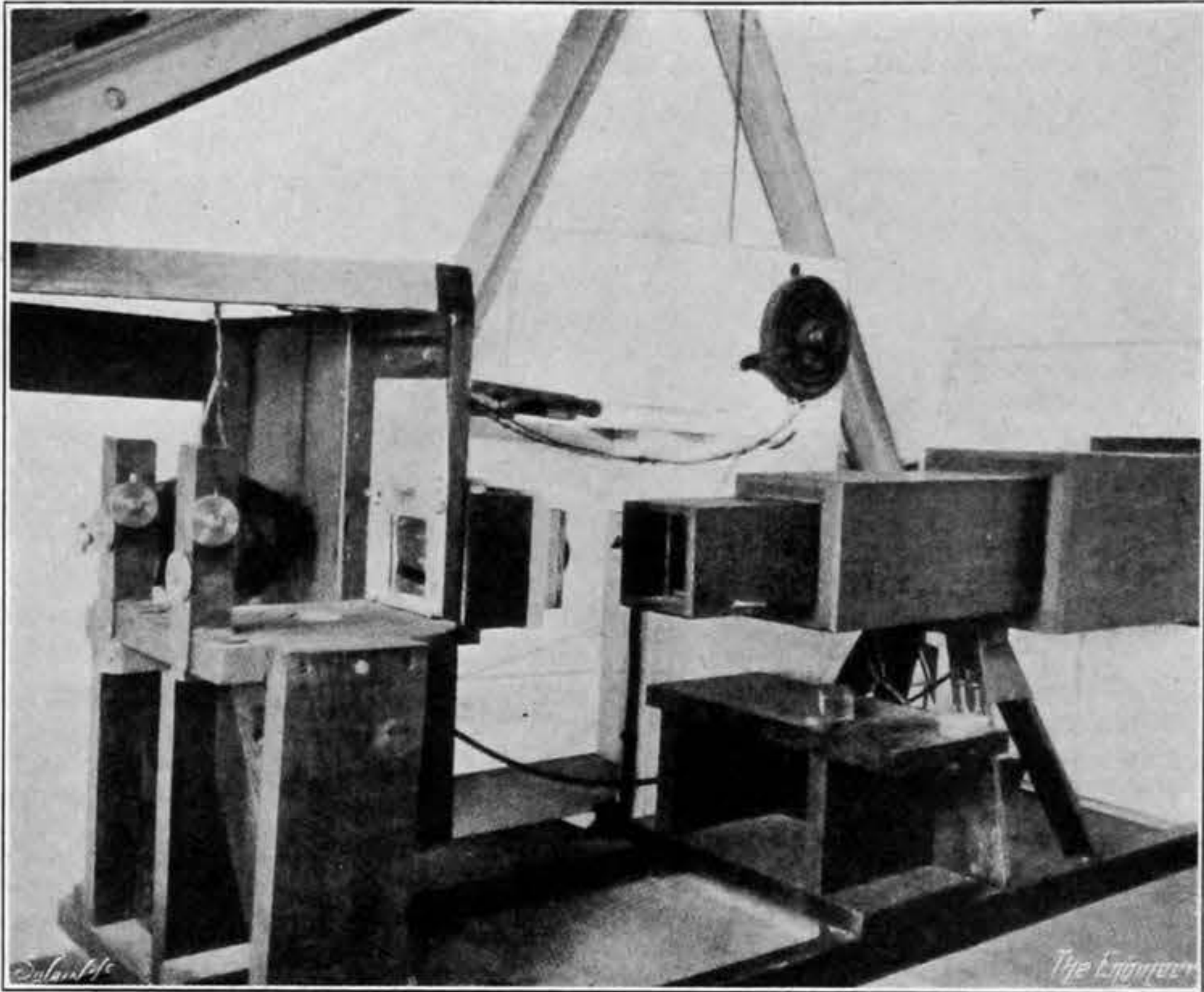
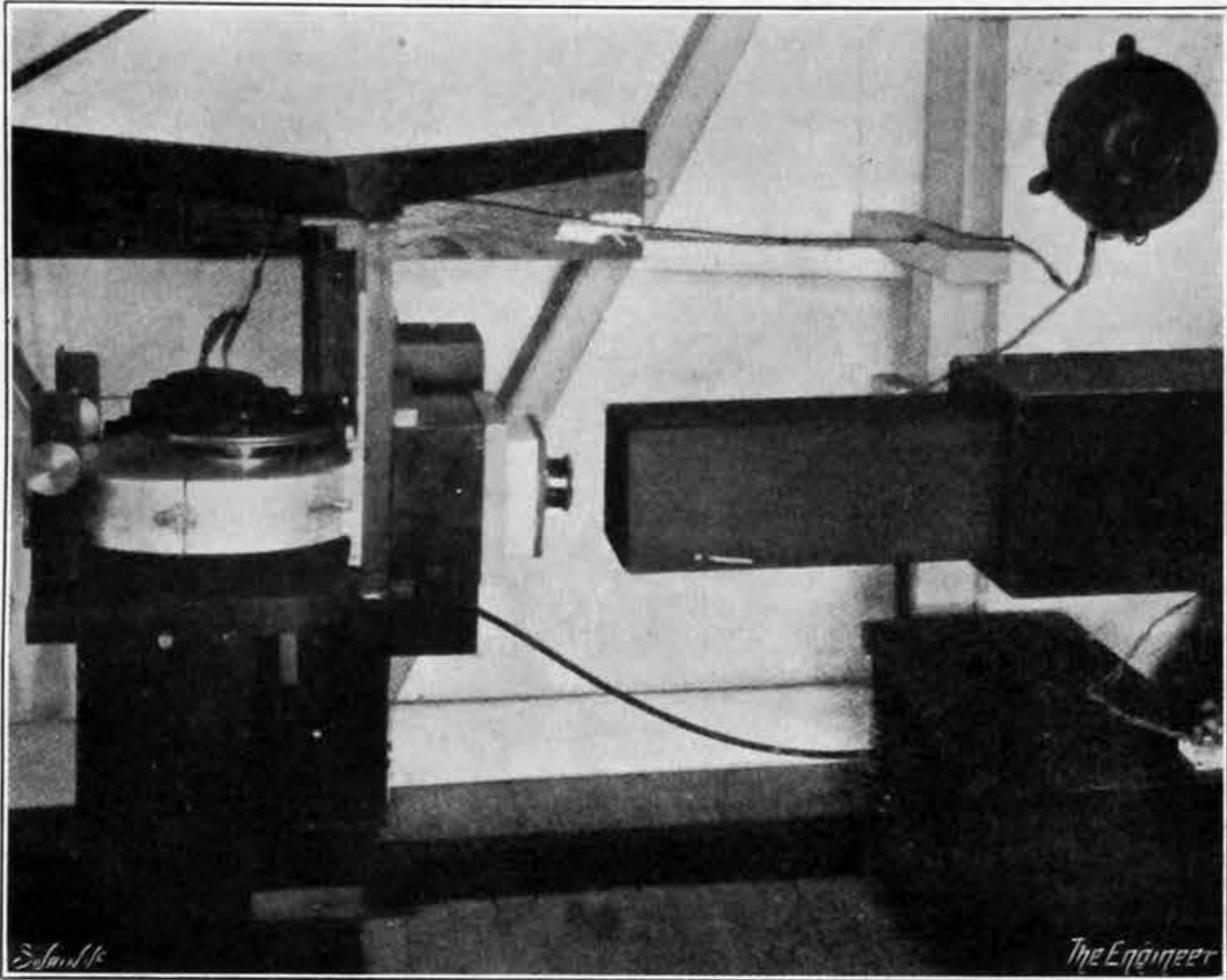
High-Speed Camera for Propeller Research.*

By Commander E. L. GAYHART (CC), U.S. Navy.†

In this article the author describes a new mechanical oddity developed by the U.S. Naval Model Basin personnel to meet the need for extreme rapidity in photography involved when pictures of a propeller travelling at full speed had to be taken. With the propeller turning in a tank and only visible through a heavy glass viewing window, the unsatisfactory conditions may well be imagined. The urgent necessity for the elimination of all

coincide with the frequency of the propeller blades; and third, a high intensity mercury arc whose flashing control is driven by a rotating contact on the propeller shaft. The first type of stroboscope referred to is commercially available under the trade name of "Rotoscope." This instrument, which is readily portable, has also been used for the observation of cavitation phenomena on the propellers of vessels at sea. In the study of the details of cavitation there are certain disadvantages in the devices of the stroboscope type. In the first place, the apparent illumination is very feeble. This is obviously due to the fact that the impression of intensity of light from the moving object is reduced in the ratio represented by the fraction whose numerator is the length of time during which the shutter is open or illumi-

faced cam has been replaced by a cam with a single face) offers the further advantage that the phase angle may be adjusted, analogously to the adjustment of the angle of spark advance in the automobile, and gives the impression of a movement of the propeller to any desired position within an angle of some 120 deg. All three types of stroboscopes described above possess a common fault, namely, that the impression produced upon the eye is actually a composite resulting from the retention and overlapping of the impression on the retina of the rapid sequence of individual images. The last-mentioned objection to the stroboscope made it desirable to develop a camera which could take and preserve individual exposures. Otherwise, it would have been perfectly practicable to make time exposures of a



FIGS. 1 AND 2—FINAL ARRANGEMENT OF HIGH-SPEED CAMERA

vibration in the focal unit and the poor visibility made the problem an extremely difficult one to solve, and its solution reflects great credit on the ingenuity of the laboratory personnel. As an introduction to the following description of the high-speed camera for propeller research at the Experimental Model Basin it is desirable to begin with an outline of the conditions under which the camera is used and of the equipment which the camera supplements. The variable-pressure water tunnel has already been fully described in the technical literature ("Transactions" of the Society of Naval Architects and Marine Engineers, Volume 38). At the risk of repetition the reader will be informed that the testing chamber of the propeller tunnel is provided at each side with a glass port some 16½ in. in

nant giving off light and whose denominator is the total length of the cycle. Referring to another principle of the stroboscope, the sharpness of definition obtained with the stroboscope is determined by the amount of motion during the illuminated portion of the cycle. The operator must therefore make a compromise between apparent illumination and definition. The hand-operated stroboscope gives good definition, but the apparent illumination is very feeble. The stroboscope of the interrupted light beam

standing image of a propeller apparently stopped by the application of the stroboscopic principle. In fact, experiments were made following this procedure and using the mercury arc stroboscope. In such a picture the propeller would be well defined because the picture consisted of a rapid succession of exposures on the sensitive plate of the repeated image of the propeller, but necessarily the cavitation phenomena would vary from one exposure to the next and the resulting picture would then show only the envelope and region of the cavitation phenomena in lieu of the details.

When it was decided to construct a camera that could take individual exposures in lieu of composite pictures, the following single consideration fixed its design, namely, that the time of exposure of the single image must be so brief that the tip of the propeller blade will not move more than 1/100 of an inch during the exposure. The speed of rotation for model propellers when cavitating is of the order of 1400 r.p.m. for models of destroyers, which would correspond to a speed of rotation of the ship's propeller of approximately 350 r.p.m. (The law of comparison requires for propellers that the ratio of model speed to full-scale speed vary inversely as the square root of the linear ratio.) An average propeller diameter is 8 in. These considerations, namely, 1400 r.p.m., 8 in. diameter, and peripheral motion limited to 1/100 in., lead to an exposure time of approximately 1/50,000 of a second.

Two methods of arriving at a short exposure time are offered; one of them would be by spark photography and the other by a mechanical shutter. The plan for using spark photography was never seriously considered. To obtain the required amount of illumination from a spark would involve an inordinate amount of power with the attendant objections associated with the high voltage and noise and a probable difficulty of recharging the condenser and repeating the spark at a sufficiently rapid rate. In

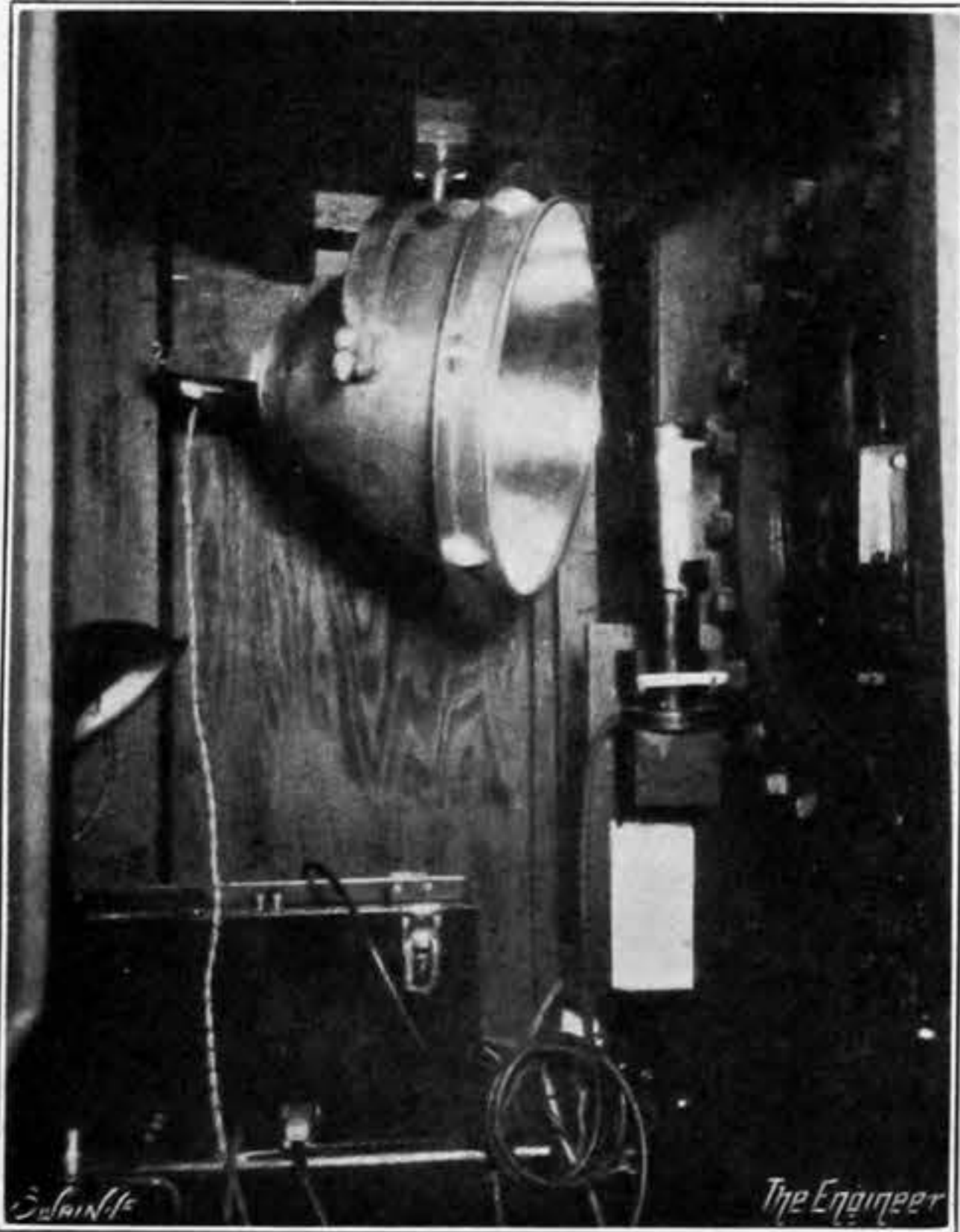


FIG. 3—LIGHTING UNIT

diameter. Obviously, the only important visible manifestations on propellers and other objects in the stream of water are the various aspects of cavitation phenomena. The water, kept clear by filtering, enables easy visual observation, although the chamber is 27 in. net width, with the consequence that visual observations must be made through a thickness of in. of glass and 13½ in. of water. The observation of such phenomena on rotating propellers is most conveniently made by use of some form of stroboscope. At the Model Basin three types of stroboscopes have been used: first, a portable type consisting of a spring motor device for rotating a shutter at an adjustable speed; second, an interrupted light beam for illuminating the propeller with a flickering light timed to

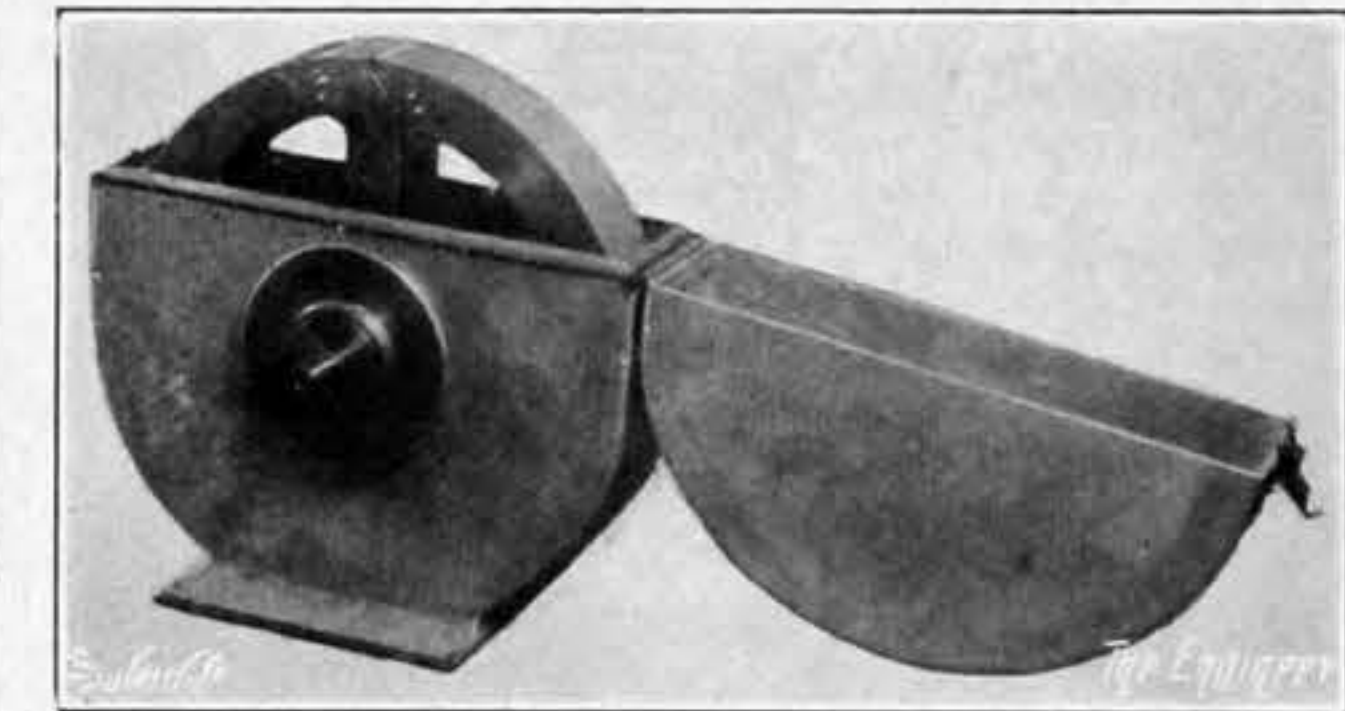


FIG. 4—IMPROVED DRUM

type, which was developed for the water tunnel, gave fairly good illumination, but the definition was not satisfactory. The high intensity mercury arc (the one in use at the Model Basin is the Edgerton stroboscope manufactured by the General Radio Company) has a flashing time or duration of flash of the order of 5 micro seconds. The light intensity of the flash is very high, but because of the extremely brief flashing time the impression on the eye is slight. Although this type of stroboscope gives definition of amazing sharpness, the apparent illumination is feeble and it was necessary to enclose the observation port with a small dark room before this stroboscope could give satisfactory observations.

Another difficulty which occurs with the stroboscope arises from the fact that these devices require a synchronisation of the light flashes or observing shutter with the motion of the object being observed. In the hand-operated Rotoscope there is a centrifugal governor, which must be adjusted until the object observed apparently becomes stationary. In the stroboscope employing the interrupted light beam it was necessary to adjust the speed of the motor which revolved the occulting shutter. The mercury arc stroboscope is self-synchronising; that is, the contactor for controlling the flash is driven by the propeller shaft, an arrangement which automatically accomplishes synchronisation and produces a perfect standing image. This contact arrangement (the actual contact is itself an automobile timer in which the multiple-

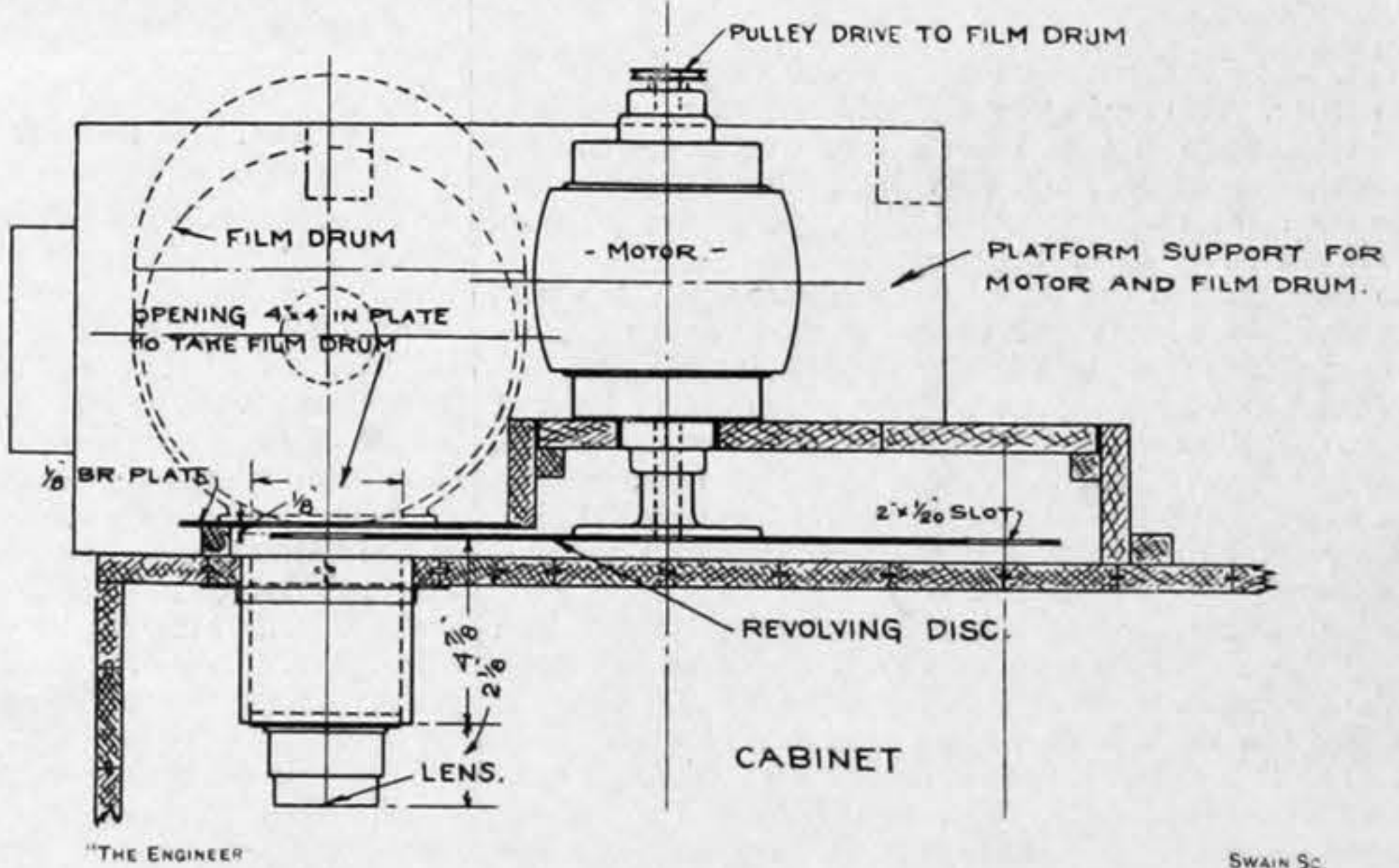


FIG. 5—ARRANGEMENT OF HIGH-SPEED CAMERA

this connection it is to be noted that the mercury arc stroboscope has a limit of 250 flashes per second. It was decided to use a mechanical shutter, which, in view of the short exposure required, would be of necessity of the focal plane type. Mechanical considerations, such as the refinement required in the finish of the slit edge when using a very narrow slit as well as objectionable

* From the Journal of the American Society of Naval Engineers, May, 1937.
† U.S. Experimental Model Basin, Navy Yard, Washington, D.C.

diffraction phenomena that would develop with the use of too narrow a slit, appeared to fix the desirable width at not less than $1/20$ of an inch. The slit width of $1/20$ of an inch and exposure time of $1/50,000$ of a second would require a linear speed in a shutter curtain of 2500 in. per second. It would be impracticable to start and stop a shutter curtain and attain such a high curtain speed in any arrangement of the customary type. The high curtain speed could only be reached with a continuously moving curtain, which consideration leads to the obvious use of a radial slit in a revolving disc.

The shutter was therefore designed as a disc having an outside diameter of 20 in. and a slit 2 in. long with its outer end at a radius of $19\frac{1}{4}$ in. This disc, to attain the linear velocity of 2500 in. per second at the mean radius of the slit, must be driven at a speed approaching 40 revolutions per second, which is the convenient value of 2400 r.p.m. In the use of the camera the disc is brought to and held at this speed by a stroboscopic control, timing the stroboscope with a 60-cycle A.C. impulse. At 2400 r.p.m. three

usual motion picture camera the successive pictures are made on film which is stationary during the exposure and advanced by the pitch of the frames during the interval when the shutter is closed, but upon the Model Basin camera it was necessary, owing to the high speeds involved, to use a continuously moving film. The method adopted was to wrap a length of film upon the outer surface of a drum, driven by the motor which rotates the disc. The motion of the film during the sweep of the shutter slit across its width causes a distortion or rake in the individual pictures, the amount of the rake being determined by the ratio of drum peripheral speed to shutter surface speed. Additional slits were cut in the disc to increase the number of exposures per second. It is obvious that as the exposures per second are increased the film speed must be increased, with increased rake, or narrower individual frames must be accepted to exclude the overlapping portions of the pictures. As attempts were made to increase the film speed it was soon discovered that the blur induced by the motion of the film with respect to the

subtended by the slit width of $1/20$ in. corresponded in the language of photographers to an aperture of $F/8$, while the lens has an aperture of $F/4.5$. In other words, a point on the surface of the film cannot receive light at one time from more of the lens than about half its diameter (in the direction at right angles to the slit). The slit acts as a rectangular diaphragm stop on the lens, undoubtedly causing an unusual distribution of the effect of the errors of the lens.

Furthermore, the separation of the disc from the focal plane reduces the efficiency or light transmitting capacity of the shutter. This efficiency is the ratio of the total light action upon an element of film surface during an exposure as compared with the action that would result if the light were of full intensity for the entire exposure. In other words, shutter efficiency recognises the fact that part of the exposure time is used in opening and closing the shutter with full intensity transmitted only during the middle portion.

The camera was redesigned to improve the aperture and shutter efficiency. This was accomplished in part by a new film drum and container, in which the film surface is brought closer to the disc than previously. The reduced separation simultaneously increases the aperture as well

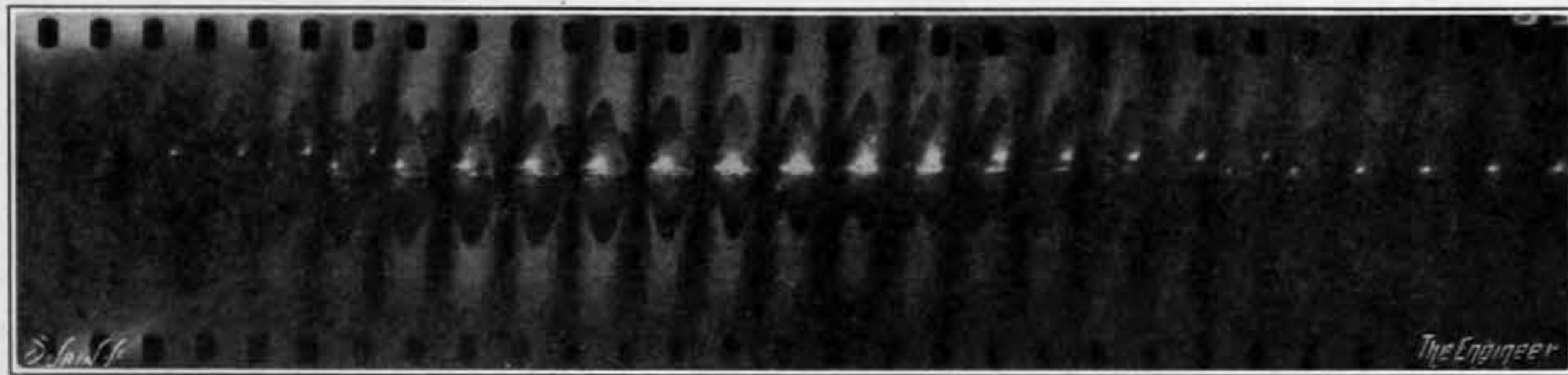


FIG. 6—STRIP OF PICTURES FOR ONE EXPOSURE

radial marks on the end of the motor shaft appear stationary when illuminated at sixty flashes per second.

The problem of illumination offered some complications. The light must enter with oblique incidence upon the glass of the port, entailing perhaps a loss of 40 per cent. Furthermore, the light in its entire travel to the propeller and back to lens must traverse 27 in. of water and 2 in. of glass. This illumination problem was solved by the use of photo flash lamps. These lamps develop an extremely high intensity of light for a brief interval of time. The No. 75 photo flash bulb, which is used with this camera, develops a maximum intensity of 9,000,000 lumens and the intensity is in excess of 4,000,000 lumens for approximately $1/50$ of a second. In other words, the peak candle-power of such a flash lamp is well in excess of 750,000.

Originally the flash bulbs were placed close to the glass port, suitably screened from the view of the camera. The illumination so obtained was not sufficiently intense and accordingly a reflector was developed for the purpose of concentrating the light upon the propeller. This reflector, which follows principles of geometrical optics, is shaped as an ellipsoid of revolution placed with the centre of the

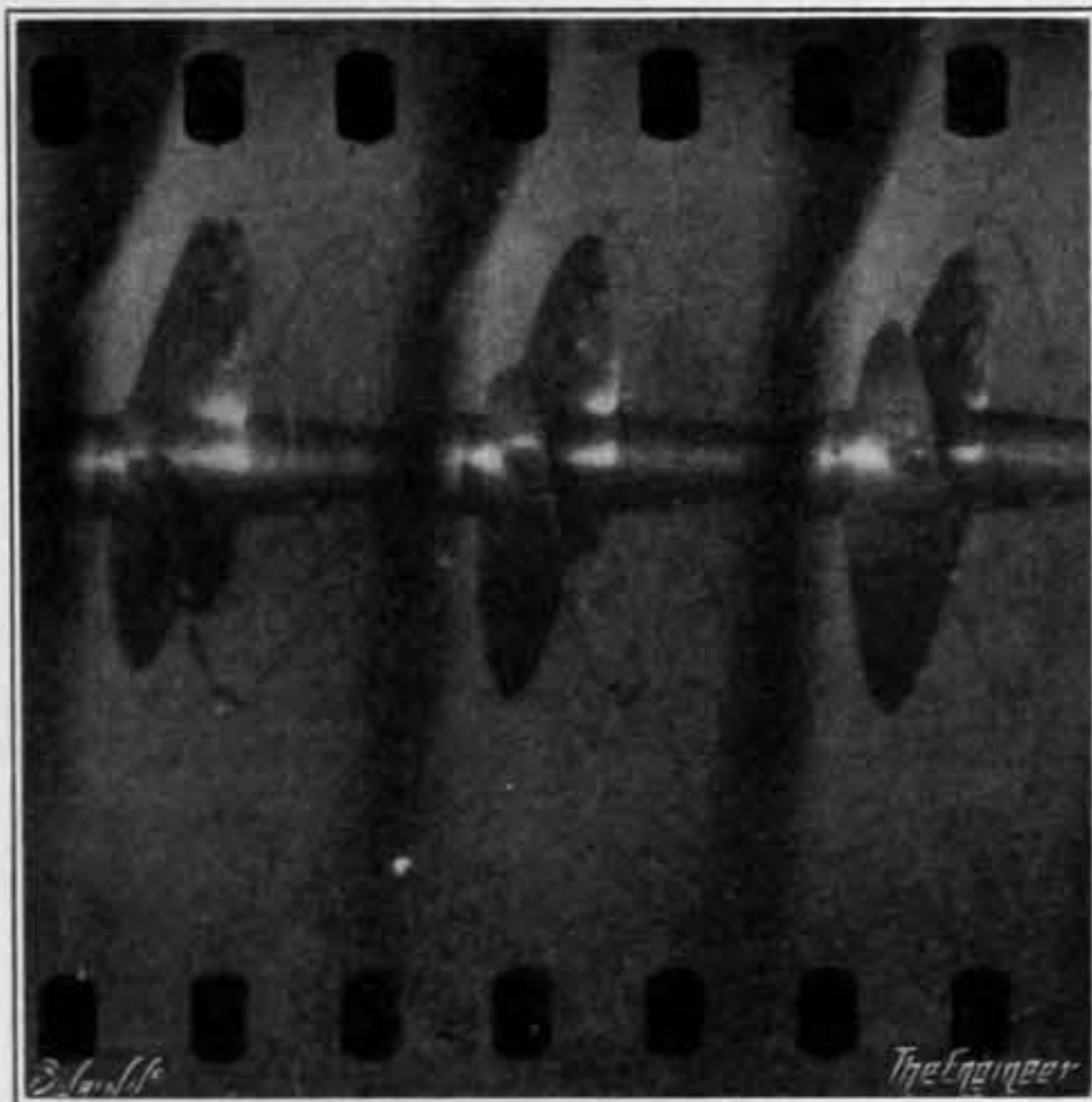


FIG. 7—PROPELLER TIP VORTICES

lamp bulb at one focus of the ellipse and the propeller hub at the other. The arrangement of the reflector, which was built in the shop of the Model Basin, can be seen in the accompanying photograph, Fig. 3, in which there is also to be seen the mercury arc stroboscope in the position where it is used for observing propellers.

The camera was originally constructed upon the wall of the small dark room (Fig. 5) and worked out for making single exposures; a plate holder for 4 in. by 5 in. cut film was affixed to a light-tight enclosure immediately back of the plane of the disc, with the radial slit sweeping across the narrow width of the film. The axis of the camera was placed to intercept the horizontal radius through the disc. The tangential motion of the slit was therefore vertical and in the plane of the propeller.

The procedure for making the exposure consisted in bringing the motor disc up to speed, checking the same with the stroboscope, pulling the slide on the plate holder, and firing the flash bulb in the closed cabinet or dark room. The firing circuit for the flash bulb included a contactor on the disc shaft, with an arrangement for shifting the phase angle of the contactor. The angle of advance for this contactor was found by trial in order to bring the slit opposite the plate holder during the maximum intensity of the flash. Later, a further refinement was introduced, namely, the use of an additional series contact in the firing circuit, this one actuated by the propeller shaft, in order to make the exposure with the propeller blade in a desired position.

The single exposure made on a 4 in. by 5 in. plate by this procedure having proved satisfactory, it was next determined to obtain a rapid sequence of pictures. In the

image during exposure placed a limit on the film speed. After reaching this maximum permissible film speed as limited by blur, an increase in the exposures per second could only be obtained by accepting a narrower frame for the single pictures. The final compromise in the design was reached by the use of twenty-four slits in the disc, which with the velocity of 40 revolutions per second produced an exposure rate of 960 frames per second. Pulley sizes were then worked out for the motor and film drum which give a pitch of the individual frames on the film of approximately $\frac{1}{4}$ in., which is a sufficient width to accommodate the image of the hub of any propeller ordinarily to be met with. The film drum, which is 10 in. in diameter, uses a strip of standard 35 mm. motion picture film somewhat over 30 in. long.

As mentioned before, the camera was originally constructed upon the rear wall of the light-tight cabinet which encloses one of the propeller observation ports. Later, the camera was reconstructed and placed upon wooden rails which would permit it to be moved to various distances from the propellers, and allow the use of lenses of various focal lengths. A wooden duct in telescoping sections was made to connect the lens board of the camera to the opening in the side of the dark room. The resulting arrangement of the camera is shown in Figs. 1 and 2. In Fig. 2 the film drum is removed, exposing to view a portion of the disc, with several slits clearly evident.

Some examples of the photographs produced by this camera appear in Figs. 6, 7, and 8. The useful portion of the flash is generally of sufficient duration to produce exposures on sixteen or seventeen frames, of which eight

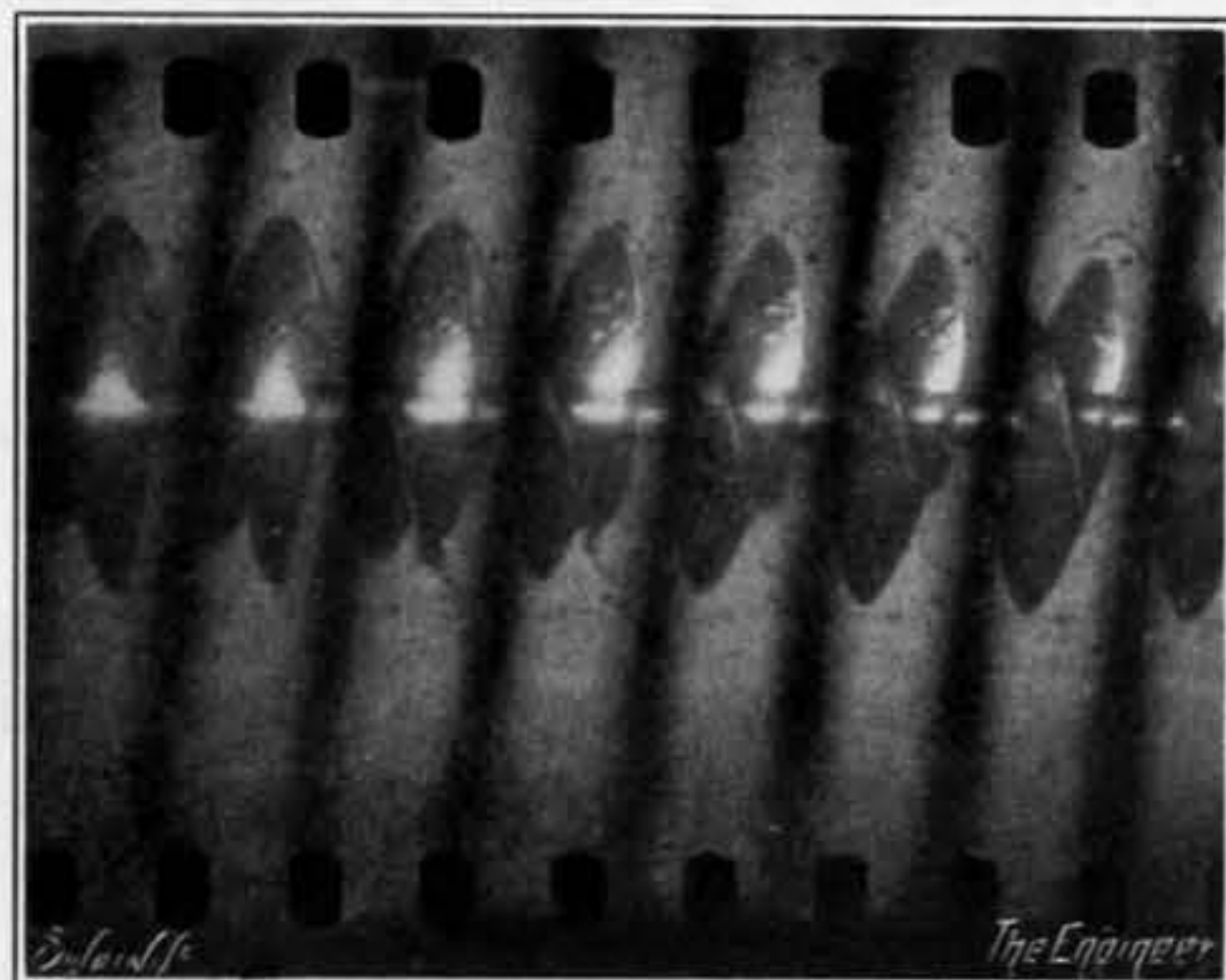


FIG. 8—BUBBLES AROUND PROPELLER

or ten will be fully exposed. Fig. 6 is a strip of pictures in natural size, 960 exposures per second. In this view the film is travelling from right to left and illustrates the rapid growth of light intensity and the slow dying out of the light with the central useful portion extending over about eight frames. Fig. 7 is an enlargement of a strip of film with the width of the frames increased in order better to show the peculiar pattern made by the propeller tip vortices. In this view, where the cavitation on the back of the blade is clearly evident, the growth and motion of the bubbles can be followed by examining successive frames. The interval between frames is $1/480$ second in this figure. In Fig. 8, showing cavitation on another propeller, numerous bubbles also can be seen in the current beyond the propeller.

This camera was developed early in 1935. The first single exposure photographs on 4 in. by 5 in. cut film were made on or before May 1st of that year. The moving film drum was developed and installed and photographs were made by this arrangement on or before July 24th, 1935. Since that date the camera has been used as a matter of routine in propeller study.

Use of the camera has brought out the desirability of change in certain respects with the object of improvement in illumination and in definition. In particular, the camera as originally designed could not utilise effectively the full aperture of the photographic objective. With the disc at a distance of nearly $\frac{1}{2}$ in. from the film the angle

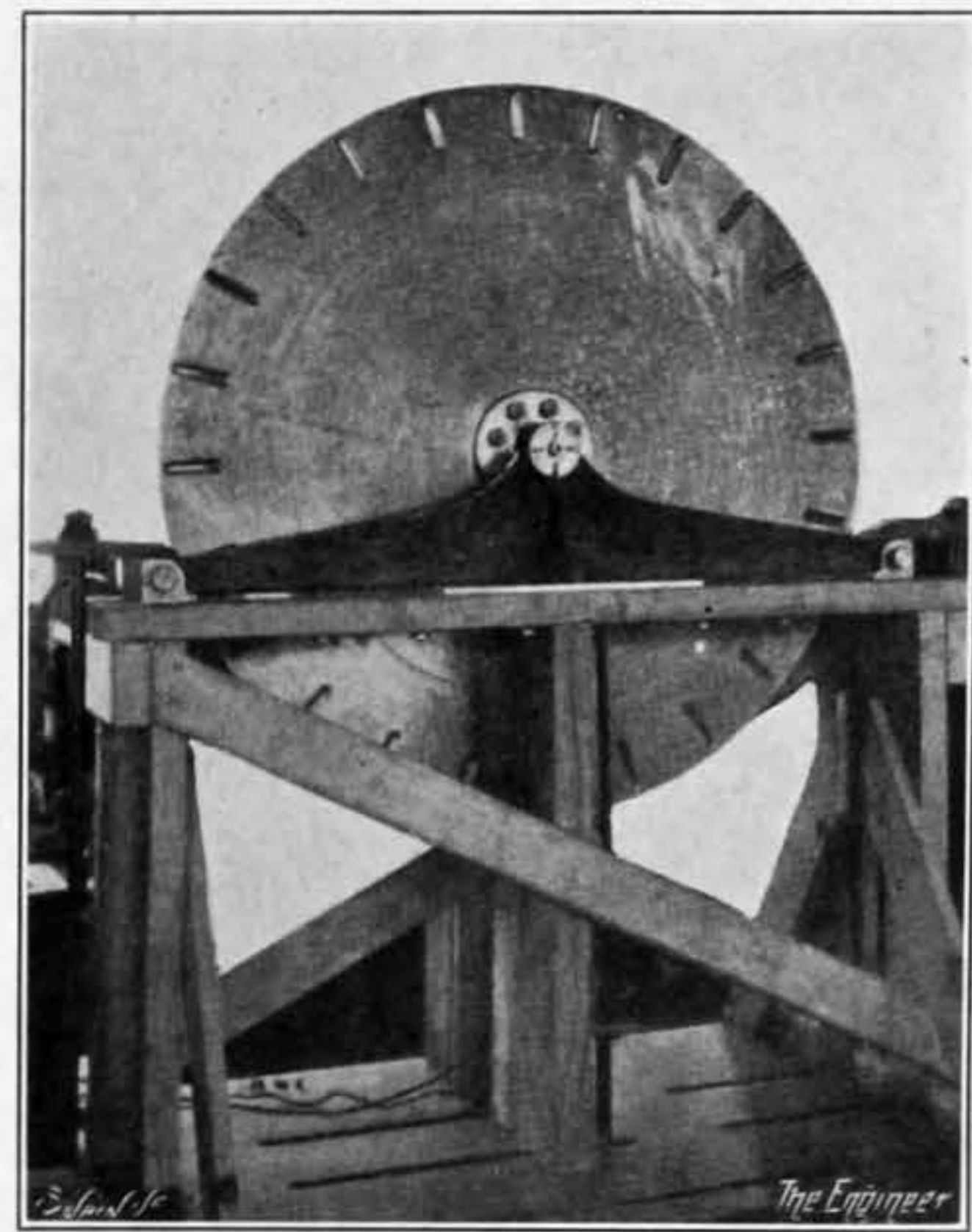


FIG. 9—SHOP ASSEMBLY OF NEW DISC

as the efficiency. The improved drum, which has been completed, is already in use on the present camera and is illustrated in Fig. 4.

In the new camera design the effective aperture of the shutter will be further increased by using a slit width of $1/10$ in., which, with the drum change, brings the aperture to $F/2.5$. After doubling the slit width in the new design it becomes necessary to double the peripheral speed, which is accomplished by the construction of a new disc of approximately double the former diameter. This larger disc gives the same exposure time as previously without increasing the angular speed. The shop assembly of the new disc with shafting and bearings appears in Fig. 9.

With the object of improving definition, in so far as the pictures taken with the present camera may suffer from the effect of vibration, the new design includes two distinct improvements. In the first place, the relatively heavy disc will be surrounded by a steel cylindrical ring, $\frac{1}{2}$ in. thick and several inches wide, to serve as an enclosing guard. The inertia of these two members is expected to shut off any vibrations of high frequency in the structure as a whole. As a further measure against the effect of vibration the lens support will be carried as a rigid U-shaped yoke around the edge of the disc. This yoke will hold the lens in a fixed position with respect to the film drum, will reduce the motion of the image with respect to the film, and eliminate such lack of definition as arises from that cause.

Fluid-Flow Analyzer.*

By H. L. PARR.†

RESEARCH work in fluid dynamics, carried on in the last few years chiefly for the benefit of aeroplane designers, has shown engineers, engaged in many other fields, that a knowledge of some fluid-flow characteristics is necessary for intelligent design of a wide range of apparatus. Such information would result, in certain cases, in a reduction of pressure loss in the fluid passing through a machine; but, in many others, the vital information desired is concerned with the distribution or pattern of the fluid flow. Apparatus has been built with which such information can be obtained, but it is generally expensive, bulky, and difficult to operate. To be of maximum service, such an apparatus should be inexpensive, small enough to be placed in a shop or draughting room, and so simple in operation that almost anyone can use it. To meet this need the author designed and built the apparatus described in this article. The immediate object of the design was really to illustrate the principles of fluid dynamics to engineering students, but the possibilities of broader use soon became evident. Examples of the type of work that can be done are shown in the accompanying illustrations.

In the usual design of smoke tunnel the size of the duct is such that the air must be run through it at low velocities

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to maintain laminar flow. If the flow be turbulent the smoke streams will be dispersed and the flow pattern indistinguishable. Flow at low velocities is easily disturbed by slight air currents in the surrounding space, and a honey-comb system of straightening vanes must be installed in the air inlet.

SMOKE FLOWS BETWEEN TWO CLOSELY SPACED PLATES.

The main feature of the design of this apparatus is that the flow takes place between two flat surfaces set so close

mounted on the extension of the bottom of the box and connected with D by a short pipe. Between the inlet and outlet is a centre chamber that is painted black on the inside to form a background and contains properly shielded lights. A 33in. by 14in. sheet of plate glass G is let into the edges of the box so that its upper surface is flush with the top. Extending down both sides and across the inlet edge of the box is a strip of sheet rubber H, which is 1/4in. thick and is cemented in place. When the 43in. by 14in. sheet of plate glass I, which is shown in a raised position, is lowered and rests on the rubber strips, a continuous

Titanium tetrachloride is spread with a dropper in the slotted trough K, Fig. 1, which is shaped and located as shown in Fig. 4. It is made of sheet copper, and in the curved edge above the liquid level holes are drilled, 3/32 in. in diameter and with 1in. spacing. Slots 1/8 in. wide are cut through the upper portion of the trough from the holes to the back edge, and smoke from the titanium tetrachloride flows between the two plates in a number of streams from these slots. The trough extends across the whole width of the channel and is supported on the sides of the box by lugs and held in position by pins. Fumes

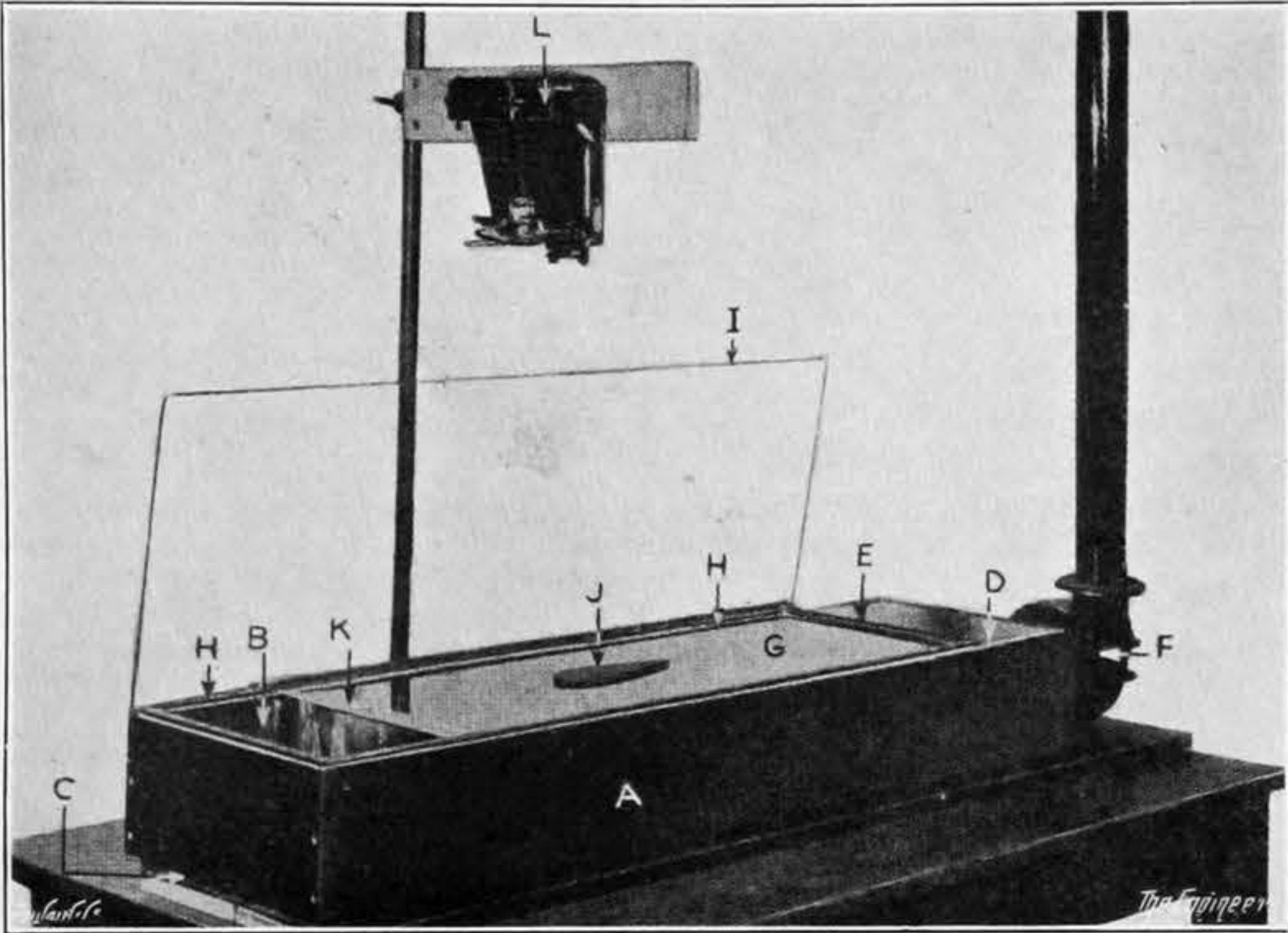


FIG. 1—EXTERIOR OF THE ANALYZER

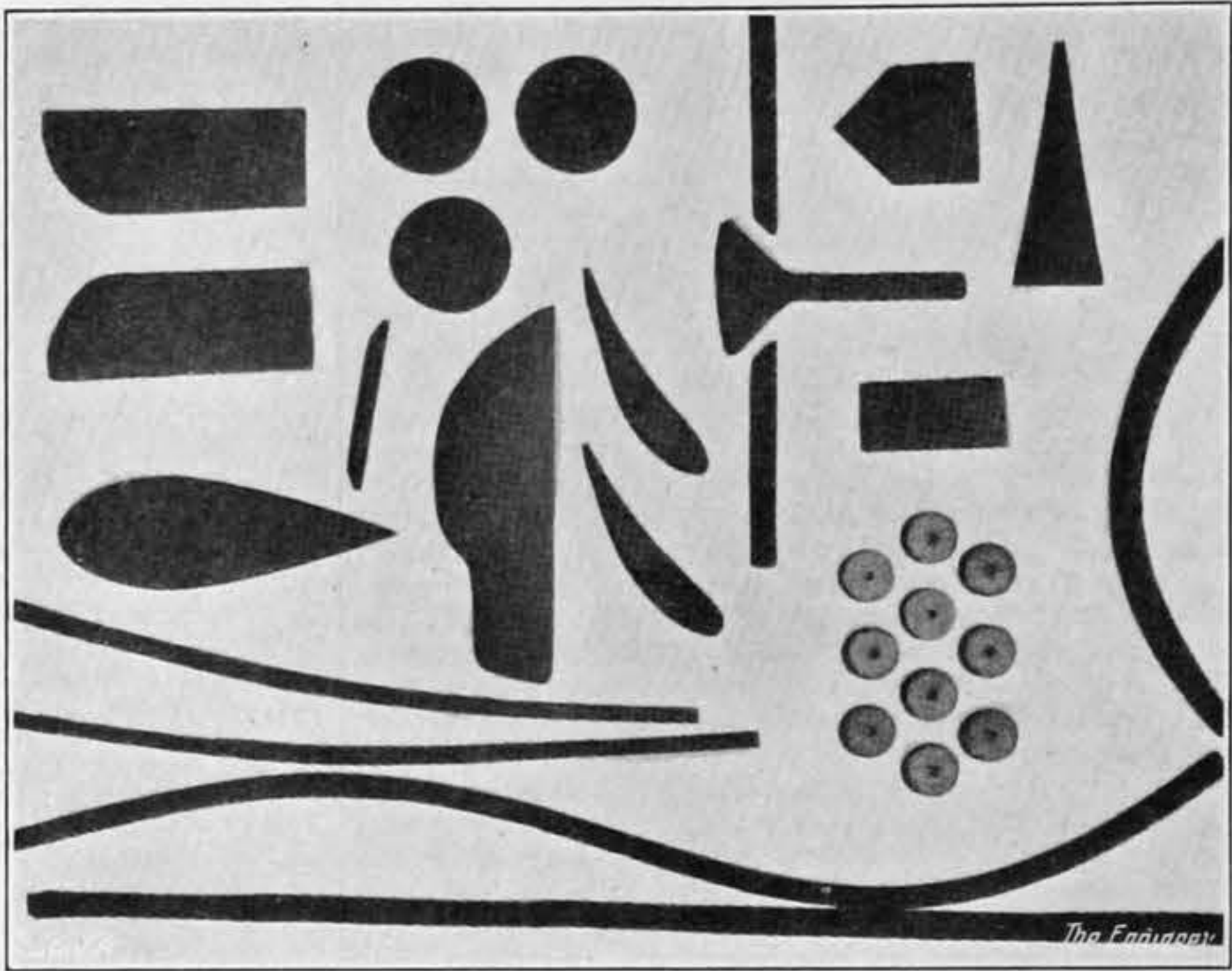


FIG. 3—COLLECTION OF RUBBER MODELS USED WITH THE ANALYZER

together that considerable air velocities can be used, and little protection is necessary to maintain parallel flow. The details of the construction are shown in Fig. 1. Dimensions given are those of the apparatus shown, but they can be varied widely to suit particular needs. The wooden box A is 48in. long, 7in. high, and 12 1/2 in. wide and is divided into three parts by partitions. That at the left, B, is 8in. long and the top is open. It is the air inlet, the air entering through the small opening C at the bottom of the end. The chamber at the right, D, is the air outlet, the air entering through the slot E in the top of the box and being drawn out by the motor-driven fan F, which is

channel, 1/4 in. deep and 12in. wide, connects chambers B and D.

All models are cut from 1/4 in. rubber sheet, which is the thickness of the channel, and laid on the lower glass plate as shown at J. A collection of models is shown in Fig. 3. Uses of most of them will be readily apparent. Many can be used singly or in combination. Small discs are employed to show flow through tube banks. Flexible strips are used to make up channels of varying cross section, baffles, or to represent the ground for such conditions as are shown in photographs k and l, Fig. 2. Metal ribbon has also been used to simulate sails on a boat.

from a shallow dish of ammonium hydroxide placed in the bottom of the inlet chamber will produce a denser smoke and counteract the hydrochloric acid set free by the titanium tetrachloride.

RESULTS SHOWN PHOTOGRAPHICALLY.

Streamlines are best observed by lighting from beneath, and satisfactory photographs have been taken by a camera L, Fig. 1, with illumination from either top or bottom. A board painted with black enamel can be used instead of the lower glass plate. A vacuum cleaner type blower will be found of ample capacity for handling a sufficient volume of air. The blower F has a much larger capacity than is required, and the end of the duct at E is left open to by-pass some of the air. A strip of rubber, 1/4 in. thick, is cemented across the outlet end of the lower glass plate to cause a pressure drop at that point and hold the streamlines parallel to the end of the passage. Properly arranged baffles in the outlet chamber would accomplish the same purpose.

Obviously, photographs reproduced in Fig. 2 cannot show all that can be seen by the eye unless moving pictures are taken. In c and d the vortices indicated are in rapid motion. In f the portions showing dense smoke without streamlines are either without motion or have a slow reverse whirl. In g two vortices are located behind the

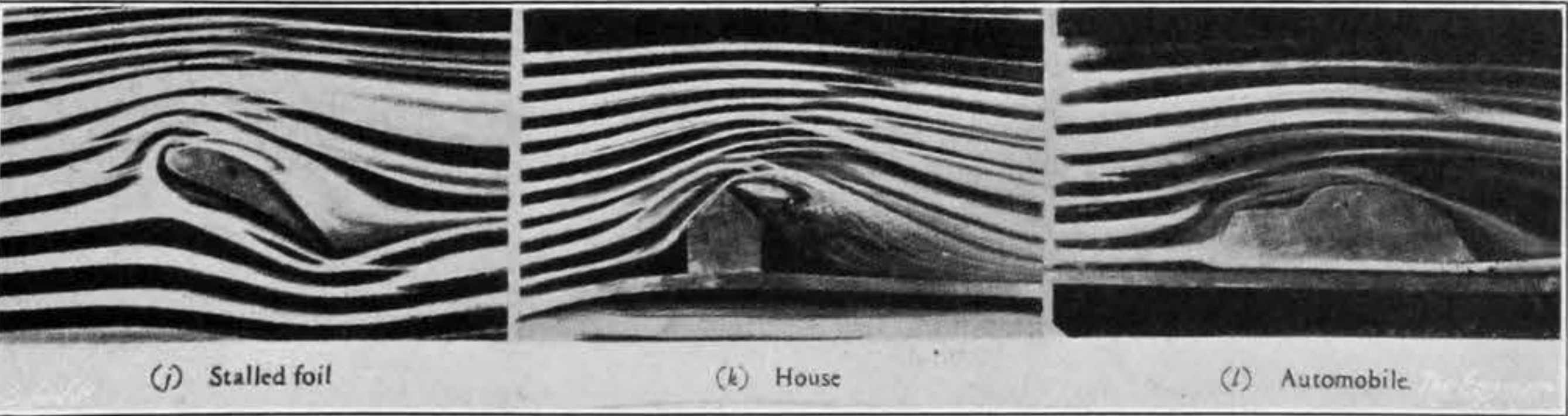
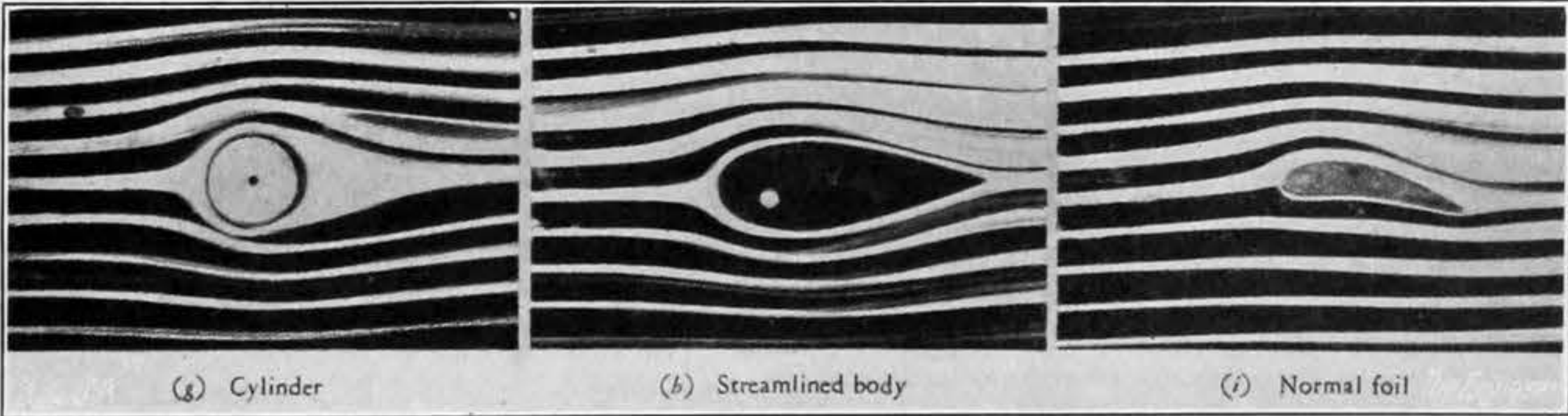
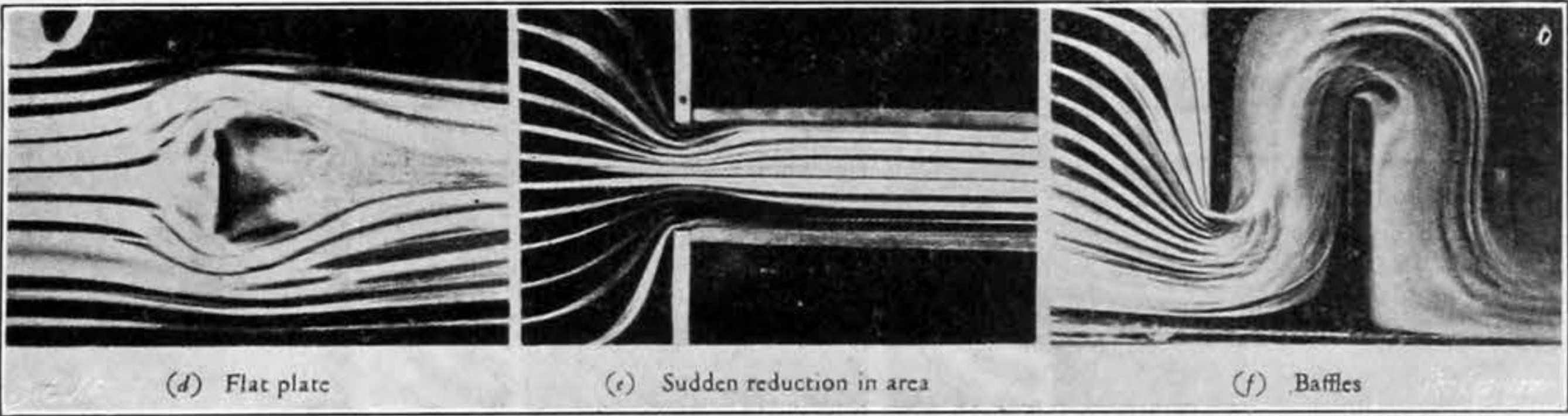
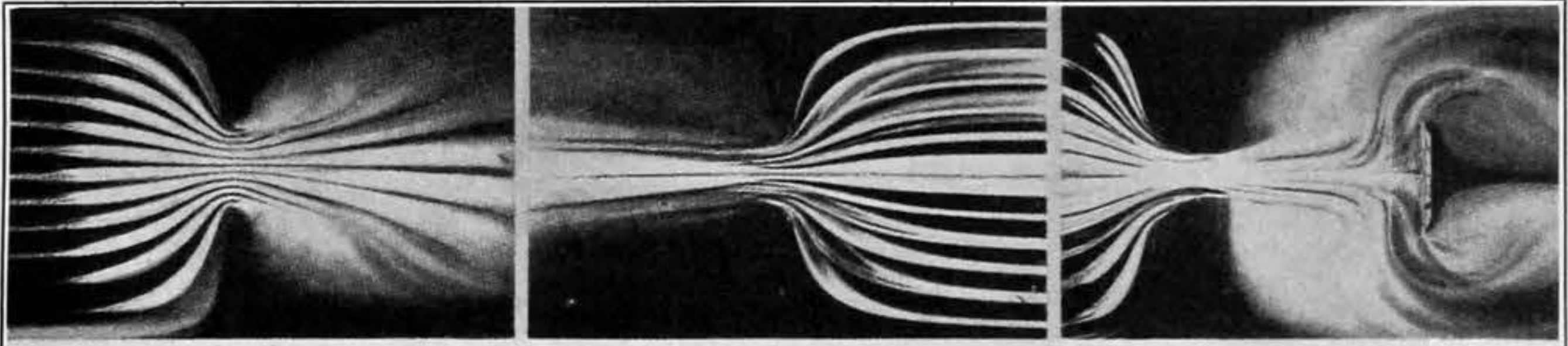


FIG. 2—PHOTOGRAPHS OF FLUID FLOWS FOR VARIOUS MODELS AND CONDITIONS

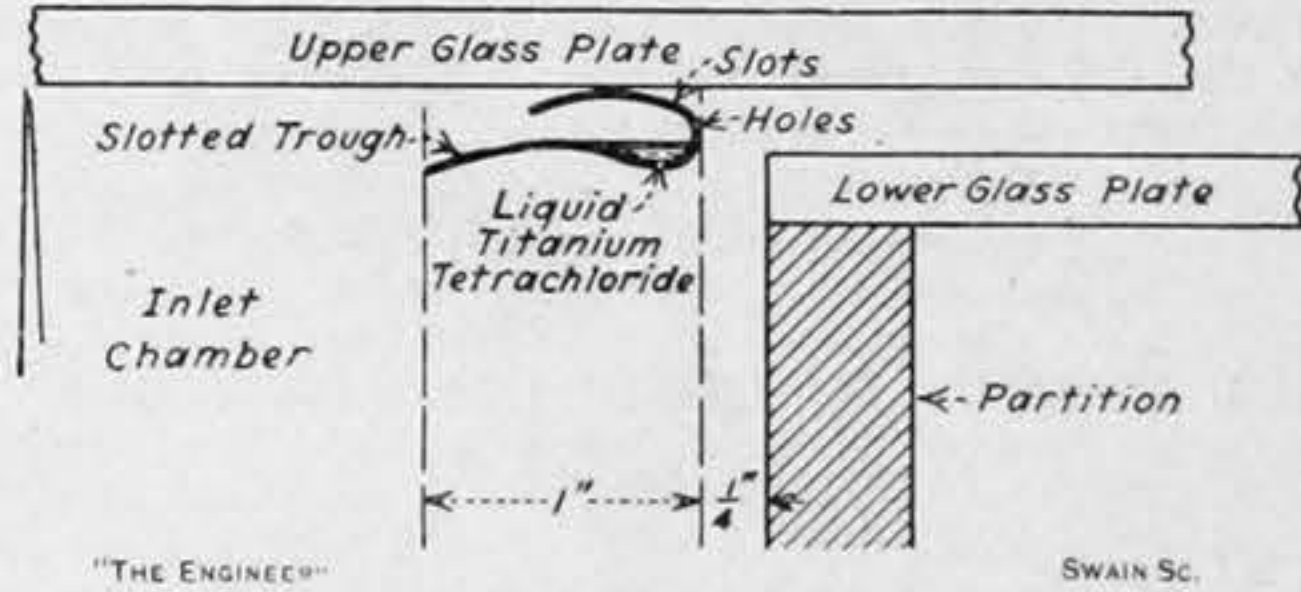


FIG. 4—SHAPE AND LOCATION OF THE SLOTTED TROUGH

cylinder, a definite reverse circulation starting almost at the right edge of the photograph and travelling up the centre to the cylinder and around the back to the points of separation at the sides. Definite reverse whirls are also shown in j, k, and l. With many model shapes the flow patterns are greatly affected by change in velocity, one such effect being shown in a and b. In some instances the picture was taken of the moving stream shortly after starting, while in others smoke was allowed to deposit upon the glass plate to give more contrast. Such deposits are more easily removed if the glass be kept waxed.

While the results obtained by such an apparatus are largely qualitative, they have a wide practical application in addition to their usefulness in illustrating the principles of fluid flow. When some new apparatus is to be designed, through or over which fluids are to pass, a model can easily be made of the flow passage and the flow pattern observed by the smoke lines. If the result be unsatisfactory, alterations and adjustments can be made until the best shape and proportions are obtained. Such applications are, of course, limited to cases in which two-dimensional flow will reproduce the actual conditions with sufficient accuracy.

New Canadian Cold Reduction Mill.

AFTER one year's successful operation of a small cold reduction mill with an annual capacity of 8000 tons, Dominion Foundries and Steel, Ltd., of Hamilton, Ontario, has added a large four-high reversing cold reduction mill with an annual capacity of 30,000 tons of cold rolled strip. This mill will produce cold rolled strip up to a maximum of 40in. wide and less than 10/1000 of

an inch thick. From the raw materials to the finished article this strip is entirely Canadian. The steel is made in the company's own open-hearth furnaces, and reduced to hot coils 1/10 of an inch thick and 500ft. long in the hot reduction mill. These hot rolled coils are the raw material for the cold rolling department.

The first operation after the coils are transferred to the cold rolling department is pickling. By continuous operation of the uncoiling and recoiling, the strip is passed in strands through a bath of sulphuric acid to remove surface scale. The coil is then reduced on the cold reduction mill to 10/1000 of an inch by travelling back and forth between the work rolls. These work rolls are supported by backing-up rolls having bearings with a capacity of 2,500,000 lb. each. The strip is carried over deflector rolls and the ends locked on a reel drum on each side of the mill. These reels maintain continuous tension on the strip on both sides of the mill, even though the mill is stopped during a pass. The work-roll-drive and the reels are synchronised by an elaborate electrical control system and are designed for a maximum strip speed of 1150ft. per minute at the delivery side. The strip, in passing between the work rolls, is reduced by a definite, predetermined amount. Uniformity of gauge is obtained by flying micrometers, which ride the edge of the strip and indicate the exact thickness as it comes through the rolls. The unit is operated from a central table, where operators—by means of meters and controls—can check the numerous varying factors which effect the quality and dimensions of the finished product.

Accompanying the mill, a complete sub-station furnishes the synchronised power through a motor generator set that consists of four generators of 1500 kW, 250 kW, and 30 kW capacity, driven by a 2500 H.P. synchronous motor, direct connected. There are three circulating systems for lubrication; one for backing-up roll bearings, one for the gear drives, and a small unit for the screw-down gearing. Grease is applied by a motor-driven pump, through Farval valves, to the roller bearing and screws on the mill.

A blower of 50,000 cubic feet per minute capacity supplies filtered air for cooling the D.C. motors. The circulating equipment for lubrications and roll cooling is housed in cellars adjacent to the mill. The roll coolant system has two 600 gallons per minute centrifugal pumps which take the fluid from the 7500-gallon receiving and settling tank, pumps it through cooling filters, and delivers it by spray jets under 60 lb. pressure.

The required decimal thickness having been obtained, the finished strip, which is a mile or more in length, is removed and slit by rotary knives to exact width. It is then sent to an electrolytic cleaner. This operation is also continuous. The strip is drawn through an electrically agitated bath of caustic soda, which removes all oil. The strip is then cut to length by an automatic shear. The sheets of desired dimensions are piled in the annealing furnace, where, by accurate control of temperature and surrounding atmosphere, the required physical properties and surface characteristics of the steel are obtained. The material is fed through two-high skin pass mills to produce the surface and temper desired. The black plate is stacked on edge in racks, immersed and agitated in a bath of sulphuric acid, removing all traces of oxide. The plate is then stored in tanks of acidified water.

The single sheets are carried through molten flux into molten tin (600 deg. Fah.), and then deflected upward to contact the rolls of the tinning machine proper. This machine operates in a bath of palm oil (460 deg. Fah.), and controls the weight and distribution of the tin coating on the steel sheets. As the sheets emerge from the palm oil, they are cooled by a blast of air and are carried by a conveyor into a washer, where the palm oil is removed, thence through polishing rolls with bran as a polishing medium. The finished tin-plate falls into piles and is removed to the sorting room, where it is assorted into the different classifications, packed, and prepared for shipment.

The Steam Engine on Tyneside, 1715-1778.*

By A. RAISTRICK, M.Sc., Ph.D.

THE steam engine of Thomas Newcomen was exploited under the patent of Thomas Savery of 1698 extended to 1733 by Act of Parliament. This patent was understood to be a master one, covering every kind of engine worked by the "impellent force of fire"; it therefore included Newcomen's engine, although the latter differed entirely in principle from Savery's.

After Savery's death in 1715 the patent was acquired in some way or other by the "Proprietors of the Invention for Raising Water by Fire." They issued an advertisement in 1716 announcing that the engine was "at work in the counties of Stafford, Warwick, Cornwall, and Flint," but nothing is said about Tyneside, although it is known that an engine was erected there as early as 1715.

The research in this paper was undertaken with the object of finding out if Newcomen himself or the "proprietors" aforesaid had any connection with the district, whether by the payment of royalty for the use of the patent or otherwise. It may be said at once that the author has failed entirely to establish any such connection, although he has traced as many as thirteen engines as having been built between 1715 and 1733. The only conclusion to be drawn is that these engines were pirated copies; even so, it must occasion surprise that legal proceedings were not taken by the "proprietors" before mentioned to claim royalties on these engines.

Pursuing these investigations further, the author found records of 104 engines built between 1733 and 1778 when Boulton and Watt came on the scene with their improved engine. The paper places on record details of date, locality, reports, and estimates of cost of construction, cost of working, &c., of a large number of these engines. It may be interesting to mention that a rough figure for the prime cost of an engine of about 33in.

diameter cylinder was £1200, and the annual cost of working it £400.

This interesting survey is based mainly on MS. material preserved in the archives of the North of England Institute of Mining Engineers, Newcastle-upon-Tyne, to whom the author returns his thanks for permission to make the extracts. The existing material is of three main categories:

(a) The "View Books" compiled by the various colliery "Viewers" (prototypes of the present-day mining engineers). These include most of the reports on the state of flooding of the collieries with recommendations and estimates of the cost of pumping.

(b) A few letter books of the early Viewers.

(c) The Watson Collection of papers and plans relating to collieries; in most cases these only duplicate the reports contained in the "View Books."

(d) Letters and papers in the possession of the Newcastle Society of Antiquaries and the "Delaval Papers" in the possession of the Newcastle Central Library.

The following "Estimation of the Charge of a Fire Engine," dated 1733, and extracted from Mr. Raistrick's paper, will be read with interest. The engine was, of course, of the Newcomen type. It is worth noting that the cylinder alone cost far more than the "boiler":—

	£	s.	d.
The Bore of Pumps that will Discharge 400 hhd. in One Hour must be 13 Inches Diameter also the Diameter of the Cylinder 33 Inches to run 12 Stroke p. Minute ye Strakes 6 foot long.			
To 22 fathom of Pumps 13 Inches Diameter ...	30	0	0
To Boreing Joynting Plugging Hooping and Screw Bolts to fasten the Pluggs in the Pumps...	24	0	0
For Two Brass Barrells for the Baques to Work in 13 Inches Diameter ...	90	0	0
To Two Bucketts and Two Clacks ...	6	0	0
To Iron to hoop the Pumps ...	37	0	0
To 40 Fathom of Spears & Joynts belonging to them To the Cistern & Slippers to bear the pillar of Pumps To Smith Work ...	19	0	0
To the Regulator Beam with Arches to it ...	24	0	0
To The Gudgeon that Carries the Beam, Stirrups, Bars and Screw Plates ...	3	15	0
To Two Brasses that the Gudgeon Runs in ...	6	0	0
To Three Chains, Catch pins, and 4 Plates belonging to the Regulator Beam ...	26	0	0
To the Engine House ...	120	0	0
To 33 Inches Cylinder ...	150	0	0
To 2 Cylinder Beams, 2 plates and 7 screw bolts ...	27	0	0
To the Piston ...	3	0	0
To the Boyler ...	80	0	0
To Leading the Boyler top ...	32	0	0
To the Regulator that stands at the Top of the Boyler To the Sinking Pipes ...	9	0	0
To the other Pipes about the Cylinder ...	12	0	0
To the Small the F & Y & 2 Small Brasses ye Y runs in ...	8	0	0
To Cocks about the Cistern ...	2	6	0
To Small Valves ...	3	15	0
To Bars for the Fireplace ...	10	0	0
To Bricks, Lime & Workmanship ...	12	0	0
To a Crab Rope ...	13	0	0
To 2 Shear Legs and a Block ...	8	0	0
To a New Crab ...	10	0	0
To Sodder ...	2	10	0
To Jack Head Barrells and Pumps ...	15	0	0
To Deals to make ye Great Cistern & Workmanship ...	35	0	0
	12	0	0
	849	16	0

Twenty years later the following "Estimate of the Expence of Erecting a Fire Engine at Saltwellside Colliery, March 17th, 1754," was recorded. It will be seen that the price of a cylinder only lin. less in bore was only £20:—

	£	s.	d.
2 Iron working Pieces ...			
A Firr Regulating Beam with Arches to it ...	10	4	0
A Gudgeon Stirrup, Bars and Screw Bolts for do... 2 Brass Cods for the Gudgeon to work in ...	4	15	0
Chain Catch Pins and Plates belonging to the Regulator ...	4	0	0
A Cylinder 32 Inches diameter ...	20	0	0
A New Boyler ...	73	0	0
2 Cylinder Beams Plates and Screw Bolts ...	14	8	0
An Iron Peston ...	2	10	0
A Regulator for the Boyler Top ...	10	10	0
Sinking Pipe and other pipes ...	18	0	0
A Sett of Working Geer ...	7	0	0
Bars for the Fire Grate ...	8	0	0
Solder for the Pipes ...	5	0	0
Jack Head Barrells ...	20	0	0
Deals, Oak & Workmanship for Great Cistern ...	20	0	0
Hotwell Cistern & Lining it with Lead ...	10	10	0
An Injection Cock ...	4	4	0
Carpenter work for the whole ...	10	0	0
Building the Engine House... ..	148	1	6
	410	2	6

LAUNCHES AND TRIAL TRIPS.

BRITISH DILIGENCE, motor tanker; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of British Tanker Company, Ltd.; dimensions, length 48ft., breadth 6ft. 9in., depth 34ft.; to carry 12,250 tons. Engines, four-cylinder, opposed-piston; trial trip, June 9th.

LADY NORTHCOOTE, motorship; built by Ferguson Brothers (Port Glasgow), Ltd.; dimensions, length 125ft. 9in., breadth 29ft., depth 10ft. Engines, six-cylinder, four-stroke, cold-starting airless injection; constructed by Davey, Paxman and Co., Ltd. Launch, June 14th.

BACHAQUERO, tanker; built by Furness Shipbuilding Company, Ltd.; to the order of Lago Shipping Company, Ltd.; dimensions, length 365ft., breadth 64ft., depth 18ft.; to carry 6800 tons. Engines, two triple-expansion; constructed by North-Eastern Marine Engineering Company, Ltd. Trial trip, June 18th.

MISOA, oil tank steamship; built by Furness Shipbuilding Company, Ltd., to the order of Lago Shipping Company, Ltd.; dimensions, length 365ft., breadth 64ft., depth 18ft., to carry 6800 tons deadweight. Engines, twin triple-expansion; constructed by North-Eastern Marine Engineering Company, Ltd.; launch, June 22nd.

SAN CIPRIANO, oil tanker; built by Blythswood Shipbuilding Company, Ltd., to the order of Eagle Oil and Shipping Company, Ltd.; dimensions, length 460ft., breadth 59ft., depth 34ft., to carry 12,100 tons deadweight. Engines, eight-cylinder,

four-stroke, single-acting, 650 mm. by 1400 mm.; constructed by J. G. Kincaid and Co., Ltd.; trial trip, June 22nd.

BRITISH INTEGRITY, motor tanker; built by Harland and Wolff, Ltd., to the order of British Tanker Company, Ltd.; dimensions, length 463ft., breadth 61ft. 6in., depth 34ft. Engines, four-stroke, single-acting, airless-injection; launch, June 22nd.

MANCHESTER CITY, steamship; built by Blythswood Shipbuilding Company, Ltd., to the order of Manchester Liners, Ltd.; dimensions, length 440ft., breadth 35ft., depth 38ft. Engines, single-reduction geared turbines, pressure 225 lb. per square inch; constructed by David Rowan and Co., Ltd.; launch, June 23rd.

BELTANA, steamship; built by Caledon Shipbuilding and Engineering Company, Ltd., to the order of Adelaide Steamship Company, Ltd.; dimensions, length 350ft., breadth 48ft. 6in., depth 32ft. 7in., 5000 tons deadweight. Engines, triple-expansion in conjunction with low-pressure steam turbine; constructed by J. G. Kincaid and Co., Ltd.; launch, June 23rd.

LEINSTER, motorship; built by Harland and Wolff, Ltd.; to the order of British and Irish Steam Packet Company (1936), Ltd.; dimensions, length 367ft., breadth 50ft., depth 19ft.; to carry 4320 gross tons. Engines, two, two-stroke single-acting. Launch, June 24th.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

MERRYWEATHER AND SONS, Ltd., Greenwich, have received from the London County Council an order for a motor turntable fire escape. It will have an all-steel ladder for extension to a height of 100ft., and will be equipped with automatic plumbing gear, monitor nozzle for use as a water tower, and loudspeaker telephone. The ladder will be capable of being elevated and fully extended within thirty seconds.

RANSOMES AND RAPIER, Ltd., have received an order from Richard Thomas and Co., Ltd., for the installation of large excavators at their ironstone mines in Northamptonshire, the machinery comprising the following:—An electric stripping shovel of 8 cubic yards capacity for the removal of the overburden overlying the ironstone and discharging at 110ft. radius; and a 3½ cubic yard electric heavy duty shovel for loading the ironstone into wagons for conveyance to the treatment plant.

CATALOGUES.

HADFIELD'S, Ltd., Sheffield. Publication No. 397 on hardened steel rollers.

W. A. FELL, Ltd., Windermere.—Catalogue No. 37 of modern woodworking machinery.

R. AND J. DICK, Ltd., Greenhead Works, Glasgow.—Catalogue No. 150 of "Dixel" driving ropes.

GENERAL ELECTRIC COMPANY, Ltd., Magnet House, Kingsway, W.C.2.—A seasonal catalogue on electric fans.

MATHER AND PLATT, Ltd., Park Works, Manchester.—Pamphlets on three, four, and five-bowl calendars.

LE GRAND, SUTCLIFFE AND GELL, Ltd., Southall, London.—Publication No. 56 on electrical resistivity surveying.

BRITISH INSULATED CABLES, Ltd., Prescott, Lancs.—Particulars of high-voltage paper-insulated cables for 3 to 20 kV.

ELLIOTT BROTHERS (LONDON), Ltd., Lewisham, S.E.13.—New catalogue sheet on low range rectifier pattern instruments.

COCHRAN AND CO., ANNAN, Ltd., 34, Victoria-street, S.W.1.—Publication No. 62 on the Cochran-Kirke "Sinuflo" gas-fired boilers.

RANSOMES AND RAPIER, Ltd., Ipswich.—Publication No. 411, describing the "480" and "490" heavy-duty shovels and draglines.

BUDENBERG GAUGE COMPANY, Ltd., Broadheath, near Manchester.—A descriptive list of dial and self-recording thermometers.

AVELING BARFORD, Ltd., Grantham.—A catalogue on light rollers in weights ranging from 12½ cwt. to 5 tons and driven by either oil or petrol engines.

INTERNATIONAL COMBUSTION, Ltd., Aldwych House, W.C.2.—A publication describing the construction and capabilities of the "Vaseal" grit pump.

BATTERIES, Ltd., Hunt End Works, Redditch.—Publication No. 1437, dealing with the "Nife" nickel-cadmium alkaline battery as applied to aircraft.

BABCOCK AND WILCOX, Ltd., Babcock House, Farringdon-street, E.C.4.—A booklet illustrating and describing railway wagon discharging appliances.

E. H. JONES (Machine Tools), Ltd., The Hyde, Hendon, N.W.9.—Particulars of the "Newall" jig borer and the "C.V.A. No. 79" vertical milling machine.

LYCOCK ENGINEERING COMPANY, Ltd., Millhouses, Sheffield.—An 80-page book illustrating the various fittings made by the company for railways, tramways, and ships.

WESTINGHOUSE BRAKE AND SAGBY SIGNAL COMPANY, Ltd., 82, York-road, N.1.—A brochure, "Signalling Waterloo to Hampton Court Junction, Southern Railway."

LAURENCE SCOTT AND ELECTROMOTORS, Ltd., Australia House, Strand, W.C.2.—A booklet, "The Cooling of Totally Enclosed Motors," by P. A. Mossay, M.I. Mech. E.

E. G. ACHESON, Ltd., Thames House, Millbank, S.W.1.—Particulars of some tests carried out at the National Physical Laboratory with Acheson's "Colloidal Graphite."

SWITCHGEAR AND COWANS, Ltd., Elsinore-road, Old Trafford, Manchester.—Publication dealing with duplicate bus-bar "change-over-on-load" internal isolation switchgear.

ELLIOTT BROTHERS (LONDON), Ltd., Century Works, Lewisham, S.E.13.—Catalogue 891 on flow meters for steam, air, water, and gases. Leaflet 103 on the "G.L.C." automatic flue damper.

MOSS GEAR COMPANY, Ltd., Tyburn, Birmingham.—A new descriptive sectionalised catalogue of the firm's manufactures, which include worm, helical, and spur reduction units, geared motor drives, and allied products.

GEORGE H. ALEXANDER MACHINERY, Ltd., 82, Colleshill-street, Birmingham, 4.—A catalogue of the Barrett Cravens Company's materials handling equipment, which is distributed in this country by George H. Alexander Machinery, Ltd.

LORANT AND CO., Ltd., 98, Croydon-road, S.E.20.—Particulars of the "May" hydraulic twist drill grinding machine, the "May" point thinning machine, and the "May" floating reamer chucks made by Rohde and Dörrenberg, of Dusseldorf, Oberkassel.

* Synopsis of and extracts from a paper read before the Newcomen Society on April 21st, 1937.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The International Steel Position.

The quietness which developed recently in some of the export markets has continued and the impression seems to prevail on the Continent that buying on any scale is not likely to be resumed until the autumn. Heavy deliveries, however, have to be made to most of the larger overseas markets, and fears are entertained that there has been over-buying. In France the political and financial crises have had an upsetting effect upon trade, and the demand from the home market has again subsided, with the result that the French steel works now require more export business. In Germany, however, the position is firmer and the home market there continues to absorb large quantities of steel, whilst a good export trade also has been transacted. It is not without interest that the AVI export bounties, which were designed to make up to those steel works engaged in export business the difference between the home and export prices, have been practically wiped out by the rise in export quotations of most descriptions of steel. Last year bounties ranging from Mk. 26 to Mk. 38 were paid on about 90,000 tons of steel per month. It is unlikely, however, that they will be paid for the remainder of this year on anything except semis. In Belgium little export business has been transacted for the past few weeks, and in the first twelve days of June, of the 50,000 tons secured by Cosibel, the steel works selling organisation, only 14,000 tons was for export. The sudden drop in the demand has occasioned some surprise, as it is certainly not due to seasonal causes alone. The position with regard to delivery times is also becoming somewhat uncertain, and although most mills ask four to five months for the execution of an order, it is reported that if pressure is applied delivery can be arranged in from two to three months. The situation is complicated by the attitude of the Belgian re-rollers, who, not having participated to the full in the heavy demand during the past few months, are now determined to obtain overseas business and show a disposition to shade quotations to do so. It was reported that meetings had been held between representatives of the British steel makers and the Belgian re-rollers, as the former fear that some of their control in the home market may be lost if the Belgian re-rollers who are outside the Cartel sell independently to British consumers. The re-rollers naturally wish to benefit by the reduction in the duties and, at the same time, to obtain higher prices than those quoted by the British works.

The Pig Iron Market.

Concern appears to be growing amongst consumers regarding the outlook during the second half of the year. Business in pig iron, although it is not entirely suspended, is confined to a few isolated cases in which old customers can show an urgent need of supplies for special work. At the same time, there are numerous users who would gladly cover their requirements far into the future if they could find a producer in a position to accept the business. A few contracts have been placed for fourth quarter delivery and a lesser number for execution in September-October. For the most part the producing works order books are so full that any special transaction is at the expense of a consumer whose work does not appear to be of such immediate importance. On the North-East Coast new business in Cleveland iron has practically ceased, and local users are working on hand-to-mouth supplies. Only one furnace in this district is producing Cleveland foundry, and the tonnage is entirely insufficient to meet requirements, whilst efforts to obtain supplies of iron from other districts are seldom successful. At the same time there is little disposition to buy Continental foundry iron at the price demanded, which is in the neighbourhood of £6 15s. f.o.b. It is reported that a few parcels have been bought, but there does not seem to be much of this iron offering. The situation in the Midlands has not improved. Several furnaces are reported to be ready to be put into operation when supplies of coke and raw material are more assured. The present output, however, appears to have been sold until well into the autumn, and in some cases until the end of the year. Practically no stocks exist at the furnaces and the producers are naturally reluctant to enter into fresh contracts until they can see a chance of expanding their output. In Lancashire consumers are struggling to obtain supplies, but the deliveries reaching the consuming works are far below their requirements. The position in Scotland is similar to that ruling in England, and the fifteen furnaces in operation in that country can only satisfy a part of the needs of the consuming trades. Little business has passed in the hematite iron market as the makers have adopted a cautious policy owing to the heavy tonnage of orders already on their books. Pressure to obtain deliveries is unrelaxed and no headway seems to have been made in clearing off arrears of deliveries.

The Midlands and South Wales.

The discontent at the conditions of stringency ruling in the steel market appears to be growing in the Midlands, and the controversy which has developed on the subject of importing steel sheets from America has let loose a flood of criticism at the way in which the import duties operate. The steel makers are undoubtedly doing their best to meet the situation, but with their production booked until nearly the end of the year they do not feel it safe to take on much fresh work. Supplies from the Continent are very belated, and although recently a new release of finished steel was made, thousands of tons remain due against the release made in the spring, so that users do not anticipate much help from the Cartel. The British sheet works are in a difficult position, and it is estimated that their output is not much more than 50 per cent. of the actual capacity, although they have enough orders on their books to keep the mills running fully for months. In order to relieve the anxiety felt

by consumers a few of the steel makers have accepted orders for delivery in the first quarter of 1938; but the terms have been indefinite and the price will be that ruling on the date of dispatch. Few small firms are prepared to enter into such far distant engagements and there is considerable hardship amongst this class of consumers, who, in view of the nature of their business, usually require parcels for reasonably prompt delivery. The constructional engineers have a large amount of work in hand, but complain of interruptions due to delays in the delivery of joists and sections. Since the prices of colliery steel were increased there has been no appreciable expansion in the amount of business transacted, but large quantities had been contracted for by the collieries on the understanding that the price shall be that in force at time of delivery. It is difficult, however, to place new orders for this class of material owing to the heavy engagements which the producing works have on hand. Quotations are now, for bridge rails, £10 17s. 6d.; roofing bars, 5in., £10 10s.; heavy arches, £11 15s.; light arches, £11 10s. d/d colliery sidings. The situation in the South Wales industry is similar to that ruling in other parts of the country. The tin-plate works, however, are able to maintain a good output, since, for the most part, the mills are associated with steel works. The most recent figures of production give the rate of operation as 74.37 per cent. of capacity.

Scotland and the North.

Consumers in Scotland are exercising considerable pressure upon the Scottish steel works to obtain delivery, one reason being that the Glasgow Fair holidays commence at the end of the month, when the works will be closed for about a fortnight. Heavy deliveries are being made to all the consuming industries, and particularly to the shipyards on the Clyde; but, even so, little if any progress is being made in reducing the accumulated arrears of deliveries. Surprise has been occasioned that the new prices for bar iron have not been announced. It is known that for some time past the makers have been dissatisfied with the present range of quotations which are £12 7s. 6d. for Crown bars d/d Glasgow sidings, and £11 17s. 6d. f.o.b. Glasgow. They are disinclined to do any business except on condition that the price shall be that ruling on the date of delivery. New business in most descriptions of steel is restricted, since the makers are unable to promise execution until the last quarter of the year. The shipyards are busy and the subsidiary industry—the marine engineering department—is well supplied with work, but it is not easy to maintain a steady rate of operations owing to the difficulty of getting deliveries of steel. The re-rollers in Scotland are hoping to obtain a better production as a result of the new agreement with the British works which provides for regular supplies of billets; but at present there is a considerable amount of idle plant owing to the shortage. The production of structural steel is at a high rate in Scotland, although it does not meet the requirements of the market. New business in this material is almost non-existent, as the makers' order books are full for months to come. There is a large inquiry for sheets, but operations at the mills are restricted by the shortage of sheet bars. The home demand for galvanised sheets seems to be expanding, if anything, but until larger supplies of steel are available the makers will not be able to take full advantage of the movement. Consumers in Lancashire seem to think there is little likelihood of any improvement in the existing stringent conditions for the next six months, but nevertheless, the market is full of inquiries from firms endeavouring to get even small parcels to maintain their operations. There is a strong demand for bright bars. The production, however, is well below the requirements of the market. Engineering works are taking up large supplies of bolts and nuts, and this has created a strong request for bolt and nut bars, which is not being entirely satisfied.

Current Business.

The London and North-Eastern Railway has placed orders for 60,000 tons of steel rails, which have been divided as follows:—Dorman, Long and Co., Ltd., the Cargo Fleet Iron Company, Ltd., and the Skinningrove Iron Company, Ltd., 30,750 tons; Consett Iron Company, Ltd., 6500 tons; Lancashire Steel Corporation, Ltd., 5250 tons; Colvilles Ltd., 5000 tons; Steel Company of Scotland, Ltd., 4500 tons; Samuel Fox and Co., Ltd., 4000 tons; Shelton Iron, Steel and Coal Company, Ltd., 2000 tons; Barrow Hematite Steel Company, Ltd., 1000 tons; United Steel Companies, Ltd., 1000 tons. The Consett Iron Company, Ltd., has placed a contract with Ashmore, Benson, Pease and Co., Ltd., of Stockton-on-Tees, for the supply and erection of a blast-furnace gas cleaning plant to handle about 5,500,000 cubic feet of gas per hour. Ground has been leased at Aberdeen by the British Oxygen Company, Ltd., for the establishment of a branch works. The North British Locomotive Company, Ltd., of Springburn, Glasgow, has obtained an order for the construction of eleven locomotives of the "Pacific" type for the Federated Malay States Railways. The P. and O. Steam Navigation Company, Ltd., have placed an order with Barclay, Curle and Co., Ltd., Whiteinch, Glasgow, for a passenger vessel of about 11,000 tons gross, to be fitted with Döxford Diesel engines. Rylands Bros., Ltd., wire makers, have purchased for works extensions the 15-acre site at Warrington of the Cheshire Lines Engineering Works, which were closed down early in the year. Scottish Cables, Ltd., Shieldhall, Glasgow, have acquired 11 acres of land for the erection of a factory for the manufacture of electric cables. The Fairfield Shipbuilding and Engineering Company, Ltd., Govan, has received an order for an 11,000-ton passenger ship for the Bibby Line. The Buenos Aires Railway has ordered twenty steam locomotives and tenders and the African Gold Coast Railways five locomotives and tenders from the Vulcan Foundry,

Ltd., Newton-le-Willows. The Department of Overseas Trade announces that the following contracts are open for tender:—South African Railways and Harbours Administration: cup-head and countersunk head rivets (Johannesburg, July 12th); about 234 tons of steel work for bridges, including bolts, nuts, rivets, &c. (Johannesburg, July 19th); 361,515 lb. of copper bar, round, for fire-box stays, &c., in 12ft. lengths and in diameters ranging from $\frac{1}{2}$ in. to $2\frac{1}{2}$ in.; 9250 lb. brass piping in 12ft. lengths and in 10 and 12 S.W.G., outside diameters from $\frac{1}{2}$ in. to $1\frac{1}{2}$ in.; 14,415 lb. brass sheets, half hard and annealed, in sizes from 4ft. by 2ft. to 6ft. by 4ft., in varying S.W.G.; 37,785 lb. copper sheets, sizes from 6ft. by 3ft. to 9ft. by 6ft., varying S.W.G. (Johannesburg, August 16th); quantities of seamless copper pipes for locomotives in 12ft. to 16ft. lengths (Johannesburg, August 23rd); extruded free turning quality brass and bronze bars. Egypt, Ministry of Public Works, Mechanical and Electrical Department: Supply and erection of a complete electrical pumping station and transmission line at Bosat (Egypt, August 24th).

Copper and Tin.

The demand for electrolytic copper does not expand in accordance with the expectations entertained a short time ago. Industrial consumers appear to have covered their requirements and to be making their purchases last longer than was anticipated. On the other hand, buying by foreign public departments continues to be a feature of the market. Upon the news that the American steel strike was in the concluding stages it was expected that the copper consuming industries in that country would again come into the market. Although the strike has not affected the copper trade directly, owing to its influence upon sentiment, American buying has been comparatively light for a week or two. It is now assumed that the gap in buying will have to be made up. The wide spread between the prices of electrolytic and standard copper which has been so noticeable of late continues, but it will probably be lessened by a more rapid increase in the standard than in the electrolytic quotation. There has been a fair amount of bear selling in the standard market, but later a tendency developed to cover these transactions. . . . There has been a distinct improvement in the tone of the tin market and prices advanced rather sharply in mid-week. This was largely the result of an apparent improvement in the labour situation in the United States and to fresh purchases by users in that country, although the quantities which were taken were well below normal and will probably remain so for some time. Continental buyers have also shown slightly more interest. The belief that the world consumption of the metal is gradually expanding has been confirmed by these movements. It is interesting to note that great efforts are being made by the Bolivian Government to increase production in that country to a point nearer its quota under the international scheme. The problem of finding sufficient labour, however, remains one of the great obstacles. Speculation in the tin market continues at a low ebb and the market in London has been quiet. Complaints are still rife that the direct trade between producers and consumers is responsible for reducing the volume of business transacted on the London Metal Exchange and that hedging operations are not conducted on the same scale as formerly.

Lead and Spelter.

The improvement in the demand noticed last week has continued. In fact, it is surprising how well the requirements of the consuming industries have been maintained, one indication being that all the lead reaching this country goes quickly into consumption. It seems to be agreed that there has been some falling off from the peak figures of a few months ago, but we are now passing through a time of year when the demand usually dwindles. The general impression, however, is that with the exception of the building trade the consuming industries are taking as much metal as they did last year. The demand for pipes and sheets does not seem to have been greatly affected and large quantities of lead are passing into use in that form. Foreign requirements have expanded recently and both Russia and Japan have taken important quantities. These latter orders will be satisfied principally with Mexican lead. In America the statistics show a decline in the stocks at the end of May of 12,000 tons to 115,843 short tons. This is about two months' supply for the American market. The production in that country during May was lower at 43,605 tons, whilst shipments remained steady at 55,212 tons. As in the case of other metals in America, it was expected that the steel strike would affect the demand for lead, but now that the worst phases of the dispute appear to be over the belief prevails that the consumption figures will rise. . . . The spelter market has shared in the general improvement in the non-ferrous metal markets and the prices, which for a week or two had been distinctly on the easy side, developed a stronger tone. As a consequence there was a certain amount of bear covering, and a revival of speculative interest in bull operations. The fluctuations in this market recently seem to have been overdone, but the tone will probably be all the healthier for the decline in values, which shook out a number of weak speculators. There have been no further arrivals of Continental spelter, but some is expected to reach this country early in July. Some June contracts, however, have been settled by deliveries from warehouse. There is no scarcity of good ordinary brands, but it is by no means easy to obtain high-grade metal, although some business is reported to have been arranged for delivery in September and October. Later in the week this market was affected by the general unsettlement created by the franc crisis and by the disturbed international situation arising from events in Spain. It must be admitted, however, that of the two the financial upset was the more depressing factor. Nevertheless, the undertone of the market remained fairly steady.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Joists as well as Sections and Plates are now subject to a rebate of 15s. to home users purchasing only from associated British Steelmakers.

PIG IRON.

	Home.	Export.
	(D/d Teesside Area)	
N.E. COAST—	£ s. d.	£ s. d.
Hematite Mixed Nos.*	6 2 6	—
„ No. 1	6 3 0	—
Cleveland—	(D/d Teesside Area)	
No. 1	5 3 6	6 2 6
No. 3 G.M.B.	5 1 0	6 0 0
No. 4 Foundry	5 0 0	5 19 0
Basic (Less 5/- rebate)	5 0 0	—
MIDLANDS—		
Staffs.— (Delivered to Black Country Station)		
North Staffs. Foundry	5 6 0	—
„ Forge	5 1 0	—
Basic (Less 5/- rebate)	5 0 0	—
Northampton—		
Foundry No. 3	5 3 6	—
Forge	4 18 6	—
Derbyshire—		
No. 3 Foundry	5 6 0	—
Forge	5 1 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces*	6 3 0	—
No. 1 Foundry, ditto	5 15 6	—
No. 3 Foundry, ditto	5 13 0	—
Basic, d/d (Less 5/- rebate)	5 7 6	—
N.W. COAST—		
Hematite Mixed Nos.*	6 3 0 d/d Glasgow	—
	6 8 6 „ Sheffield	—
	6 14 6 „ Birmingham	—

* Less 5/- rebate.

MANUFACTURED IRON.

	Home.	Export.
	£ s. d.	£ s. d.
LANCS. AND YORKS.—		
Crown Bars	11 17 6	—
Best Bars	12 7 6	—
MIDLANDS—		
Crown Bars	11 17 6	—
Marked Bars (Staffs.)	13 0 0	—
No. 3 Quality	10 5 0	—
No. 4 Quality	10 15 0	—
SCOTLAND—		
Crown Bars	12 7 6	11 17 6
Best	12 17 6	12 7 6
N.E. COAST—		
Crown Bars	11 17 6	11 0 0
Best Bars	12 7 6	11 10 0
Double Best Bars	12 17 6	12 0 0
NORTHERN IRELAND AND FREE STATE—		
Crown Bars, f.o.q.	12 10 0	—

STEEL.

	Home.	Export.
	£ s. d.	£ s. d.
LONDON AND THE SOUTH—		
Angles	11 3 0	10 12 6
Tees	12 3 0	11 12 6
Joists	11 3 0	10 12 6
Channels	11 8 0	10 17 6
Rounds, 3in. and up	12 3 0	11 12 6
„ under 3in.*	12 0 6	11 0 0
Flats, under 5in.*	12 0 6	11 0 0
Plates, 3/16in. (basis)	11 13 0	11 0 0
„ 1/8in.	11 18 0	11 5 0
„ 1/4in.	12 3 0	11 10 0
„ 3/8in.	12 8 0	11 15 0
Un. 3/8in. to 1/2in. incl.	11 15 6	12 10 0
Boiler Plates, 3/16in.	12 3 0	12 2 6
NORTH-EAST COAST—		
Angles	11 0 6	10 12 6
Tees	12 0 6	11 10 0
Joists	11 0 6	10 12 6
Channels	11 5 6	10 17 6
Rounds, 3in. and up	12 0 6	11 12 6
„ under 3in.*	11 18 0	11 0 0
Plates, 3/16in. (basis)	11 8 0	11 0 0
„ 1/8in.	11 13 0	11 5 0
„ 1/4in.	11 18 0	11 10 0
„ 3/8in.	11 3 0	11 15 0
Un. 3/8in. to 1/2in. incl.	11 15 6	12 10 0
Boiler Plates, 3/16in.	11 18 0	12 2 6
MIDLANDS, AND LEEDS AND DISTRICT—		
Angles	11 0 6	10 12 6
Tees	12 0 6	11 12 6
Joists	11 0 6	10 12 6
Channels	11 5 6	10 17 6
Rounds, 3in. and up	12 0 6	11 12 6
„ under 3in.*	11 18 0	11 0 0
Flats, 5in. and under*	11 18 0	11 0 0
Plates, 3/16in. (basis)	11 10 6	11 0 0
„ 1/8in.	11 15 6	11 5 0
„ 1/4in.	12 0 6	11 10 0
„ 3/8in.	12 5 6	11 15 0
Un. 3/8in. to 1/2in. incl.	11 15 6	12 10 0
Boiler Plates, 3/16in.	12 0 6	12 2 6

STEEL (continued).

	Home.	Export.
	£ s. d.	£ s. d.
GLASGOW AND DISTRICT—		
Angles	11 0 6	10 12 6
Tees	12 0 6	11 12 6
Joists	11 0 6	10 12 6
Channels	11 5 6	10 17 6
Rounds, 3in. and up	11 0 6	11 12 6
„ under 3in.	11 18 0*	11 0 0
Flats, 5in. and under	11 18 0*	11 0 0
Plates, 3/16in. (basis)	11 8 0	11 0 0
„ 1/8in.	11 13 0	11 5 0
„ 1/4in.	11 18 0	11 10 0
„ 3/8in.	11 3 0	11 15 0
Un. 3/8in. to 1/2in. incl.	11 15 6	12 10 0
Boiler Plates, 3/16in.	11 18 0	12 2 6
SOUTH WALES AREA—		
Angles	11 0 6	10 12 6
Tees	12 0 6	11 12 6
Joists	11 0 6	10 12 6
Channels	11 5 6	10 17 6
Rounds, 3in. and up	12 0 6	11 12 6
„ under 3in.*	11 18 0	11 0 0
Flats, 5in. and under*	11 18 0	11 0 0
Plates, 3/16in. (basis)	11 10 6	11 0 0
„ 1/8in.	11 15 6	11 5 6
„ 1/4in.	12 0 6	11 10 0
„ 3/8in.	12 5 6	11 15 0
Un. 3/8in. to 1/2in. incl.	11 15 6	12 2 6
IRELAND—F.O.Q.		
Angles	11 5 6	11 8 0
Tees	12 5 6	12 8 0
Joists	11 5 6	11 15 6
Channels	11 10 6	11 13 0
Rounds, 3in. and up	12 5 6	12 8 0
„ under 3in.*	10 16 0	10 16 0
Plates, 3/16in. (basis)	11 13 0	11 15 6
„ 1/8in.	11 18 0	12 0 6
„ 1/4in.	12 3 0	12 5 6
„ 3/8in.	12 10 0	12 10 6
Un. 3/8in. to 1/2in. incl.	12 3 0	12 5 6

*Rounds and Flats tested quality; Untested 9/- less.

OTHER STEEL MATERIALS.

	Home.	Export.
	£ s. d.	£ s. d.
Sheets.		
11-G. to 12-G., d/d	15 0 0	f.o.b. 14 10 0
13-G., d/d	15 5 0	—
14-G. to 20-G., d/d	15 10 0	f.o.b. 14 15 0
21-G. to 24-G., d/d	15 15 0	f.o.b. 15 0 0
25-G. to 27-G., d/d	16 10 0	f.o.b. 15 15 0
South Africa, 24-G., Basis £15 0s., plus 3% on invoice value;		
Rhodesia, £15 10s.; Irish Free State, £16 10s., f.o.q.		
The above home trade sheet prices are for 4-ton lots and over;		
2-ton to 4-ton lots, 7s. 6d. per ton extra; and under 2-ton lots		
to 10 cwt., £2 per ton extra.		
Galvanised Corrugated Sheets, Basis 24-G.—		
Home.	£ s. d.	Export. Basis— £ s. d.
4-ton lots and up...	19 10 0	26-G. and heavier 18 15 0
2-ton to 4-ton lots	19 17 6	27-G. to 29-G. 19 15 0
Under 2 tons	21 2 6	30-G. and lighter 20 15 0
Export : India, £22 5s. c.i.f.; South Africa, £18 15s. f.o.b.,		
plus 3 p.c. invoice value; Rhodesia, £19 5s. f.o.b.;		
Irish Free State, £19 10s. f.o.q.; General, £18 15s. f.o.b.		
Tin-plates—		
20 by 14 basis, f.o.b. Bristol Channel Ports, 25s. 0d. to 26s. 0d.		
Tin-plate Bars, d/d Welsh Works, £7 15s. 0d.		
Billets. 100-ton lots and over. 35 to 100 tons, 5/- extra;		
less than 35 tons, 10/- extra.		
Soft (up to 0.25% C.), untested	7 17 6	
„ „ tested	8 7 6	
Basic (0.33% to 0.41% C.)	8 12 6	
„ Medium (0.42% to 0.60% C.)	9 2 6	
„ Hard (0.61% to 0.85% C.)	9 12 6	
„ „ (0.86% to 0.99% C.)	10 2 6	
„ „ (over 0.99% C.)	10 12 6	
Rails, Heavy, 500-ton lots, f.o.t.	10 2 6	
„ Light, f.o.t.	9 2 6	

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder...	5/1 1/2 to 5/3 per lb.	
Ferro Tungsten	5/- per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 5 0	7/6
„ „ 6 p.c. to 8 p.c.	£24 0 0	7/6
„ „ 8 p.c. to 10 p.c.	£24 0 0	7/6
„ „ Max. 2 p.c. carbon	£36 0 0	11/-
„ „ 1 p.c. carbon	£38 5 0	11/-
„ „ 0.50 p.c. carbon	£41 0 0	12/-
„ „ carbon-free	1/- per lb.	
Metallic Chromium...	2/6 per lb.	
Ferro Manganese (loose), 76 p.c.	£16 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- p.u.	
„ „ 75 p.c.	£17 0 0 scale 6/- p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/9 per lb.	
„ Titanium (carbon-free)	9d. per lb.	
Nickel (per ton)	£185 to £190 per ton.	
Cobalt	8/6 to 8/7 per lb.	

NON-FERROUS METALS.

(Official Prices, June 30th.)

COPPER—		
Cash	£54 0 0 to £54 5 0	
Three months	£53 12 6 to £53 17 6	
Electrolytic	£61 0 0 to £63 0 0	
Best Selected Ingots, d/d Bir-		
mingham	£62 15 0	
Sheets, Hot Rolled	£93 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	14 1/2d.	14 1/2d.
„ Brazed (basis)	14 1/2d.	14 1/2d.
BRASS—		
Ingots, 70/30, d/d Birmingham	£50 10 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	12 1/2d.	12 1/2d.
„ Brazed	14 1/2d.	14 1/2d.
TIN—		
Cash	£252 10 0 to £253 0 0	
Three months	£252 5 0 to £252 15 0	
LEAD :	£23 8 9 to £23 2 6	
SPELTER : Cash and Forward	£21 13 9	
Aluminium Ingots (British)	£100 to £105	

FUELS.

SCOTLAND.

LANARKSHIRE—		
(f.o.b. Grangemouth)—		Export.
Navigation Unscreened	20/6 to 21/-	
Hamilton Ell	21/6	
Splints	24/6	
AYRSHIRE—		
(f.o.b. Ports)—Steam	22/-	
FIFESHIRE—		
(f.o.b. Methil or Burntisland)—		
Prime Steam	22/6	
Unscreened Navigation	20/- to 21/-	
LOTHIANS—		
(f.o.b. Leith)—Hartley Prime	22/6	
Secondary Steam	22/-	

ENGLAND.

SOUTH YORKSHIRE, HULL—		
B.S.Y. Hards...	22/6 to 23/-	
Steam Screened	20/- to 20/6	
NORTHUMBERLAND, NEWCASTLE—		
Blyth Best	22/- to 24/-	
„ Second	22/-	
„ Best Small	18/6	
Unscreened	21/- to 22/-	
DURHAM—		
Best Gas...	22/6 to 23/-	
Foundry Coke	38/- to 44/-	
SHEFFIELD—		
Inland.		
Best Hand-picked Branch	26/- to 27/6	
South Yorkshire	22/6 to 24/6	
Seconds	20/6 to 21/6	
CARDIFF—		
SOUTH WALES.		
Steam Coals :		
Best Admiralty Large	26/- to 27/-	
Best Seconds	26/- to 27/-	
Best Dry Large	25/-	
Ordinaries	25/- to 26/-	
Bunker Smalls	19/6 to 20/-	
Cargo Smalls	17/6 to 19/-	
Dry Nuts	26/6 to 27/6	
Foundry Coke	40/- to 60/-	
Furnace Coke	37/6 to 42/6	
Pasture Fuel	26/-	

SWANSEA—		
Anthracite Coals :		
Best Large	38/- to 41/-	
Machine-made Cobbles	41/- to 51/-	
Nuts	40/- to 50/-	
Beans	27/6 to 35/-	
Peas	21/- to 26/6	
Rubbly Culm...	15/- to 16/9	
Steam Coals :		
Large Ordinary	20/- to 25/-	

FUEL OIL.

Inland consumption : contracts in bulk.		
Exclusive of Government tax of 1d. per gallon.		
Ex Ocean Installation.		Per Gallon.
Furnace Oil (0.950 gravity)	3 1/2d.	
Diesel Oil	4 1/2d.	

French Engineering Notes.

(From our own Correspondent in Paris.)

International Foundry Congress.

THE International Foundry Congress, which finished its sittings on Thursday of last week at the headquarters in Paris of the Association of Engineers of the Arts et Métiers, was attended by about 400 members from sixteen countries. The forty papers read dealt mainly with results of research work and progress in high-quality iron castings and several of them related to foundry organisation and practice. An exchange paper from Czechoslovakia provided some interesting data on work carried out by the research institute of the Skoda Company into the effects of additions of silicon and tin to grey cast iron. Communications by Professor Portevin and Monsieur Debard upon defects in cast iron raised the question of giving a more precise definition to defects and unifying the nomenclature, for the terms now applied to them are often erroneous and misleading, such as the "porosity" of cast iron, and should be replaced by names offering a sufficiently exact description of defects. It was decided that efforts in this direction should be centralised in a commission which it was proposed to create for that purpose. Two papers were presented on the broadening outlook for the foundry, one of them by Monsieur R. Lemoine, who reviewed the situation as indicating an increasing use of steel castings. One reason for this change is that many modern engineering requirements can only be met by castings of more or less special steels. Greater speeds and pressures impose a higher duty on parts subjected to them, such as brake drums on coaches and railcars, which require a material offering good mechanical properties at high temperatures. While special castings are being increasingly used for brake drums, the shoes are more frequently made of special cast iron. A reduction of weight is also favourable to a more extended application of steel castings. Failure of steel castings to make greater headway in the past is attributed to a want of collaboration between the customer and the founder, who should always be consulted before drawings are passed for execution. On the other hand, Monsieur Muguet, of Commentry-Fourchambault and Decazeville, gave a list of half-a-dozen qualities of cast iron which justified the recovery it was making of the ground it had lost, and the progress being made in cast iron of high mechanical resistance is opening up wider applications for this material. An example of these new applications is the use of special cast iron for crankshafts, for while the metal lies between iron and steel it is really cast iron.

Foundry Practice.

A paper by Monsieur Blanchot on what had been achieved by a reorganisation of the foundry at the State Railway works at Sotteville-Buddicom, was particularly welcome at a time when the forty-hour week has brought production economy to the fore. The conditions of the foundry are rather special owing to the character of the iron and non-ferrous metal castings and the quantity of scrap available in a railway foundry, and the organisation provides for an elimination of time losses apart from economy in the mechanical equipment. The result of the reorganisation is that during the past three years the hourly production per man increased by 64 per cent. in the ironfoundry and 122 per cent. in the bronze foundry. Another interesting communication was by Signor Olivo, of Milan, who described and illustrated on the screen a plant for casting radiator and similar parts with chains of vertical fixed and mobile pattern plates clamped hydraulically. A sand mixing plant known as the "Aeroplastica" was developed over a period of many years at great cost. With eight men and 25 H.P. for the whole plant the hourly production is declared to be two tons of castings and 15 tons of conditioned sand. Monsieur Louis Maillard gave the results of tests to determine the degree of humidity of cement-bonded moulding sand which is essential to its successful utilisation. He stated that cement-bonded sand was being employed in thirty foundries in eight countries. At the conclusion of the Congress the President, Monsieur A. Brizon, summed up the work accomplished during the week, and said that in order to facilitate concentration on special questions it had been decided to select a subject at each Congress to be dealt with at the one which followed it. The Congress was excellently organised by the Committee of the Association Technique de Fonderie, which arranged an extensive programme of receptions and social functions and visits to works and foundries.

Strikes and Lock Outs.

The fact that employers have no means of protecting themselves against strikes except by retaliating with lock outs is sufficient indication of the failure of existing contracts and compulsory arbitration, which was to have settled all labour difficulties without interruption to work. The carefully devised plan for preserving labour gains and putting an end to strikes proved inoperative when the men refused to accept arbitration awards that went against them. As employers and men had the right to revise contracts at the end of a year the former demanded modifications and the men wanted an increase in wages, and it was because of this wide divergence of claims and the practical certainty that they would involve trouble that the Government endeavoured to carry over the contracts during the period of the Paris Exhibition. The truce, as it was called, proved to be nothing of the kind. In the building trades the C.G.T. Union was particularly aggressive in its attempts to expel non-affiliated union workers from their jobs, and when the half-day's strike was declared on Monday of last week for the dismissal of these men, employers carried out their threat of a lock out on the following day, except in the case of firms whose men had not joined in the strike. This vigorous reaction had a salutary effect upon strikers and revealed to them, first that employers are determined to act in defence of liberty and authority and, secondly, that the considerable section of non-affiliated union workers and others who will have nothing to do with extremist action may prove a serious obstacle to the C.G.T. movement. The change in the Government's leadership, moreover, leaves the C.G.T. in some perplexity as to what will happen in the immediate future.

Newcomen Society.

SUMMER MEETING IN HEREFORDSHIRE.

WHEN the Council announced that the Society was to hold its Summer Meeting this year in Herefordshire, there was a feeling that such a predominantly agricultural county could not offer sufficient of interest to the historian of engineering and technology to justify the visit; in fact, there was a suspicion that the Society was falling from grace and that the Council meant to indulge in joy-riding amid the sylvan beauties of the county. How mistaken the feeling and suspicion were will be shown by what ensues.

The City of Hereford was the obvious place for headquarters, but had it not been so the kind invitation of the Woolhope Naturalists' Field Club to make use of its rooms in the City Museum, Art Gallery, and Library, would have been enough to turn the scale. On Wednesday evening, June 23rd, members coming from all quarters, headed by the President, Mr. W. J. Tennant, M.I.Mech. E., were received in the Museum and Art Gallery by the Town Clerk, Mr. T. B. Feltham, in the unavoidable absence from the city of Her Worship the Mayor, Councillor Mrs. Luard. Following the reception, there was an informal talk with lantern illustrations upon the Museum, which was subsequently inspected under the guidance of the lecturer, Mr. F. C. Morgan, who is Curator and Librarian, and takes an enthusiastic interest in the past and present agricultural life of the peasant and artisan—their methods, implements, tools, and clothing. The larger objects—an Elizabethan corn mill, cider mills, and cider presses, a seed drill, a chaff cutter, a corn cradle, a winnowing-machine, &c., bearing every evidence of local craftsmanship—have had to be relegated to the basement. Time did not serve to see properly the wealth of objects, but the idea and scope of the Museum evoked appreciative comment. Refreshments were served by the kindness of the Museum and Libraries Committee.

Thursday, June 24th, was devoted to a whole-day coach excursion through the Golden Valley under the able guidance of Mr. George Marshall, F.S.A., of the Woolhope Club. The first stop was at Eardisley to see what is left there of the terminal wharf of the Hay Railway or tramway, 1811-1864, through the good offices of Captain F. B. Ellison, who has rescued much documentary matter, unearthed rails and sleepers, and, in fact, has made an exhaustive study of the line. Here a pleasing ceremony took place. It was always the custom in the old days when the proprietors of the railway held their annual meeting, for the villagers to present to them bunches of flowers as a token of benefits received. Captain Ellison revived the custom by presenting buttonholes to the President and the Hon. Secretaries. The route of the tramway was followed to Whitney Bridge, and the only tramway milestone now in existence, it is believed, bearing this inscription—

HAY
RAILWAY
22 M.

i.e., from Brecon, was pointed out by the roadside.

Continuing the journey, the coach next drew up at the village green of Dorstone to let the party visit the wheelwright's shop there dating from the eighteenth century, and filled with tools of the craft, while near by is the saw pit and the cast iron bed for tiring wagon wheels; the predecessor of the latter, made of stone actually, was still lying about.

The next stop was at Vowchurch, the site of Rowland Vaughan's "Most Approved Waterworks"—a seventeenth century irrigation scheme for water meadows combined with industrial settlement. Here had existed one of the first, if not the first, water-wheel-driven saw mills in this country. The scheme was explained on the ground, with the aid of a map of the ditches and leats, &c., which he has identified, prepared by Mr. R. S. Gavin-Robinson, in a delightful short paper.

A visit to the Parish Church followed to see the independent timber roof and spire built by John Abell, a well-known local carpenter, in 1613. The queenpost roof is carried on inside posts so that no weight is carried by the walls.

Then came an interlude for much-needed luncheon in the Parish Hall, recently built, which itself was of interest as it embodies the roof and timbers of a tithe barn of the eighteenth century.

Resuming the journey, a stop was made by the roadside at Pontrilas at the wheelwright's shop of Mr. A. V. Godding to see his saw pit. An ash "stick" was in position, and he and his assistant were at work; this may be the last place in this country where such sawing can be seen. What it feels like to be a "top sawyer" was experienced by the able-bodied men of the party to the amusement of the rest.

En route again, a short stop was made at Abbey Dore to see the Early English Church, of which Mr. Marshall gave the party a brief description.

Between Pontrilas and St. Davenny were seen by the roadside traces of the Abergavenny and Hereford Railway, 1827-1853, part of the system already referred to. At the Whitfield estate a pause was made to see, by kind permission of Mr. Meysey Clive, an Easton hydraulic ram installed in 1827. This hoary antiquity was vouched for by Mr. D. Burnett, F.S.I., agent for the estate, who was kind enough to take the party to see the ram; the original invoice is still, it seems, in possession of the estate office. There was a second ram there, but of later date, as it was marked "Easton and Anderson."

In the evening the annual dinner was held at the Green Dragon Hotel, the President, Mr. Tennant, in the chair, and the occasion was honoured by the presence of the Town Clerk and of the local gentlemen who had assisted in the meeting. After some small amount of oratory, an adjournment was made to the rooms of the Woolhope Club to hear two papers that had been prepared for the occasion. The first was by Mr. Rhys Jenkins, Father of the Society, on "Industries of Herefordshire in Bygone Times." It was revealing, even to the local residents, to learn how important the county had been in manufactures in early times; particularly did this appear in the case of iron manufacture. The second paper was by Captain Ellison on the Hay Railway, seen earlier in the day; in support he had brought documentary matter,

rails, and chairs, &c., which, with lantern illustrations, provoked the liveliest interest, as proved by the discussion that ensued; some "fans" had almost to be dragged away.

Friday, June 25th, was occupied by a whole-day tour, again under the guidance of Mr. Marshall. The first call was in the village of Fownhope to see the tithe barn on "crucks," a method of construction on which a paper had been read in the last session. It was learnt with satisfaction that it was intended to repair the barn and devote it to the exhibition of particularly large objects, such as farm wagons, that could not be accommodated in Hereford Museum. The village stocks and whipping post were seen at the same time.

Ariconium, a Roman industrial and iron-smelting site, was next visited by kind permission of Mr. A. E. M. Harper, of Bollitree Castle, but, as excavation is suspended, there was practically nothing to see.

The next visit of importance was to Goodrich Castle, one of those erected to ward the Marches of Wales. Part of it dates from Norman times. The object of visiting it, rather than another of these strongholds, was to see the sanitary arrangements, c. 1300, which were discussed upon by Mr. S. B. Hamilton (member).

In passing through Whitechurch the sites of the forge and of the blast-furnace were pointed out. Through the delightful Wye gorge the coach sped on to Monmouth, with luncheon in prospect; consequently, the fine statue of the Hon. C. S. Rolls, a native of Monmouth, in the Market-place of the town, did not receive the attention it deserved. Leaving Monmouth after luncheon, the coach crossed Monnow Bridge, underneath the mediæval gate house that guards it, and after a short run reached Raglan Castle, the visit to which was decided on not merely because of its fine building and commanding situation, but largely because it was the seat of the second Marquis of Worcester of steam engine fame. The party was met and conducted over the castle by Mr. Raglan T. H. Somerset, one of the family, who has studied the history of the place for over half a century. Naturally, the talk came round to the topic of the chases or grooves in the wall of the keep, which have been supposed by Dircks and other biographers of the Marquis to have been intended for his "water commanding engine" of 1663. The present Lord Raglan and Mr. Somerset believe these grooves to belong to the drawbridge which must have existed there. Seeing that the grooves are integral with the tower which was built in the fourteenth century, and that the castle was not occupied again after being ruined in the Civil Wars in 1646, the conclusion is irresistible that the grooves have nothing to do with an engine or with pipes; thus another of the stories, dear to writers on the history of the steam engine, is exploded. The party was brought away with difficulty, even with the prospect of tea at the Beaufort Arms. The route followed to Hereford was *via* Abergavenny. Before going in to dinner, a visit was paid to Castle Green, the site of Hereford Castle—another of the strongholds of the marches—to see the bombard or mortar used in reducing Goodrich Castle in 1646, and believed to have been cast at Whitechurch, which had been visited the day before. It must weigh more than a ton, and is a notable bit of foundry work for the period.

At the Woolhope Club in the evening, an altogether delightful lecture on the Chained Library in the Cathedral was delivered by Mr. James Poulter, the Dean's Verger.

Mr. Morgan discovered, after the programme had been made up, that itinerant cloggers were at work in a field near Stretford Bridge, some 15 miles out of the city. It was decided that this could not possibly be missed, and the first visit on Saturday morning was there. The saving up of the older trees into logs, the splitting and trimming of these to make "rivings," the shaping by a dogging knife into "blocks" and "soles" and the final building of the soles into an open beehive form to season them, was fascinating to witness, the more so as it is a dying industry, and may soon disappear; clogs and silk stockings do not go together in Lancashire or elsewhere.

Hurrying back to Hereford, Mr. Morgan, who was in charge, took the party to the Cathedral, where the famous Mappa Mundi, c. 1300, was described in detail by Mr. Poulter, who later admitted the party to the Chained Library, about which he had discoursed the previous evening. There was scarcely time left to pay a visit to the "Old House" in the Market-place, formerly the Butchers' Guildhall (1621), where some interesting construction—wattle and daub, and flooring—was pointed out. This Old House belongs to the city and is appropriated to a museum of delightful domestic pieces of the same period as the house.

The weather, as it has been almost invariably on these excursions in the past, was beautifully warm and fine, although the visibility might have been better. The country was looking its freshest, and everyone enjoyed the meeting thoroughly.

British Patent Specifications.

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

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

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C.2, 1s. each.

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

STEAM ENGINES.

465,718. March 3rd, 1937.—MULTI-STAGE EXPANSION RECIPROCATING ENGINES, Schmidt'sche Heissdampf-Gesellschaft, mit beschränkter Haftung, Rolandstrasse 2, Kassel-Wilhelmshöhe, Germany.

The invention relates to multi-stage expansion reciprocating engines driven by steam or the like, with transmission gearing between the crankshaft of the high-pressure stage and a crankshaft of a lower pressure stage. In the drawing two forms of construction of a steam engine according to the invention are shown by way of example. In the figures the high-pressure cylinder is indicated by the reference letter A, the intermediate-pressure cylinder by the letter B, and the low-pressure

