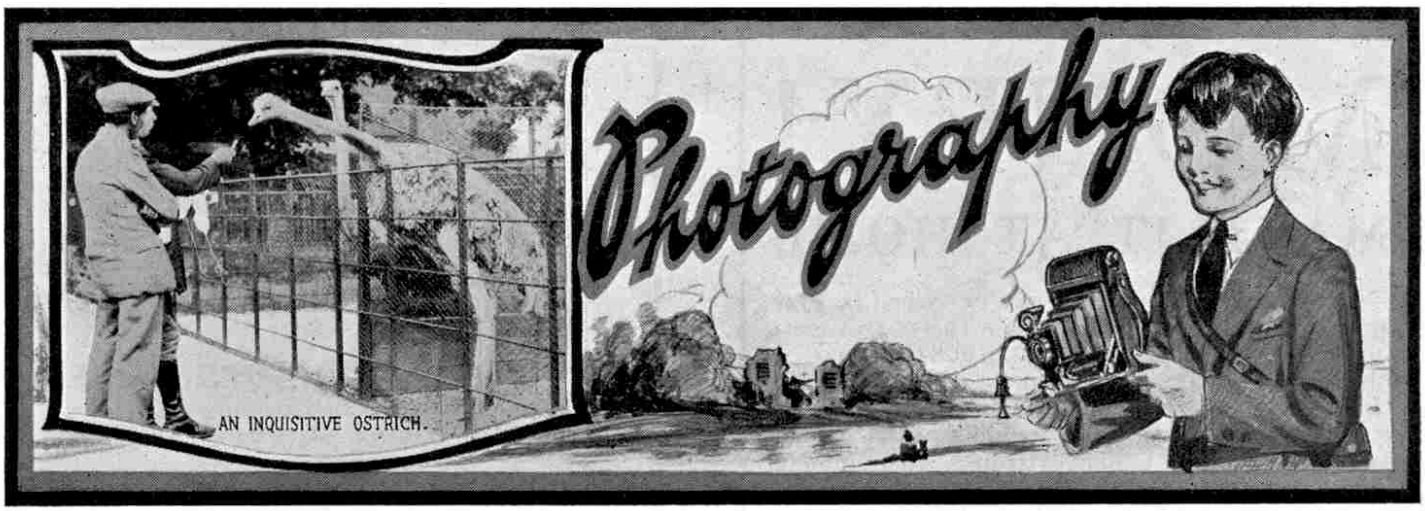


III. SHUTTERS AND THE EXPOSURE PROBLEM

LAST month we described the various types of photographic lenses, and we come now to a closely allied question, that of the shutter by means of which the lens is opened or closed as required in order to make the exposure. Exposures may be made by means of a cap fitting on the hood of the lens, and this method works quite well for fairly long exposures with a camera used on a stand. For use with a hand camera some kind of mechanical shutter is essential.

The simplest form of shutter works at one fixed speed and consists of a metal plate revolved on a pivot by a spring, and containing an aperture which passes in front of the lens, so making the exposure. Before and after the exposure the lens is covered by the metal plate. The speed of a shutter of this type may be anything up to 1/25 of a second. Sometimes an arrangement is fitted by means of which the aperture may be made to stop in front of the lens as long as required in order to give "time" exposures.

Bulb, Time and Instantaneous

This type of shutter is not only comparatively slow in working, but it has also many other disadvantages, and it is replaced on good class cameras by a shutter having two metal or vulcanite plates which open and close to make the exposure. The speed of these shutters is controlled by a pneumatic valve operated by turning a dial.

Most shutters of this type are marked with the letters "B," "T," and "I," which represent respectively "Bulb," "Time" and "Instantaneous."

If the shutter is set for "Bulb," the small trigger operating the shutter is pressed down and the shutter remains open until the trigger is released.

The term "Bulb" is derived from an earlier form of shutter which was operated by a ball and tube, such an exposure as we have just described being given by squeezing the ball and not releasing it until it was desired that the shutter should close.

When the shutter is set at "T," it opens when the trigger is pressed. The trigger is then released and the shutter remains open until a second pressure is made, when the shutter instantly closes. "Instantaneous" exposures are made by one pressure of the trigger, and the varying speeds at which the shutter will work are usually indicated on a dial which is revolved to set the required speed.

The roller-blind shutter, which works on a similar principle to the familiar domestic spring blind, has an opening that makes the exposure by passing in front of the lens. The blind is wound by pulling a cord, and released by pressure on a small trigger. This form of shutter is excellent for stand camera work, but is not at all satisfactory for small hand cameras.

In Shakespeare's Country

Photo by [*B. Bentley*

A corner of Warwick Castle

A reader's snap in a delightful district for photographers

All the foregoing types of shutter are always fixed close to the lens.

The Focal Plane Shutter

We now come to a shutter fitted at the back of the camera, so that it works immediately in front of the plate. This is the "Focal Plane" shutter, which is in many ways the most valuable and the most interesting of all shutters.

In many respects the focal plane shutter is similar to the roller-blind type, and as in the case of the latter its blind has to be wound up and released. It has two outstanding advantages—first, an exceedingly high speed, and second, great light efficiency—that is to say it allows more light to reach the plate during a given exposure than almost any other type of shutter.

A focal plane shutter is capable of giving exposures of one-thousandth of a second or even less, and for this reason it is used for the photography of rapidly-moving objects such as trains or motor cars, or for obtaining snapshots of cricket, football and other games.

Having now dealt briefly with the various types of cameras, lenses and shutters, we must now pass on to the first steps in taking an actual photograph.

The Perfect Negative

In taking a photograph, the aim of every photographer is, or should be, to produce a "perfect negative"—that is one that reproduces faithfully all the varying gradations of tone in the subject. Such a negative can only be obtained by allowing the light reflected from the subject to affect the sensitive emulsion on the plate or film for exactly the correct length of time. In other words, the plate or film must be given the correct exposure.

At one time it was generally believed that, although correct exposure was highly desirable, yet if by any chance the exposure was wrong it could be compensated for in the subsequent process of development. This idea is now known to be erroneous. It is quite true that incorrect exposure may be remedied very slightly during development, but the improvement thus effected is barely noticeable and is very difficult to obtain.

Factors Governing Exposure

We have said that a perfect negative demands correct exposure, and this brings us to the question of how to decide what is the correct exposure for a particular subject.

There are five factors governing exposure (1) The strength of the light; (2) The aperture of the lens. (3) The speed of the plate or film. (4) The nature of the subject to be photographed and (5) the movement (if any) of the subject.

The strength of the light depends mainly upon the height of the sun above the horizon and the clearness or otherwise of the atmosphere. For many years photographers used to guess the strength of the light, the success of such guesses, of course, depending largely upon the length of the

(*Continued on page* 285)

Photography (*continued from page 283*)

photographer's experience. In addition to the errors introduced by this guesswork there was also the difficulty that the speeds of the various plates used were not known with anything like accuracy.

This state of affairs has now been changed entirely, largely through the efforts of Dr. Hurter, a chemist, and Mr. V. C. Driffield, an engineer, who, working together, carried out what is probably the most important research work in photography.

"H. and D." Numbers

First of all Messrs. Hurter and Driffield dealt with the question of light values, and presently they were able to tabulate the changing powers of daylight and to express these in the form of regular curves. Next these investigators turned their attention to the matter of plate speeds, and they worked out a system of plate testing by means of which the speed of a plate could be definitely expressed as a number. The numbers obtained by this method are always preceded by the initials "H. and D."

If we pick up a packet of plates marked "H. and D. 200" and another packet marked "H. and D. 100," we understand that the plates in the first packet require half the exposure of those in the second, or in other words that they are twice as fast. As a matter of fact, although the letters "H. and D." are still in general use, different plate makers have modified their methods of testing so that a plate of one maker marked, say, "H. and D. 250," is not necessarily of exactly the same speed as another plate similarly marked but produced by another firm.

Measuring the Light

To-day the exposure problem is rendered comparatively simple by means of exposure meters or exposure calculators.

In order to estimate exposures accurately by either of these means it is obviously necessary that the speeds of the various brands of plates or films should be known, and therefore the makers of the best exposure meters and calculators issue lists of plates giving definite and accurate speed numbers, which are obtained by actual tests without reference to the numbers given to the plates by their manufacturers.

An exposure meter consists essentially of some kind of a case containing a strip of sensitized paper which darkens when exposed to light in accordance with the photographic strength of that light. A tiny piece of this paper is exposed to the light falling upon the subject to be photographed, and a note is made of the time taken by this paper to darken to the same shade as that of a sample tint alongside it. Having found this time, the correct exposure is quickly calculated for the particular plate or film in use, according to the instructions issued with the meter.

Exposure Calculators

In the case of an exposure calculator, the light is not actually measured, but its value is ascertained by means of a scheme carefully worked out with reference to the month of the year, the time of day, cloud conditions, etc. One of the best-known of these calculators is that incorporated in the Burroughs Wellcome Photographic Handbook. This handbook gives speed factors for practically every brand of plate and film, together with light tables for every month and for every hour of the day during which photography is reasonably possible.

Having found the factor for the plate or film in use, the light table for the month is consulted and the factor found for the hour of the day and the weather conditions prevailing. The calculator is then referred to, and from these two factors the correct exposure is instantly and automatically found.

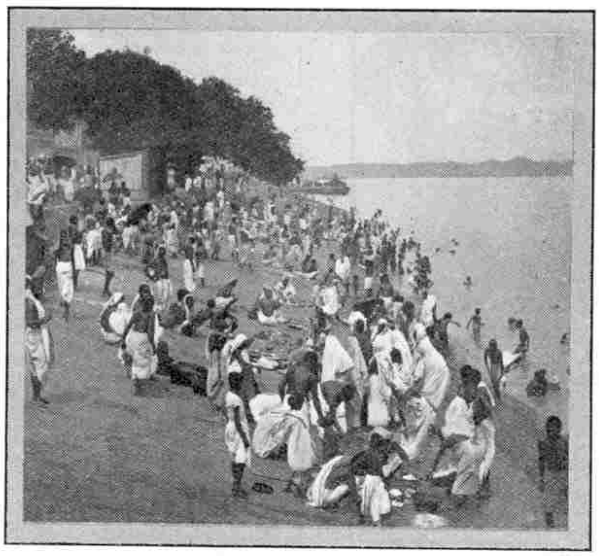
Nature of the Subject

The fourth factor governing exposure, the nature of the subject to be photographed, requires the use of judgment on the part of the photographer. Fortunately this is not a very difficult matter. If we are using an exposure meter we measure the light and from this ascertain the correct exposure for a normal or standard subject when using a certain speed of plate. This normal subject may be described as an average landscape with no dark trees or buildings in the immediate foreground, and it includes the great majority of outdoor views taken by the average amateur.

If the subject is not of this normal type certain modifications in the exposure must be made, and the nature of these is indicated clearly in the instructions for the various makes of meters. If we are using a Wellcome calculator the problem is made still easier, for the various types of subject are illustrated so clearly by a series of small photographs that it is almost impossible to go wrong.

(*To be continued*)

From "India's Coral Strand"



This photograph, sent by Birendra N. Roy, of Calcutta, was awarded First Prize (Section A) in our Tenth Photo Contest (Overseas Section). It shows a bathing scene on the banks of the sacred River Ganges

Sixteenth Photo Contest

Although the seasons appear to have altered to some extent, June is still in many respects the most beautiful month of the year. Certainly at no other period is an English landscape so full of freshness.

For this reason we are selecting as the subject of our Sixteenth Photo Contest—"A June Landscape." We make no restrictions as to what is to be included in the landscape, and all that is necessary is for the competitor to take a photograph of some interesting open-air view. In judging this competition we shall be influenced mainly by two things—the interest and beauty of the scene chosen and the accuracy with which the scene is photographically depicted.

Of course, a good deal of what we have just said does not apply to large numbers of our overseas readers whose seasonal conditions are quite different from ours, and naturally we shall not expect the same kind of landscape from an Australian boy as from an English boy. Overseas entries, therefore, will be judged entirely on their own merits, without any comparison with the nature of the home entries.

Prints may be of any size and made by any process, and the work may be done by the competitor himself or by a photographic dealer. We are very anxious to encourage our readers to complete the whole photographic process, from making the exposure up to the finished print, entirely unaided, for the full fascination of photography cannot be realised if one merely clicks the shutter and then leaves everything else to a dealer. For this reason, in the event of a tie for a prize, preference will be given to prints that have been made by the competitor himself, and therefore every entrant must state on the back of his print by whom it has been made. In addition, each print must bear the name, address and age of the competitor clearly written.

The competition will be divided into two sections—(A) for competitors of 16 and over, and (B) for those under 16. Four prizes are offered—photographic goods to the value of £1/1/- and 10/6, to be chosen by the winners, as first and second prizes respectively in each section.

Closing date 30th June (Overseas, 31st October).

We wish to draw the special attention of our home readers to the additional prizes generously offered by Messrs. Gevaert Ltd., the well-known manufacturers of photographic products. Messrs. Gevaert offer an additional prize of photographic goods to the value of 5/- to each of the four prize winners in the home section of this contest, on condition either that *the negatives have been made on Gevaert roll films or Gevaert plates* or that *the prints have been made on one of the Gevaert papers.* Competitors who wish to try for these additional prizes must send in, along with their entry, the label from the packet of Gevaert films, plates or papers used by them, and also the name and address of the dealer from whom the material was obtained.

Gevaert Photo Materials

We have received from Messrs. Gevaert Ltd. (Walmer Road, London, W.10) some interesting particulars about the various photographic materials manufactured by them and also some samples of their papers.

The most interesting of this firm's products is the Gevaert Roll Film, which possesses the high speed and excellent quality that go to make a first-class film. In addition it has a feature of particular interest to the amateur who develops his own films in the usual form of tank, for other makes of film have first to be stuck down at the end of the film, which is a somewhat tricky operation. In the Gevaert spools the end of the film is already attached under a freely moving slot, however, and the exposed film is accordingly ready to be put straight into the tank.

Interesting literature regarding these films and also the other Gevaert products—plates, gaslight and self-toning paper—will be sent on application to any reader mentioning the "*M.M.*" Incidentally we would draw our readers' attention to the additional prizes offered by Messrs. Gevaert for our Sixteenth Photo Competition announced on this page.

RESULT OF Thirteenth Photo Contest

There was a large number of entries for this Competition (photograph of a train standing in or starting from a station). Many of the snapshots indicated that the takers were aware of the absolute need of securing a really good vantage-point from which to direct their cameras. Especially where large stations are concerned, it is often impossible while standing on the platform to snap an incoming or outgoing train without getting a blurred effect owing to steam. Some of the best efforts submitted were apparently taken from an overbridge of some kind.

In one or two cases it was impossible to tell whether the train was in motion or standing, owing to the absence of steam and smoke emanating from the locomotive. As we intend to hold a similar competition in the near future it may be well to point out that a really arresting and effectual snapshot can be got only by waiting for a good smoke and steam effect, such as occurs when a heavy train is starting on a greasy rail, or when a locomotive is blowing off steam strongly as the pressure gauge ticks round to the maximum.

Selecting the winning photographs proved to be no easy task, but after full consideration we made our awards as follows:—CLASS A. First Prize (Photographic goods value 10/6), F. G. Simpkins (Treharris, Glam.) Second Prize (Photographic goods value 5/-), J. Duckworth (Accrington). CLASS B. First Prize (Photographic goods value 10/6), R. S. Hardy (Parkstone, Dorset). Second Prize (Photographic goods value 5/-), F. H. Jackson (Burton-on-Trent).

Lives of Famous Engineers—

(*Continued from page* 269)

of drapery and tea merchants and subjected to the indignity of being used as a kind of show place for advertising purposes. Four years later she was sold to be broken up, and thus ended her career.

An Unlucky Ship

The "*Great Eastern*" was dogged by misfortune, and almost everybody who was connected with her suffered financially. Regarded from a commercial point of view she was a failure, but this was due almost entirely to the fact that she was too far in advance of the times, and thus never really had a fair chance. If the "*Great Eastern*" could have been fitted with thoroughly efficient engines her story would probably have been very different. Although this great ship did not accomplish the wonderful things expected of her, nevertheless she marked an epoch in the history of steamship construction, and she paved the way towards the building of the giant liners of to-day.

Brunel's Ability as Ship Designer

We cannot do better than close this brief account of Brunel's work as a ship designer by quoting the following passage from Sir William White's address to the Institution of Civil Engineers in 1903:—

"Having recently gone again most carefully through Brunel's notes and reports, my admiration for the remarkable grasp and foresight therein displayed has been greatly increased. In regard to the provision of ample structural strength with a minimum of weight; the increase of safety by water-tight subdivision and cellular double bottom; the design of propelling machinery and boilers, with a view to economy of coal and great endurance for long-distance steaming; the selection of forms and dimensions likely to minimise resistance and favour good behaviour at sea; and to other features of the design which need not be specified, Brunel displayed a knowledge of principles such as no other ship-designer of that time seems to have possessed, and in most of these features his intentions were realised."

NEXT MONTH:—

BRUNEL'S CLOSING YEARS

OUR MAIL BAG

In these columns the Editor replies to letters from his readers, from whom he is always pleased to hear. He receives hundreds of letters each day, but only those that deal with matters of general interest can be dealt with here.

Correspondents will help the Editor if they will write neatly in ink and on one side of the paper only.

H. S. Downey (New Malden).—"Not for one moment did I dream that I should receive an answer from you and I take this opportunity of thanking you from the bottom of my humble heart." We are glad to note that you are revising your opinion of Editors and that you realise now that "most of them are good sports." We receive hundreds of letters every week from boys all over the world and we invariably answer each one individually. It makes no difference to us whether the writer is a very small boy or a very big one, or whether he lives in London or Timbuctoo; we read every letter with interest, and in replying try to imagine what the writer is like and to convey to him our spirit of friendliness. We are glad that our letters have "bucked you up" and we hope you will write to us very often and let us know what you are doing.

W. Wilson (Edinburgh).—"I think the '*M.M.*' improves with every issue and as long as it improves I do not mind if the price goes up to 2/6." We are afraid that there would most decidedly be a riot among our readers if the price went up as high as that, William, but we quite understand what you mean. You feel, as thousands of other boys feel, that the "*M.M.*" is the Meccano boys' own Magazine and that no other magazine can ever take its place. You have been a little unfortunate in sending in puzzles that have previously been submitted by other boys, but we hope you will try again, and next time with success.

E. P. Naish (Leeds).—We are interested to hear that you have had a year's "*M.M's*" bound for such a small cost as 5/-. Your suggestion with regard to an index is one that has been put forward by many readers, and you will be interested to know that we are now taking steps to have an index prepared for this year's issues. It will be published in December and we agree with you that such an index will greatly enhance the value of bound sets.

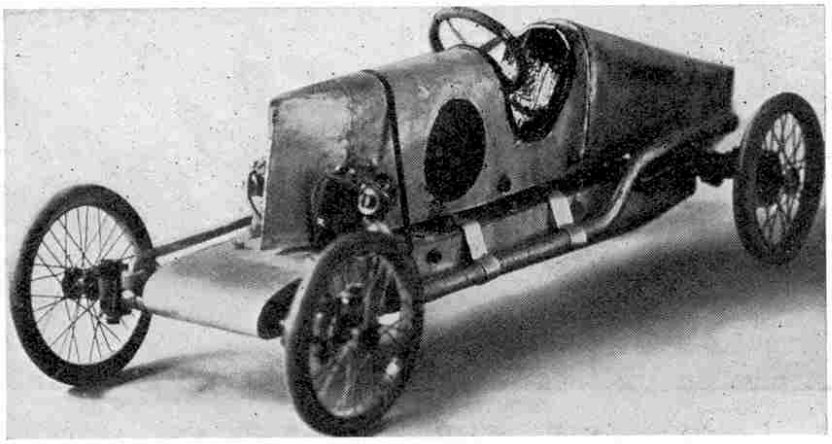
J. R. Campbell (Bloemfontein).—"I received the ever-interesting '*M.M.*' last month with its fascinating cover." We feel greatly encouraged by hundreds of such appreciations, J. R., for it makes us feel well repaid for the time and labour spent in producing the Magazine. We are glad to hear that you were so amused by "*Discoveries in Meccanoland.*" The inhabitants are certainly very remarkable people judging by their photographs. We cannot say what the motor cyclist takes to keep his nerves in good condition! Our own special tonic is to read such cheery and encouraging letters as yours. Send the next one along quickly!

W. Harvey (London, N.1).—"Although not a 'boy,' I find a set of Meccano has given me more enjoyment in my leisure hours than anything contained in my workshop." Your experience affords another proof of the truth of our slogan, "The correct age to start Meccano is anywhere between 5 and 70." We read somewhere the other day that "a man is but a boy thinly disguised." We agree with this and we are convinced that nothing penetrates that disguise so effectively as a Meccano set.

J. D. Richardson (Auckland, N.Z.)—We were very interested to read that your boy is allowed to monopolise the dining room table and floor during his holidays. Fathers and mothers very often try to pretend that they are not interested in Meccano or Hornby Trains, but we have a shrewd idea of what happens in thousands of homes when Dick and his brothers have been sent off to bed! Your confession—"After bedtime his mother and father have a go at it, and Oh! it's great stuff"—was indeed refreshing to read.

C. L. Pereira (Ceylon).—As in the case of many readers, you appear to be keenly interested in anything connected with nature study and we think you will appreciate our new feature 'How to Start an Aquarium.' These articles are written by an expert, a man who has made the creatures of pond and stream a life study and who is anxious to pass on some of his own enthusiasm. No doubt some of the plants and creatures referred to in these articles will not be quite the same as those to be found in your part of the world, but none the less we feel sure you will read the articles with keen enjoyment. Perhaps you might be able to write a short contribution for our "Readers' Page," dealing with some of the water creatures peculiar to Ceylon.

A Famous Racing Motor Car



The above is a clever model of the famous racing car Kim II. The framework of the model is entirely constructed with Meccano, being afterwards covered with sheet tin and painted.

The racing car of which this is a model is fitted with a two-cylinder air-cooled engine, the drive being transmitted by a shaft to bevel box, thence by cross-shaft and dog-clutch change-speed mechanism to chains driving the rear axle. This car was successfully raced for several years by Captain A. G. Fraser-Nash, who succeeded in making some of the fastest ascents that have ever been accomplished on hill trials in several speed events.

Fittings for Model Ships

The casting moulds of A. Rodway (102, Long St., Birmingham) are already well known and our readers will be interested in a new development by this enterprising firm in the shape of fittings for all kinds of model sailing boats, steamers, warships, etc. These fittings are well made and can be recommended for giving the finishing touches to any model ship. In addition the firm supply drawings, instructions and materials for building a wooden passenger liner, 2 ft. in length. The materials are sold in two separate parcels, one containing all the essential parts and the other the additional fittings required to complete the model. A scale drawing of this liner, together with an interesting list of fittings, will be sent to any of our readers for 6d., post free.

Famous Locos under Test—

(*Continued from page* 271)

principally upon its splendid work in connection with the "Cornish Riviera" Express—a train noted for its speed and precision in timing throughout its regular journeys from London to Plymouth—a distance of 226 miles, representing the longest daily non-stop run in the world.

As in all other "Castle" Locos, the boiler of the "*Pendennis Castle*" has a maximum diameter of 69″, and a minimum of 62″ (at the front end) and is 14′ 10″ in length. It is fitted with 201 2″ and 14 5″ tubes, and has a total heating surface of 2,312 sq. ft.

Four cylinders, each of 16″ bore and 26″ stroke, are fitted, two being mounted between the engine frames and two outside. The inner pair are connected to the forward driving axle, while those outside transmit power to the central pair of coupled wheels, which are 6′ 8½″ in diameter. Steam is supplied at the exceptionally high boiler pressure of 225 lbs., and the tractive effort equals 31,625 lbs. The engine with tender scales nearly 120 tons in full working trim, of which 59 tons are available for adhesion.

As soon as a detailed report of the recent te ts is available we shall print further particulars of the performance of each loco.

Tuition by Correspondence

Tuition by correspondence appears to be steadily gaining ground in popular favour, especially among those who wish to pass some particular examination but can only study in spare time. The tutorial Service College (183, Fulham Palace Road, Hammersmith, London, W.6) has been engaged for many years in teaching by correspondence and by means of its system instruction by expert tutors is brought to each student in his own home.

The Meccano Jersey

The popularity of the Meccano Jersey, made specially by the Jaeger Co. Ltd., increases steadily as the excellent qualities of the jersey become better known. Recently the jersey has been further improved by giving the collar a wider turnover in front and by tacking it down at the back, which will prevent the curling at front or back that has occurred occasionally in the past. The jersey is now obtainable from any Jaeger agent in five colours.—Navy/Saxe, Mixed Grey/White, French Grey/Mole, Camel shade/Brown, Brown/Camel shade.

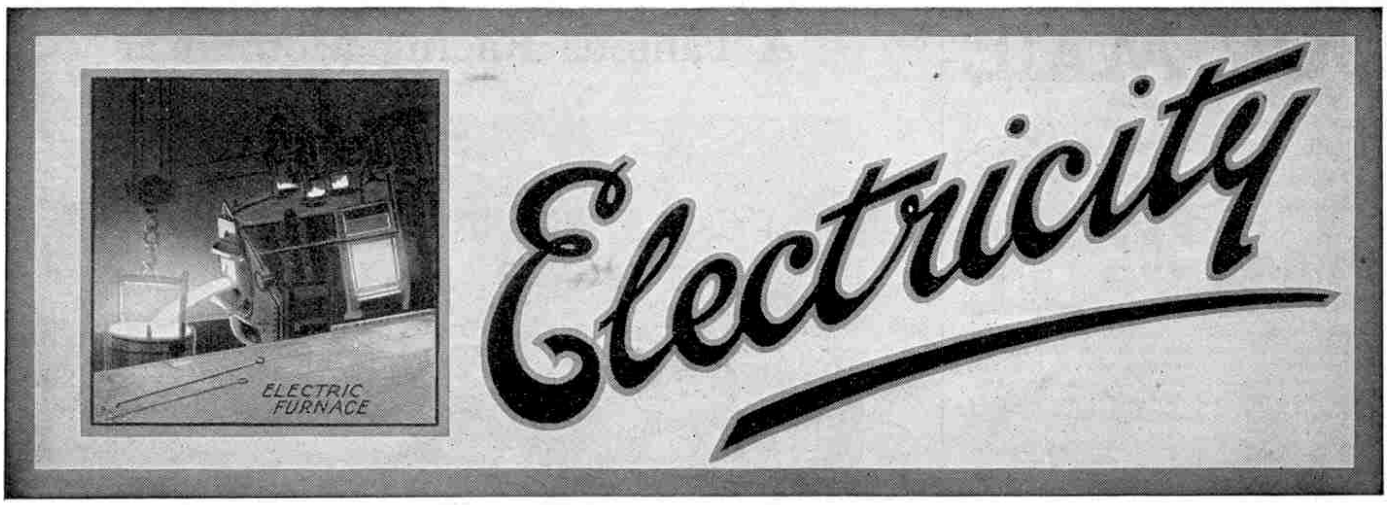
The Jaeger underwear for boys fully maintains its excellent quality, and as it is made of pure wool it is the best possible safeguard against chills after strenuous exercise of any kind.

The Story of Metals—

(*cont. from page* 277)

It is the heaviest of all the common metals. It is very malleable, being easily rolled into thin foil, but on the other hand it cannot be drawn out into fine wire in the same way as copper.

Lead is the most durable of all the common metals. If it is exposed to the action of the atmosphere a coating of rust forms upon it just as rust forms upon iron, but there the similarity between the two metals ends. Whereas rust gradually penetrates deeper and deeper into iron, lead is protected by the first coating of rust formed, and provided this coating is not scraped away no further corrosion occurs. So perfectly is the metal protected by this coating that lead pipes laid down in Rome, Herculaneum, and Pompeii some 1,800 years ago have lasted to the present day. For the same reason the lead roofs of many buildings erected hundreds of years ago are still in a state of excellent preservation.



XVI. THE WHEATSTONE AUTOMATIC SYSTEM

EARLY in the history of the land telegraph it was found that the telegraph lines, especially those suspended in the air on poles, were capable of transmitting the dots and dashes of the Morse code at a much greater rate than it was possible for any operator to send them by hand. It was also found that the Morse inker at the receiving station was capable of operating at a much greater speed than that at which it worked when the signals were hand transmitted.

The maximum speed of a skilled Morse operator is about 30 words per minute. Duplex circuits (already described in this series) will thus take 60 words per minute per circuit and quadruplex circuits 120 words. This is still less than the line is capable of taking, and consequently it was not long before telegraph engineers began to search for a method of transmitting Morse automatically.

Sir Charles Wheatstone

The Wheatstone automatic system of telegraphy was invented by Sir Charles Wheatstone, and it was the crowning achievement of a life devoted to scientific research.

Wheatstone was born in February 1802 at Gloucester, his father being a music seller in that city. Four years later the family removed to London and the boy received his education at various local private schools. He does not appear to have shown any outstanding ability, and his most noticeable characteristic was an almost painful shyness and sensitiveness that made it almost impossible for him to make friends. At the age of 14 he was sent to his uncle, a musical instrument maker in the Strand, to learn the trade, but he never really settled down to this business and he spent more time in reading than at work. On the death of his uncle in 1823 Wheatstone and his brother took up the business, but Charles practically retired after about six years and devoted himself to experimental research.

Wheatstone's first work was chiefly concerned with sound. Among the various ingenious contrivances that he invented was one known as the "Acoucryptophone," which consisted of a box shaped something like an ancient lyre and suspended by means of a wire from a piano in the room above. When the piano was played the vibrations were transmitted silently along the wire to the lyre and there became audible, the instrument thus appearing to play of itself! Wheatstone's shyness was a great drawback to him in his scientific life as it prevented him from becoming a successful lecturer. As a matter of fact many of his investigations were first publicly described by Faraday in his discourses at the Royal Institution.

Sir Charles Wheatstone

Original Experimental Work

Wheatstone's originality and ability were fully recognised by 1824 and in that year he was appointed Professor of Experimental Philosophy at King's College, London. He became a Fellow of the Royal Society in 1837, and in 1868, after the completion of the automatic telegraph, he was knighted. The remainder of his life was uneventful except for the progress he made in scientific research. In 1875 he was in Paris working upon a receiving instrument for submarine cables and while there he caught a cold and died on 19th October.

The experimental work carried out by Wheatstone covered a very wide field. In addition to his telegraphic inventions he devised a cryptographic machine for printing cipher messages which were utterly unintelligible until translated by a duplicate instrument. He also invented various musical instruments, the best known of which was the concertina. It should be noted that the Wheatstone bridge, which we described last month, was not invented by Wheatstone. The actual inventor was a man named Christie, and Wheatstone was only instrumental in giving the apparatus publicity.

The Wheatstone System

Since its invention in 1867 the Wheatstone automatic system has undergone only small modification and it is still in practical use throughout the world for all types of telegraph work. A system that has withstood so successfully all the competition it has had to face from the great advances in telegraph science during the past 58 years must be extremely efficient and it is therefore interesting to study its operation. It can be worked at speeds ranging from 25 to 400 words per minute and even at 600 words per minute for short periods. In practice it has been found that a speed of 250 or 300 words per minute is quite sufficient for all normal purposes.

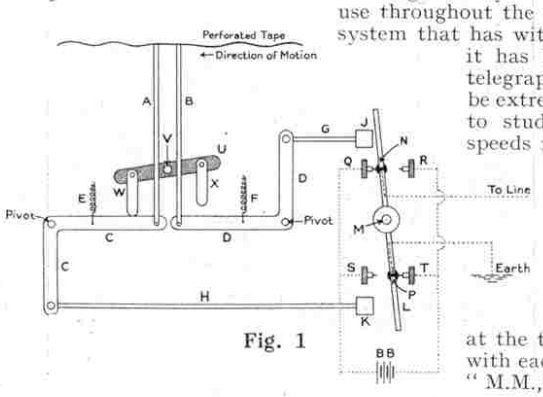
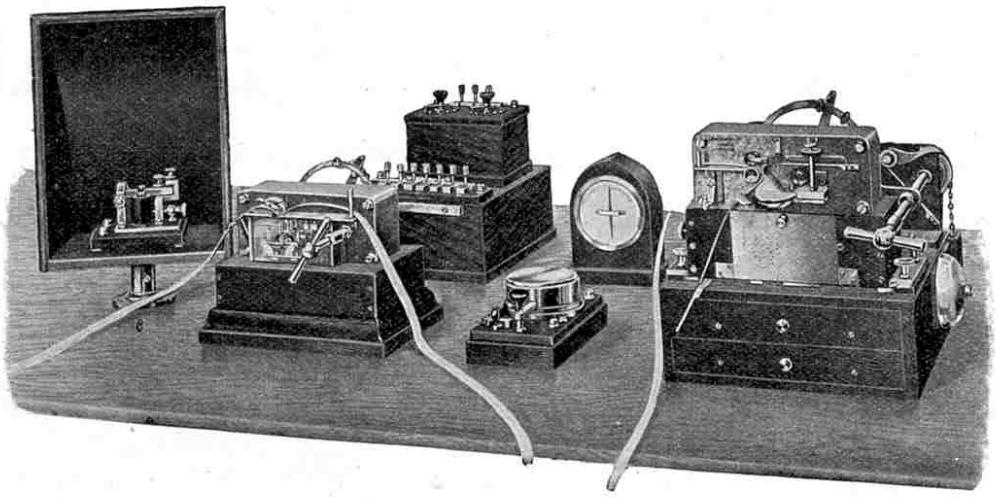


Fig. 1

The Wheatstone system possesses an advantage over the Baudot and other similar systems in that no moving parts at the two stations need to be in synchronisation with each other. As we explained in last month's "M.M.," in the Baudot system the two distributing

arms, one at each station, must both revolve at exactly the same speed. This means that the stations must always send and receive at the same speed, whereas in the Wheatstone system the transmitter works independently of the receiver, and the speed of the transmitter may be regulated without reference to the receiver.

The Wheatstone is a double current system, that is to say a current is flowing through the line the whole time but its direction is reversed to indicate a dot or a dash of the Morse code. Thus a reversal of short duration represents a dot and a reversal of long duration represents a dash.



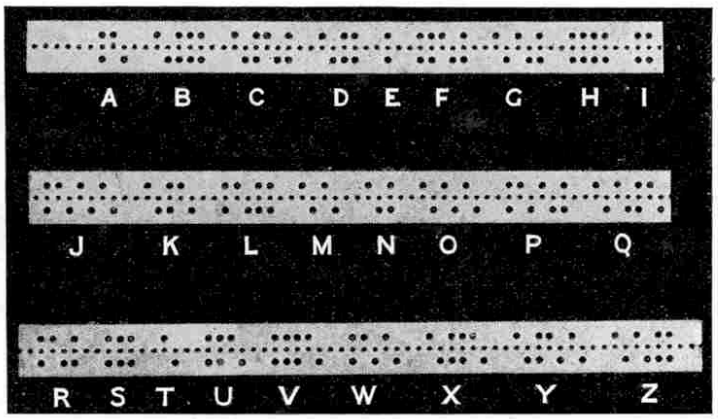
Courtesy [*Messrs. Siemens Bros. & Co. Ltd.*

Fig. 2. Wheatstone Station Set

The Wheatstone Perforator

The Wheatstone apparatus consists of three units. First there is the perforator by means of which holes are punched in a strip of paper tape. Then there is the transmitter which controls the reversals of current in the line in accordance with the perforations of the tape and finally there is the receiver which is a type of polarised inker and which receives the signals in the Morse code and marks them on a paper tape in the usual manner.

The hand perforator, shown in Fig. 4, consists of three keys operating three sets of punches. When the left-hand key is pressed two holes opposite to one another are punched, representing a dot. When the right-hand key is pressed two diagonal holes are punched representing a dash. The manner in which the holes are punched for dots and dashes respectively is shown in Fig. 3 which represents the Morse alphabet as it appears in the perforated tape. For example, the letter A consists of a dot followed by a dash, and to indicate this letter the operator would first press the left-hand key thus punching two holes in line, and then the right-hand key punching two diagonal holes. The letter B would require one depression of the right-hand key followed by three consecutive depressions of the left-hand key, and so on for each letter of the alphabet.



Courtesy [*Messrs. Siemens Bros. & Co. Ltd.*

Fig. 3. Alphabet in Perforated Tape

In Fig. 3 it will be noticed that there is a third line of holes, between the outside holes representing the dots and dashes. The purpose of this centre line of holes is to guide the paper tape steadily and regularly through the transmitter, the holes being used in the manner of a rack. There are 121 centre perforations for every 12 inches of tape.

When one message is required to be sent to several destinations, such as newspaper offices, several thicknesses of tape are punched at once by feeding the requisite number into the machine one over the other. In certain cases the punches are then operated by compressed air. There are also perforators with a lettered keyboard operated in a similar manner to that of a typewriter.

The Transmitter

The essential working parts of the Wheatstone transmitter are shown in Fig. 1.

Two light rods A B, pivoted to the cranks C D, are maintained pressing against the underside of the perforated tape by means of two springs E F. The distance between the two rods A B is the same as the distance between two of the centre holes in the paper tape. The rod A is in a line with the lower row of holes (Fig. 3) and rod B is in a line with the upper holes. The other ends of the cranks C D carry rods G H, on the ends of which are collars, J K. The rods G H are supported in bearings (not shown).

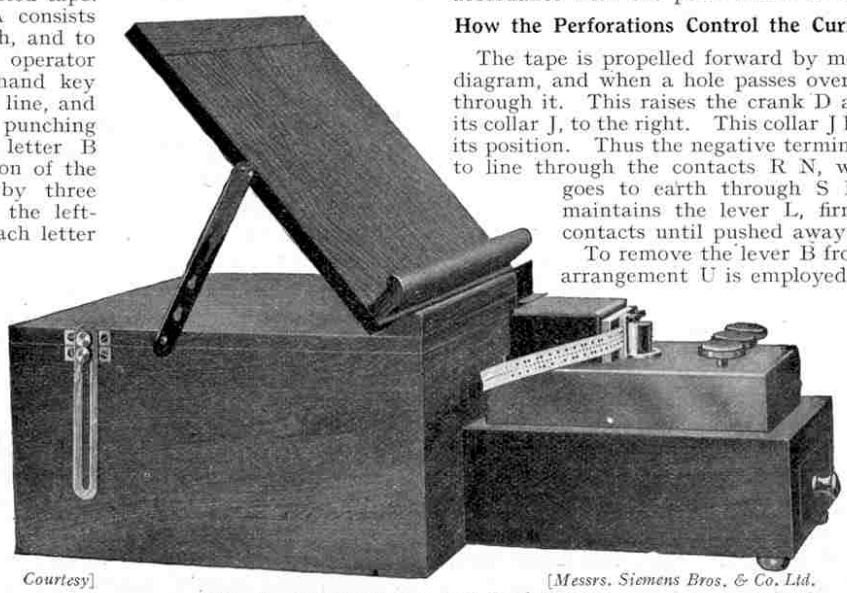
L is a lever, pivoted at M, carrying two pairs of contacts N P. One pair, N, is electrically connected to line and the other pair, P, to earth. The lever L with its contacts is associated with four contact screws Q, R, S and T, which are connected to the battery BB as shown by the dotted lines. Thus it will be seen that lever L is really a reversing switch for the battery BB, and it is by movements of this lever that the current reversals are put on the line. The object of the whole mechanism is to operate this lever in the correct manner in accordance with the perforations in the tape.

How the Perforations Control the Current

The tape is propelled forward by mechanism not shown in the diagram, and when a hole passes over the rod B, this rod rises through it. This raises the crank D and moves the rod G, with its collar J, to the right. This collar J hits the lever L and reverses its position. Thus the negative terminal of the battery BB is put to line through the contacts R N, while the positive terminal goes to earth through S P. A spring (not shown) maintains the lever L, firmly against either pair of contacts until pushed away.

To remove the lever B from the hole in the tape the arrangement U is employed. U is a beam pivoted at V and carrying the two rods W X. This beam is rocked very quickly the whole time the machine is in action. When rod A enters a hole in the tape and thus allows the crank C to rise, it is almost immediately removed by the rod W striking C and pressing it downward. The same applies to rod B.

Suppose the tape is moved from right to left



Courtesy [*Messrs. Siemens Bros. & Co. Ltd.*

Fig. 4. Wheatstone Hand Perforator

(*Continued on page* 300)

The Conquest of the Air

IV. Argentine Airman's Attempt to Circle the Earth

Photo courtesy [*Messrs. D. Napier & Son, Ltd.*

Major Zanni and his Fokker Aeroplane

OUR illustration shows Major Zanni of the Argentine Air Force, who is endeavouring to fly around the world on Fokker aeroplanes, fitted with 450 h.p. Napier "Lion" engines.

Major Zanni commenced his flight at Amsterdam on 26th July of last year. He reached Hanoi (7,500 miles) in 17 flying days and Tokio (10,000 miles) in 22 flying days, after many adventures.

Owing to his late start from Amsterdam heavy rains had set in by the time he had reached Hanoi and the aerodrome there was in an appalling condition. The result was that in landing the carriage sank into the soft mud causing the machine to fall forward on to its nose, breaking the propeller and damaging the machine in such a manner that it was impossible to get it repaired. Another machine therefore had to be sent to him from Tokio.

At Tokio he has been delayed by the advent of winter and adverse weather conditions, but a recent cablegram announced that he hoped to recommence his flight on 9th May last. He will proceed via Paramushir, Petropavlovsk, the Aleutian Islands, and Alaska to Vancouver, from thence to Chicago, New York, Halifax, St. Johns, Ireland, London and Amsterdam, making the journey across the Atlantic in one direct flight.

Major Zanni will use a Fokker seaplane in this part of his flight, and again a Napier "Lion" engine will be fitted. This engine, it is interesting to note, is very popular with the Royal Air Force and has been used with success by Imperial Airways Ltd.

Major Zanni has sent some interesting particulars about the behaviour of his engine during his flight from Amsterdam in a letter written from Tokio. He writes :—

"My first engine, the one that brought me along from Amsterdam to Hanoi, was really a fine specimen of trustworthiness and reliability. When I had to part with it—simply because my other machine sent to me from Japan had already a Napier engine mounted—it felt like parting with one's best friend. My mechanic was delighted with it, and was very sorry that it could not accompany us on to Japan, as he was sure it would have lasted all the way, and more if necessary.

"After the accident at Hanoi, with the aid of personnel of the French Aviation Corps stationed there, we dismounted the engine and found that it was still in perfect condition and without any apparent change from the day it was delivered, despite having flown for 105 hours through sand-storms, the most appalling rain imaginable (which came down just like a curtain), and most of the time through a heat that was too awful for words. These were unfortunately the conditions in which I had to fly.

"The French aviators at Hanoi found it difficult to believe that my engine had flown 105 hours. If I had not started too late, owing to the illness of my navigator who eventually had to stay behind, I think the accident at Hanoi would not have happened, as the conditions would have been good instead of finding

myself flying over lakes, caused by torrential rains.

Held-up by Winter Conditions

"Some days ago the Japanese Imperial Aeronautical Association asked me to give a lecture relating my experiences during the flight, the organisation of it, and any interesting features of same as they intend to make a Round-the-World flight also.

"During the flight we had very little time to give to the engine, as it was a case of arriving at a place in the afternoon, and off next day early, and then very seldom had we any hangar accommodation to protect the machine.

"Unfortunately I got to Japan so late in the year that I could not get ships to lay the provisions and fuel along the course. The owners would not venture their steamers beyond a certain latitude in the winter, because they were convinced that most of the ports and places that I had to touch were frozen. I endeavoured by all means to get the ships but had, eventually, to give it up and resign myself to interrupt the flight until next spring."

In addition to his mechanic Beltrame, who has been with him since he left Amsterdam, Major Zanni will carry with him for his journey across the Pacific Lieut. E. Velo, as navigator. He hopes to be able to finish the flight with the same Napier engines as he used in the first part of his epoch-making flight.

We feel sure that all our readers will join us in wishing Major Zanni "Good Luck!" on the resumption of his flight and we hope soon to be able to announce that he has not only safely reached Vancouver, but crossed the Atlantic and that he is once more in Europe.

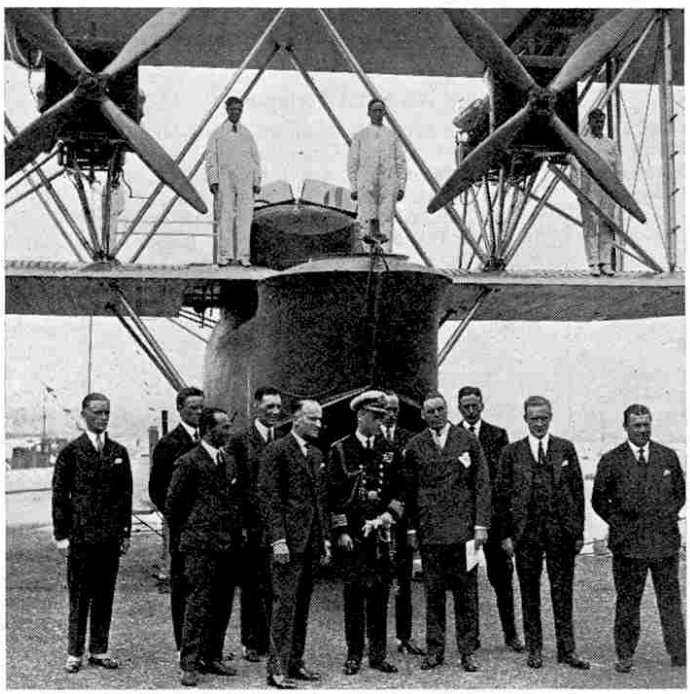
NEXT MONTH:—

THE PARNALL "PIXIE"

£50,000 Going Begging!

The Air Ministry offered a series of prizes in May 1923 amounting to £50,000 for a helicopter, or flying machine that is capable of ascending and descending without running along the ground, as is necessary with all present forms of aeroplanes. The conditions governing the competition were so strict that, although several machines have been built with a view to competing, none has actually been brought to test, and the £50,000 has therefore not been awarded. Competing machines were required to hover for half-an-hour at a height of 2,000 ft. in a wind blowing 20 miles an hour, to complete a 20-mile closed circuit at a speed of 60 miles an hour, and to alight, with the engine shut off at 500 ft., within 100 ft. of a mark on the ground. The entries for the contest closed at the end of April last year, and the 15 entrants were allowed twelve months in which to complete their tests. This period expired last month, but none of the entrants has even submitted a machine, much less demonstrated its capabilities.

The Prince's Interest in Aircraft



H.R.H. The Prince of Wales visiting the Supermarine Aviation Works at Southampton

A Cinema in the Air

Recently a passenger aeroplane left Croydon Aerodrome and while it flew over Kent and Surrey, a cinema film was shown to the passengers for nearly an hour.

The machine used for the flight was a twin-engined Handley-Page. The screen was situated on the bulkhead that divided the passenger cabin from the pilot's cockpit, with the operator's cabin in the baggage compartment at the rear. "Cold" light, and a specially non-inflammable film, were used to ensure safety from fire.

The film was exceedingly good, and apart from three short breaks, caused by the machine dropping into air pockets, the showing was quite uniform.

The experience was, of course, a great novelty, but it is doubtful whether cinema entertainments will ever become popular with the flying public. For one thing, they necessitate darkening the cabin windows, and anyone who has flown knows that one of the greatest attractions of flying is to study the scenery over which the machine is passing.

* * * *

Wireless from Aeroplanes

Many boys cannot understand how it is possible to communicate by Radio from an aeroplane without connecting the apparatus to earth. The aerial proper is formed by a wire that hangs from the aeroplane, and forms an "open" aerial. With such an aerial an "earth" is required only to serve as a capacity that will balance the aerial circuit. This is obtained by using the fuselage of the aeroplane, which is, of course, insulated from the trailing aerial. This arrangement acts as a condenser between the "plates" of which the oscillations take place. The system is thus similar to the "counterpoise" aerial sometimes used in land stations.

* * * *

A Secret Aeroplane

An aeroplane intended to ascend to greater heights and to attain higher speeds than have hitherto been possible, is now being constructed in France.

Not only are the engine and the propeller designed to function efficiently when the machine is moving in thin air at immense heights, but pilot, navigator, and engineer will have a special cabin, to which oxygen will be fed automatically.

The machine's first long-distance test will be an attempt to fly, non-stop, the distance of about 3,300 miles from Paris to New York.

* * * *

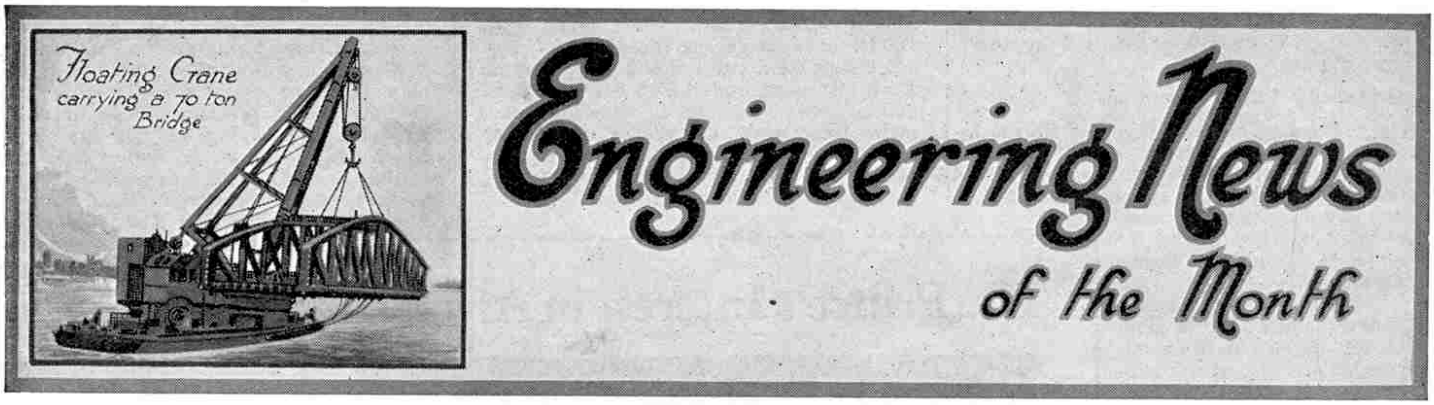
Money from the Air!

Those of our readers who remember reading of the special interview we had with Mr. G. Constantinesco, the inventor of the Torque Converter that bears his name, will be interested to hear that the famous inventor has recently been awarded £85,000. This sum has been paid to him and his collaborator, Mr. W. Haddon, by the Royal Commission of Awards to Inventors for their special timing apparatus for machine-guns. The invention enabled machine-guns to fire between the propeller-blades of an aeroplane at the rate of 2,000 rounds a minute. Over 40,000 of these synchronising gears were made for the British Air Force, and about 10,000 for the American Service, the U.S. Government contributing £15,000 of the award.

Other aerial inventions for which awards have recently been made include £50,000 for the Bristol Fighter aeroplane; £40,000 for the Sopwith machine; £40,000 for the Avro; £159,000 for the Gnome and Le Rhone engines, in addition to £200,000 already been received; £15,000 to the inventors of dual control for aeroplanes; £35,000 for the De Havilland aeroplane; and £6,500 to the inventors of the Parnall-Panther aeroplane.

Claims paid by the U.S.A. included £9,000 for the "0" type Handley Page biplane; £65,000 for the D.H. machine; £2,500 to Lieut.-Colonel J. T. C. Moore-Brabazon for his aerial cameras; £400 to the inventor of aircraft cameras; and £1,500 to Mrs. Minnie Porte for inventions in connection with flying boats.

These awards are for inventions that proved of value to the British and United States Governments during the war. Further awards are yet to be made.



The Russian Navy

The Russian Navy in the Baltic now consists of two dreadnoughts, one armoured cruiser, one light cruiser, eight destroyers, four submarines and four mine-layers. These ships are all seaworthy and other vessels, including two battleships and three light cruisers are being made ready for commission.

* * * *

New Dredger for Aberdeen

Tenders have been invited for a new suction hopper dredger for work in Aberdeen Harbour. A dredger costs anything up to £100,000 and it is interesting to note that a German firm have offered an excellent dredger for less than half this price. Representatives of the Aberdeen Harbour Board have visited Germany and have seen the dredger working on its speed trials in the River Elbe. The question of purchasing the German dredger has now to be discussed by the Board.

* * * *

Dry Dock for Durban

A large dry dock has recently been constructed at Durban, South Africa. It is 1,150 ft. in length, the width at the entrance is 110 ft., and the depth at high water 41 ft. The dock is divided into two lengths of 660 ft. and 440 ft. respectively, so that the dock may be used for one large vessel or two smaller vessels, which may be docked simultaneously. The dock is equipped with six 15-ton electric capstans along the dock walls for drawing vessels into the dock.

To construct the dock it was necessary to excavate 530,000 cubic yards of earth and 80,000 cubic yards of rock. The excavated material was used in reclaiming 100 acres of ground.

* * * *

New High Speed Cruisers

A new scout cruiser, the "*Marblehead*," has recently been launched for the United States Navy. She belongs to the Omaha class, which consists of ten vessels of uniform design. They are 555½ ft. in length, 55 ft. in breadth and have a displacement of 7,500 tons. The engines develop 90,000 shaft h.p. giving a speed of 33.7 knots.

On her trial run over a measured mile, the "*Marblehead*" developed just over 35 knots or 95,950 shaft horse power. The average speed during a four-hour full-power trial was 34.24 knots. The "*Marblehead*" is the fastest cruiser at present afloat under any flag with the possible exception of her sister ship the "*Detroit*."

All-Metal Flying-boat

A new type of all-metal flying-boat is announced from Copenhagen. In this boat duralumin is used throughout, no fabric being employed. The span of the wings is 96 ft. 9 in. and the length of the boat 54 ft. Its weight, fully laden is 8,140 lbs. and it is designed for a speed of 124 m.p.h. We hope to give further particulars of this flying boat in a future issue.

* * * *

Repairs to a Dry Dock

The dry dock of the Navy Yard at Philadelphia recently developed extensive leakages, which have now been repaired. The dock is one of the largest of its kind, being 1,025 ft. in length and 142 ft. in width. It has never been actually watertight, and four years ago the leakages became so considerable that action had to be taken. Wooden wedges were driven into the cracks but as soon as one leak was stopped the water broke through in another place. Grouting with liquid cement was resorted to and this was quite satisfactory. Three grouting machines were mounted on a heavy timber platform which could easily be moved by the cranes with which the dry-dock is equipped.

* * * *

Large Destroyers for Japanese Navy

It is reported that several very large destroyers are about to be built in Japan for the Japanese Navy. They will probably mount four or five 4.5 guns and have a speed of 35 knots, and their displacement of 3,000 tons will make them larger than any similar class of boats in existence.

As in the case of submarines, the dimensions of destroyers have steadily increased during the past ten years until some modern destroyers closely approach light cruisers in their displacement and armament. For instance, destroyers of 2,300 tons were built by the Germans during the war and those in the "Jaguar" class of the French Navy are of 2,359 tons displacement. The largest destroyers in the British Navy are the seven boats of the "Admiralty" Class, the displacement of which is 1,800 tons.

The new Japanese destroyers are considerably larger than any existing vessels of their type—they are, indeed, of only 500 tons less displacement than the famous light cruisers of the "Arethusa" class. Japan's famous cruiser "Yubari," completed in August 1923, is of 1,300 tons displacement, steams at 33 knots, mounts six 5.5 guns, one 12 pounder anti-aircraft gun and four torpedo tubes.

New Niagara Bridge

The new bridge built by the American Bridge Company for the Michigan Central Railway at Niagara Falls was opened on 16th February last. The bridge, which is a combination of the steel arch and cantilever types, was commenced as a cantilever bridge until the lower chord was connected at the centre, when it was made into a two-hinged arch. The arch measures 640 ft. in length, and the total weight of the structure is 6,130 tons. There are two railway tracks, and two footways, and the total cost was $2,225,000 —over £550,000. The bridge is so constructed as to allow trains carrying the heaviest loads to cross without diminishing speed.

* * * *

World's Water Power

The United States Geological Survey has recently issued a review in which they estimate the possible water power of the world at 453,000,000 h.p. As far as they can ascertain the development of water power has increased by some 26% in three years, bringing the actual total water power developed to about 29,000,000 h.p. at the end of 1923. Although the development of water power is now being given increasing attention in the United States, they are still behind Europe, which has increased its water power by a much larger percentage during the same period.

* * * *

Preventing Metal Corrosion

Approximately 300 million dollars' worth of metal structures fall every year in the United States owing to corrosion, and with a view to preventing this a Corrosion Institute is to be formed. It is estimated that Great Britain could not produce enough metal to replace the world's structures that are wrecked every year by corrosion.

* * * *

New High Power Wireless Station

Wireless enthusiasts, and particularly owners of crystal sets, will regret to learn that in all probability the B.B.C.'s new high power station at present being erected at Daventry, Northamptonshire, will not be completed before August. The original intention was to open the station this month, but the work has proved greater than was at first anticipated and the opening has had to be postponed. The new station will use the same power and work on the same wave-length (1,600 metres) as Chelmsford, which was only built as an experimental station and will be closed as soon as Daventry is completed.

America's Latest Submarine

Further to our recent paragraph regarding large submarines we now learn that the latest United States submarine is twice as large as the biggest undersea vessel ever before built in America. It is the submarine cruiser V-1, launched at the Portsmouth Navy Yard last summer, commissioned a few weeks ago, and now is in service with the U.S. Navy.

The V-1 is 341 ft. in length, 27 ft. maximum breadth, and of 2,164 tons displacement. She is propelled by four Diesel engines developing 6,500 h.p. and has a surface speed of 21 knots and a submerged speed of nine knots. Her armament consists of six 21-inch and one five-inch torpedo tubes, a 51 calibre rifle, and two machine-guns.

V-1 is the first of three submarine cruisers, and is designed primarily to accompany the fleet at sea in any weather and to maintain any speed of which the fleet itself is capable.

* * * *

Cathode-Ray Oscillograph

The Liverpool University has acquired a cathode-ray oscillograph, one of four in use in this country. With the instruments at the University it is now possible to measure such small amounts of power as a ten-billionth of a horse-power!

* * * *

Hydro-Electric Works in Italy

The continued development of hydro-electric works in Italy is shown by a report from Rome. This states that no fewer than 67 new works of a total of 300,000 h.p. have been brought into operation in the past two years, and that in the same period a beginning was made with 51 more works with 27 reservoirs, which are to yield 364,000 h.p. Further hydro-electric works are projected, particularly in the province of Trient and in four years Italy will have hydro-electric works of at least 3,000,000 h.p., or twice the power available in 1914.

* * * *

A New Motor Ship

An interesting single-screw motor ship, the *Raby Castle*, has recently been built by the Caledon Shipbuilding and Engineering Co., Dundee. The vessel is of about 4,900 tons gross, with an overall length of 412 ft. 9 in., a breadth of 52 ft. 3 in. and a depth of 37 ft. She is engined with an eight-cylinder North Eastern Werkspoor motor, the largest of its type yet installed in a single-screw ship.

The main motor is designed for a normal output of 2,200 brake horse-power, at a speed of 92 revolutions per minute. The eight cylinders each have a bore of 28¾ in. and a stroke of 4 ft. 3 $\frac{3}{16}$ in. All auxiliaries are electrically driven, with the exception of a small steam boiler to be used only for emergency starting. The ship has undergone successful trials and has taken up her work, which lies between New York and the Far East.

* * * *

N.S.W. Hydro-Electric Station

The Premier of New South Wales recently opened at Nymboida, 27 miles from Grafton, N.S.W., another Hydro-electric station, with a capacity of 2,000 horse power. It will supply the needs of Grafton, South Grafton, and Ulmarra, whilst connection is also being made with the municipality of Maclean, some 56 miles away so that power will be available to farmers along the river.

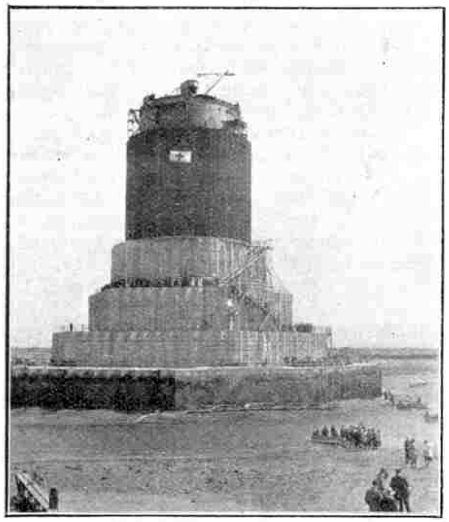
Remarkable Towers

Photo] [*F. Cordingley*

We illustrate two remarkable structures both of which are engineering achievements of considerable merit, although differing widely in almost every particular.

The photograph above shows the Blackpool Tower, which, graceful and elegant, rises to a height of 500 ft. Built of steel girders, it was constructed entirely for pleasure.

Below we illustrate one of the "Mystery Towers" of the war, broad and massive



and as different in appearance from the Blackpool Tower as it is possible to imagine. These towers were constructed for—nobody knows what, hence their name! Some say they were to be used for generating devastating death rays to protect our coasts against submarines. Others assure us that they were to carry more powerful searchlights than have been imagined, and with big guns working in unison, would "win the war" for the Allies. Whatever was to be their use, they were not completed when the Armistice was signed. The one in our illustration (at Shoreham, by the way) was thrown open for inspection by the public, who are to be seen on one of the galleries, the proceeds being given to local hospitals, hence the Red Cross flag on the tower.

Can any of our readers tell us for what the "Mystery Towers" were really built?

Joint Power Plant

Two 33,000-volt cables are to link up the Corporation power plants of Halifax and Huddersfield, so that when the load is light one station can be shut down altogether.

Canadian Hydro-Electric Development

The latest report issued by the Dominion brings the figures of hydro-electric development in Canada up to 1st June 1924. At that date the total water power in actual use was 3,569,275 h.p. and of this 2,696,997 h.p. was being developed by central stations, 503,039 h.p. by pulp and paper mills, and 369,239 h.p. by other industries.

The total installed generator capacity in the Dominion was 2,046,104 kVA at 1st June 1924.

The latest figures of the water power available show 18,255,316 h.p. at ordinary minimum flow, or 32,075,998 h.p. at ordinary six months' flow.

* * * *

Marine Oil Engine for R.M.S.P. Liners

Messrs. Harland & Wolff Ltd., have recently had under test an eight-cylinder four-cycle Burmeister & Wain type double-acting marine oil engine, the largest built in Great Britain. The engine is designed for an output of 10,000 b.h.p. at 110–120 r.p.m. Two of these engines will be installed in a new liner of 22,000 tons, at present being built for the Royal Mail Steam Packet Company.

* * * *

Completed at Last

H.M.S. "Effingham," the new cruiser that is to take over the duties of flag ship and replace the "Chatham" at the East Indies Station, has now carried out her sea trials. Built at Portsmouth Dockyard, she was laid down on 2nd April 1917, but was not launched until June 1921, construction having been held up until the Navy Estimate provided the money required to complete her. Her displacement is over 9,750 tons, length overall 605 ft., breadth 65 ft., and mean draught 17½ ft. The turbine machinery develops 65,000 shaft horse power, and the ship is designed for a speed of about 30½ knots.

Owing to the long time the cruiser has been under construction she was once referred to in the House of Commons as H.M.S. "Methuselah!"

* * * *

Motor Ship Era

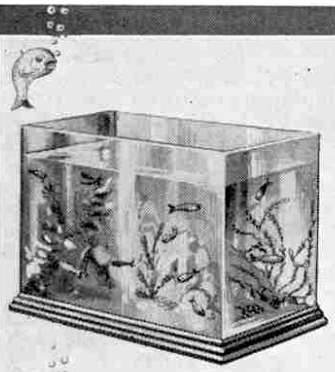
The most interesting and noteworthy feature of the annual report of Messrs. Harland & Wolff Ltd., the famous ship-builders and engineers, is a prediction regarding the future of the motor-ship. Speaking of these vessels the report says:—"Although their first cost is at present retarding somewhat their more general adoption, it seems probable that within a comparatively few years (unless some way should be found of greatly increasing the efficiency of steamships) the motor ship will supersede the steamship in much the same way as in the course of last century the steamship superseded the sailing ship."

It is interesting to note that Messrs. Harland & Wolff at present have 21 vessels under construction. Of these vessels 13 are motor-ships, three of which are mail and passenger liners of over 20,000 tons gross register each.

* * * *

Fire in Coal Mine

A cutting 1,600 ft. in length, from 45 ft. to 65 ft. in depth, and 70 ft. in width has been made in Pennsylvania for the purpose of stopping a coal mine fire. The cutting, which took a year to make, was made in the overburden between the fire and the unburnt coal, and the remainder of a 9 ft. seam of coal was saved as a result of this cut.



How to Start an Aquarium.

by

W. COLES-FINCH

(Resident Engineer, Chatham etc. Water Co.)

I. GENERAL HINTS

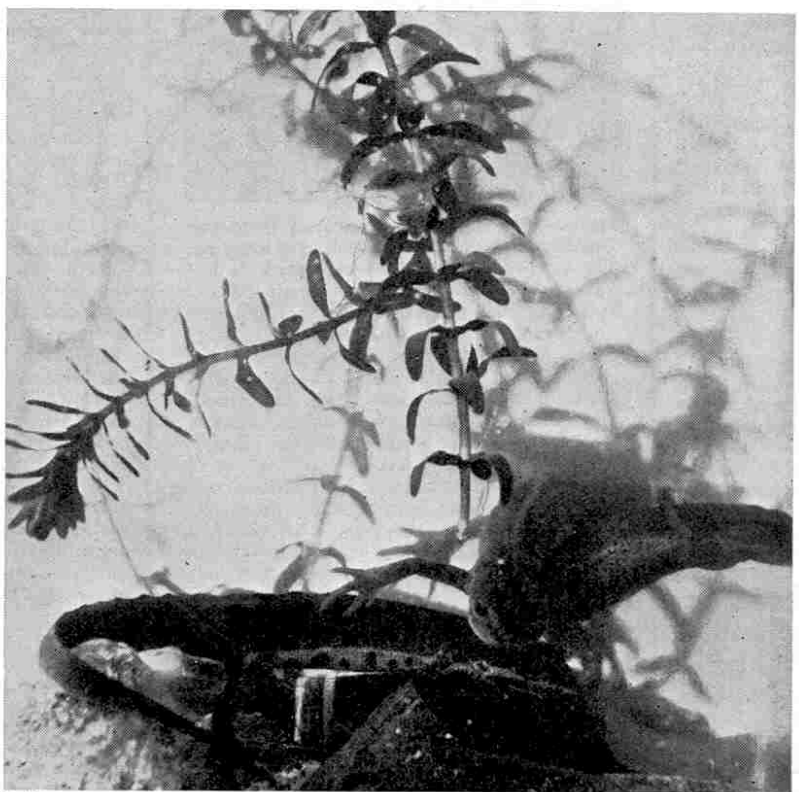
PROVIDED the necessary few minutes each day are devoted to the keeping of a fresh water aquarium, no hobby affords so much interest with so little trouble. Unfortunately there is a general impression that, given a tank or a bell glass and a few fishes, a satisfactory aquarium is an accomplished fact. Alas for the poor fishes! Under such conditions they are condemned to a lingering death. If a student of pond and river creatures were to raise a protest against "cruelty to fishes" most people would certainly think he had "a bee in his bonnet." Nevertheless it is a fact that much cruelty is unwittingly inflicted on these delicate creatures.

Cruelty to Fishes

We frequently see live fishes offered for sale in our shops. They are generally accommodated in an inverted bell glass which is placed in as prominent a position as possible in the shop window. The result is that in summer the sun's rays beat down upon the fishes during a considerable part of the day and the unfortunate creatures, having no shelter from the glare, get no seclusion or rest. We shall probably notice also that small pieces of biscuit and other food lie at the bottom of the tank, polluting the water, and as a general rule there is an entire absence of plant life without which the fishes cannot thrive.

In this tank of exhausted water the fishes swim round and round with painful weariness, their mouths skimming the under surface of the water. Day by day they linger through their miserable lives until a purchaser buys them when we can only hope that a better fate awaits them, which assuredly will be the case if they fall into the hands of one who knows how to tend and care for his new pets. Even with the best care, however, it is possible that many of the fishes will not survive long on account of the injuries already inflicted upon them by the neglect to which they have been exposed.

The reader will probably ask what is meant by "exhausted" water, why the fishes need protection from the direct rays of the sun, and why they skim the surface of the water. The answers to these questions are interesting and of great importance if the correct method of maintaining an aquarium is to be understood.



Photo] [*W. Coles-Finch*

Canadian Water-weed
Notice the beads of oxygen on the leaves of the plant

How Fishes Breathe

Everybody who has watched fishes swimming about in an aquarium has noticed that they ceaselessly open and close their mouths. It is quite natural to think that in doing this the fishes are drinking water, but as a matter of fact they are breathing. The water is received by the mouth of the fish, driven to the gills by an action similar to that of swallowing, and expelled through the gill openings. During this process the delicate membrane of the gills takes up from the water the oxygen necessary to the life of the fish. It is important to understand that the oxygen consumed by fishes is not the oxygen that forms one of the chemical constituents of water, but is contained in the air that is dissolved in the water.

Having made use of the oxygen breathed in, fishes exhale or breathe out carbon di-oxide (carbonic acid gas) just as we ourselves do. This carbon di-oxide is the main food of growing plants which, by the aid of sunlight, break it up and utilise the carbon, along with water and a small quantity of mineral constituents, to build up their structure, afterwards giving out the oxygen that remains. Thus fishes breathe in oxygen and breathe out carbon di-oxide, while the aquatic plants absorb the carbon di-oxide and return oxygen to the water. In other words the fishes and plants in an aquarium supply one another's needs and in order that life in the aquarium may proceed on sound lines a balance must be effected between the plant and the animal life.

"Exhausted" Water

This brings us to the

question of "exhausted" water, that is water exhausted of the life-giving oxygen. This exhaustion is caused by having too many or too large fishes in the aquarium, with the result that they use up the oxygen faster than it can be replaced by the water plants and faster than the water surface in contact with the air can replace the supply. When this condition arises the fishes are driven to the surface of the water for air, and the fact that the little creatures are doing this is an infallible sign that the water is incapable of supporting its inhabitants and that they are suffering.

In such a tank the conditions are very similar to those that would exist if we were forced to breathe the same air over and over again. The terrible consequences of such a state of affairs may be realised by recalling the awful tragedy of "The Black Hole of Calcutta." In 1756 Suraj-ud-Daula, the Nawab of Bengal, captured Calcutta and at the point of the sword drove 146 Europeans into the guardroom, a chamber barely 20 ft. square and having only two small windows. The result of crowding so many people into such a small room was that the air quickly became exhausted of its oxygen and unfit to support life, and next morning when the room was opened only 23 of the prisoners were found alive!

Renewing the Supply of Oxygen

When the fishes in an aquarium show by coming to the surface of the water that there is a shortage of oxygen, prompt steps must be taken to remedy the evil. First the number of the occupants of the aquarium must be reduced. Then a portion of the water should be drawn off and replaced by fresh water or the water should be aerated by injecting air, as will be described in a later article. The tank should then be watched carefully for some time to make certain that good conditions have been restored before the fishes that have been removed are replaced.

Fishes that have been negligently treated should not on any account be bought for an aquarium. The unnatural breathing of atmospheric air instead of air dissolved in the water is liable to set up inflammation in the delicate gills of the fishes and the little creatures will not recover from this malady. Fishes should be bought only from those who understand and care for them and who may be relied upon to supply only healthy specimens.

Shade for the Fishes

Fishes cannot thrive if they are always exposed to the glare of sunlight. They need shade and seclusion, which, in their natural surroundings, is provided by various plants overhanging the pond or stream in which they live. Further, out in the open the sun's rays strike downward only, whereas in a glass bowl the illumination comes from all points and this is very trying to the fish. It is necessary therefore to provide some means of shading the aquarium from too much sunlight.

Another source of trouble in an aquarium arises from leaving unconsumed food in the tank, where it turns sour and quickly poisons the water.

Starting an Aquarium

When you have finally decided to start an aquarium the first thing to do is to obtain a tank or bell glass. Do not be persuaded to purchase one of the fashionable fish globes, for everything placed in these globes is distorted in appearance, so that the inhabitants are never seen as they really are. If your tank has putty or paint likely to come in contact with the water it should be given a coating of shellac and spirits of wine, obtainable from a chemist. This coating is impervious to water and will securely seal up any impurity.

Next procure from the nearest builder's yard a small quantity of pea-gravel or coarse sand, scald it, wash it, and rinse it with clean water and then place it in the aquarium. If the tank is small a rockery is not advisable because it displaces too much of the more necessary water. If desired, however, a few pieces of rough vitrified brick may be cemented together and used for this purpose.

The next step is to visit a local stream or pond and collect some suitable water plants, which should be washed clear of mud. If your selection includes the Canadian Water-weed, starwort, mare's tail, or other trailing varieties, gather the plant up into small bunches, attach each to a piece of broken flower-pot and bury this in the sand to act as an anchor for the plant.

Filling the Tank

Stand the tank near or in front of a window where, without inconvenience to the household, it can receive light and yet at times be shaded by a blind or otherwise until the plants have grown sufficiently to afford the necessary shade and seclusion.

The tank should then be filled with clear spring, stream or rain water, or failing these, water from the domestic tap. The water should be poured very gently into the tank so as not to disturb the sandy bottom or the plants. However carefully this is done, however, the water will no doubt be cloudy at first, but it will soon clear. By means of a thin rod or pencil the plants should be assisted to spread themselves gracefully and naturally in the water. This is the first step in the stocking of an aquarium.

Need for Patience

The time is not yet ripe for the purchase of the fishes, and it is necessary to be patient for a while if success is to be assured. The plants must be carefully watched and their progress noted. When, by indications of natural growth and form, they show signs of thriving, or when streams of silvery beads of oxygen rise from their leaves to the surface of the water, we may be sure that all is well. Another visit may now be made to the pond or stream for the purpose of collecting a number of water snails which should be placed in the tank. These snails will act as the scavengers in our aquarium, their occupation being to eat the confervoid growth that forms on the glass of the tank, as well as decaying portions of the water plants.

Introducing the Fishes

The object of first establishing plant life is to ensure that when the fish are placed in the tank they will be in a healthy environment. Just as the trees and plants of our land live and thrive on carbon di-oxide and give back to the atmosphere the life-giving oxygen, so in our miniature water world the plants prepare the water for its occupants.

In our next article we shall give instructions how to make a glass tank and later articles will deal with suggestions in regard to the best and hardiest fishes with which to stock the aquarium, together with methods of aeration, feeding, and other necessary matters to help the lover of aquatic creatures to attain success in the management of his aquarium.

Matched Headphones

As everyone knows headphones are the most important part of a Receiving Set, and because of the extremely minute currents with which they are expected to operate, they must be of great sensitivity. Too little attention is paid to getting both receivers of a double headphone exactly matched in tone. This is a very important point for with unmatched receivers a signal sounds differently in one of the receivers than in the other. In the case of faint signals it would really be better if one of the receivers did not operate, as the user unconsciously concentrates his attention on the receiver giving the louder signal, and thus loses the value of the second 'phone.

To those readers who wish to get the very best out of their sets, the "Matched Tone" Headphones (made by Messrs. Brandes Limited, 296, Regent Street, London, W.1), should particularly appeal. The 'phones are matched with an ingenious apparatus that secures the same tone in strength and sensitivity to within five degrees. Signals in each therefore sound exactly alike, and in this way even the faintest signals are clearly heard and free from 'mush.' Brandes' Matched Tone Headphones are so well made that they are not easily thrown out of adjustment, and there are no moving parts to wear out.

We recommend all our Radio readers to send to the makers for a booklet giving full particulars of these 'Phones. On request the firm will also send particulars of their Table Talker, an instrument which, both in quality and price, should appeal to owners of valve sets.

Competition Results

(*See page* 307)

Sharp Eyes

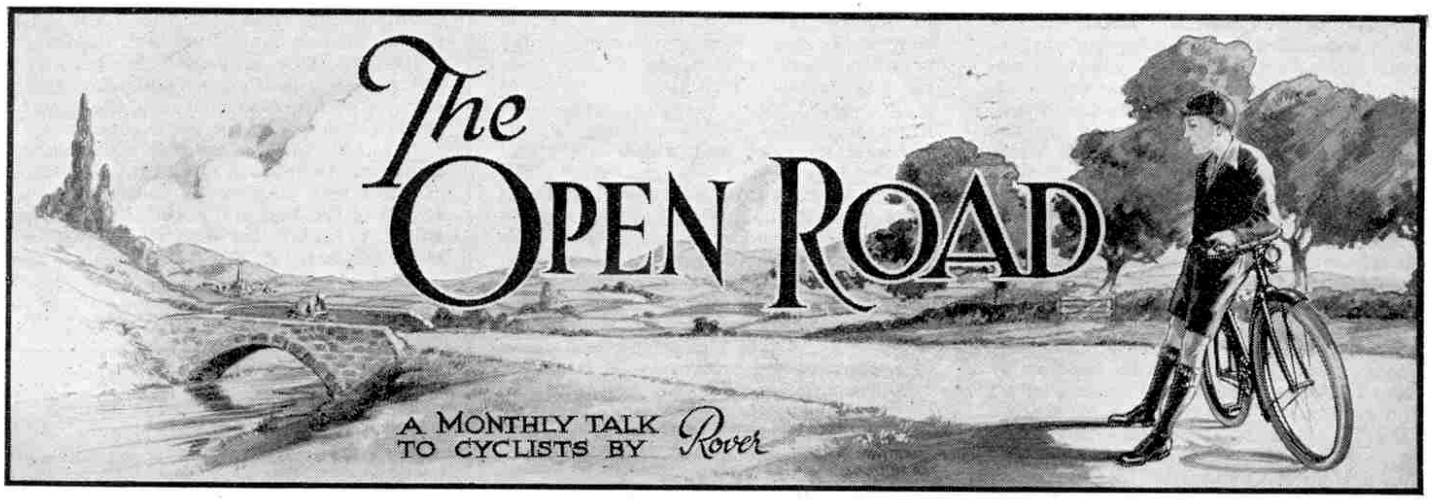
The drawing of the motor-car, horse and trap, and steam-roller in their somewhat bizarre surroundings brought in a vast shoal of lists of mistakes. In common with many competitors in the Home Section of this contest, a large number of entrants pointed out the absence of fittings on the vehicles that could not possibly have been visible to anyone on the side-walk where our erratic artist installed himself. Other competitors could have saved us trouble by checking their own lists and deleting items entered more than once. Another difficulty in judging was caused by the use of foreign or colonial terms for items on the drawings, particularly in regard to the motor car.

Long and patient scrutiny and correction have resulted in the final award of the three prizes offered as follows:—First Prize (Hornby No. 2 Goods Set), Harold Turner (Hastings, New Zealand). Second Prize (Hornby No. 1 Goods Set), Bertie Graveur (Sydney, New South Wales). Third Prize (Meccano No. 1 Radio Receiver or Double Headphones), R. V. Shutte (New Brighton, Christchurch, New Zealand).

"Bargain Hunt"

It was interesting to find the Overseas entrants for this contest arriving at a different verdict from that of our home readers. To decide from the voting the first in order of popularity of our advertisers was not difficult, but two firms tied for second place and very little behind them came the third. Votes were carefully counted with the following results:—(1) Nelson T. Hillier (Horsmorden); (2) Messrs. Witherick (Coventry) and Messrs. Watkins (Barnet) a tie; (3) Messrs. Lisburn & Townsend (Liverpool). One competitor, Jack Weatherway, Brantford, Ontario, sent in a correct entry and to him is awarded the first prize of stamps to the value of £1/1/- to be chosen from the list of any firm advertising in the "Meccano Magazine." Prizes of a free advertisement in the "Meccano Magazine" to advertise their own wants or sales are awarded to C. W. Watkins (Sydney, N.S.W.); Arthur Wilson (Hamilton, Ont.) and H. V. Reynolds (Georgetown, British Guiana).

The two consolation prizes awarded by Nelson T. Hillier for the two best runners-up under and over 12 years of age have been won by V. Sammie (Trichinopoli, S. India), collection of 1,000 different stamps, and Stan. Hutchinson (Ebendale, New Zealand), Standard Catalogue of postage stamps (1925 edition).



LAST month I gave some hints about touring, and I see from my mail bag that already several readers have completed enjoyable tours and they write to say they intend planning many more tours during the summer holidays. Good luck to them and to all who take to the Open Road! There is no more enjoyable holiday than one spent awheel, among the hills or on the moors, where the pure bracing air gives new life and makes us feel that it is good to be alive.

Don't Ask the Way!

All Meccano boys—cyclists and non-cyclists alike—should be able to read a map. Maps are as fascinating as good books, and to those who hold the key to their secrets they yield endless information. To every cyclist on tour a good map is essential, and assuming that you have arranged the main lines of the tour the next thing is to buy a good map of the district. But it is no use buying a map unless you can read it—you will be like an uneducated savage with a good book!

Although there is nowadays such a large number of road users—both motorists and cyclists—it is surprising how very few know how to read a road map correctly. No doubt this is largely due to the excellent system of sign-posting that obtains in most parts of this country. Sometimes, however, as in the west of Scotland, if you cannot read a map you will probably be lost, for sign posts do not exist and you may ride for hours without meeting anyone of whom you can ask direction.

A good map will save you a great amount of time and trouble and it should be your endeavour to complete your tour without once having to stop and ask the way. There should be no difficulty about this to anyone who can read a map.

Road maps are made in such large variety that it is impossible to describe here exactly how each one is to be read. Certain general hints, however, will be found of use in every case.

Scale, Surface and Signs

In map-reading there are three main things to study—the scale on which the map is drawn, the means employed to indicate the nature of the surface of the country mapped, and the conventional signs used in the map.

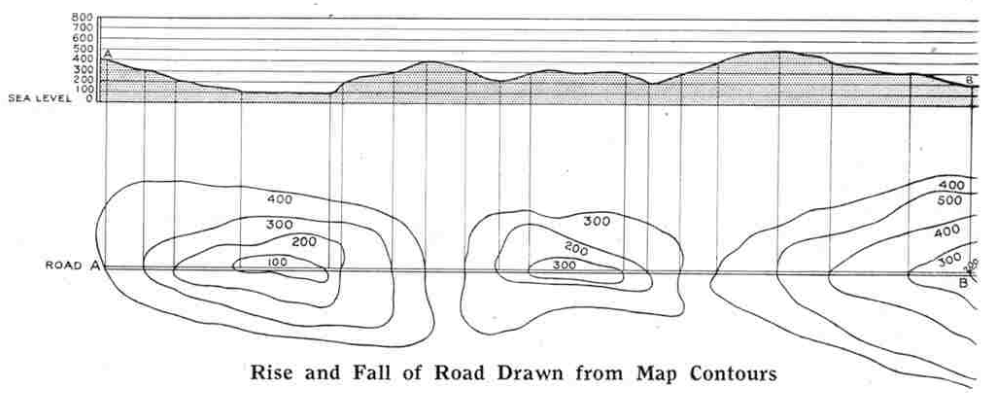
The scale on which the map is drawn will probably be given in one of three ways. It may be shown by a statement in the margin, such as "1 inch equals 4 miles," or "2 miles to the inch." Such a statement as the former means, of course, that one inch on the map equals four miles of country, or in the latter case—that two miles of country are represented by the space of one inch on the map.

The second method of showing the distance is by means of what is called a "representative fraction," such as 1/63,360, which means that one unit on the map equals 63,360 units on the road. If the unit given is one inch, therefore, it is obvious that one inch on the map is equal to 63,360 inches—or one mile—on the road.

The third method is by means of a line marked off in equal divisions, each of which represents a given distance of country. This method is known as a "plain scale."

The Meaning of Contour

The next thing to consider is the "contour" showing the nature of the country with which the map deals, and this will interest intending tourists for the nature of the country naturally determines the type of roads that run through it—they will be hilly or otherwise.



Rise and Fall of Road Drawn from Map Contours

Contours are lines drawn on a map at different points showing the height above sea level at the particular point marked. Look at a good map and you will see that there are numerous lines drawn over it in the form of irregular circles or ovals. Each line has a number at its side, which number indicates in feet the height above sea level of the ground enclosed by that line. In some maps the different heights are shown by means of different colours or shadings—green for the lower areas, light brown for higher regions and dark brown for the highest points.

On most maps contour lines are marked off at intervals of from about 25 to 50 ft. according to the nature of the country they represent and the scale on which the map is drawn. Sometimes, if the country is very hilly, the differences between the contours may be shown at 150 ft. intervals, but if there is very little rise or fall only 25 ft. intervals may be used.

Before you can make use of the contour lines of your map you must find out this difference in level between them. If, for instance, they are plotted at 50 ft. intervals, then the ground shown between two adjacent contours rises or falls 50 ft. By referring to the scale the distance between the lines can be ascertained and the average gradient worked out.

Drawing a Contour

It is very interesting to draw out the contour of the roads over which your tour will take you, for by so doing it is possible to follow accurately the rise and fall of the road and see exactly what hills you will encounter. Such a drawing may be easily prepared in the following manner.

On a sheet of paper draw a number of horizontal lines, say, not more than one eighth of an inch apart, and mark them at the left-hand side with the figures given on your map for the different contours between the two points denoting the beginning and end of your ride. The lowest line of all represents sea level and is marked "O" and the other numbers

for the different contours are allotted in ascending order to the various lines. Now place the lower edge of the paper—which of course is parallel to the lines you have drawn—on the map, so that the edge connects up the two chosen points, and draw vertical lines from where the edge of the paper crosses the contours to the horizontal lines above indicating respectively the same heights. Then by joining up the ends of these lines, a curve will be produced that will show exactly the rise and fall of the road. This description may appear rather complicated, but a few minutes' study of the accompanying diagram will make matters quite clear. A and B represent the starting and finishing points of the ride. The lower part of the diagram represents the contours shown on the map, and the upper part shows how the curve representing the rise and fall of the road is obtained from the contours.

Special contour books of most of the roads in the United Kingdom may be obtained and these are very useful to the tourist in showing him what hills he has to face.

Before commencing a tour it is best to make a careful study of your map so as to be as certain as possible of the general route before starting out. Every now and then a halt may be called and the map consulted for the next few miles, when the chief features should be memorised and important turnings noted.

Where to Buy Maps

In buying a map it should be borne in mind also that, while large scale maps are most interesting and useful, they are very bulky to carry, and it is often wiser to buy a map which, although drawn on a smaller scale, can be carried conveniently in your pocket. There are many good maps to be bought but the tourist cannot do better than purchase either Ordnance Survey maps or those issued by Messrs. Bartholomew & Son Ltd. (Duncan Street, Edinburgh). If there is a choice as to whether the map shall be of paper or mounted on linen, choose the latter kind every time—they last longer, do not tear when opened in the wind, and are altogether to be preferred.

The signs used on all Ordnance maps are standardised and are known as "conventional signs." By studying these signs the nature of the country to be covered may be ascertained. Fenced roads, for instance, are shown by means of straight lines, and unfenced roads by dotted lines. Two thick parallel lines indicate a first-class fenced road, one thick and one thin line a second-class road, two thin lines a third-class road, and so on. Other signs indicate the position of churches, castles, abbeys and other objects of interest.

If a guide to places of local interest is required, Messrs. E. J. Burrows & Co. (of Cheltenham) publish a large selection covering practically every point of interest in the British Isles. Another good and complete guide is that issued by the Michelin Tyre Co. (81, Fulham Road, S.W.3). This contains much information useful to the tourist, concerning maps, routes, hotels and their charges, places of interest, etc., and it can be conveniently carried in the pocket. Another useful but more expensive guide is the "Dunlop Book," published by the Dunlop Rubber Co. (55-56, Pall Mall, London, S.W.1), but this is really intended for motorists, and while cyclists will find anything they require in it, it is too bulky to be taken on a tour.

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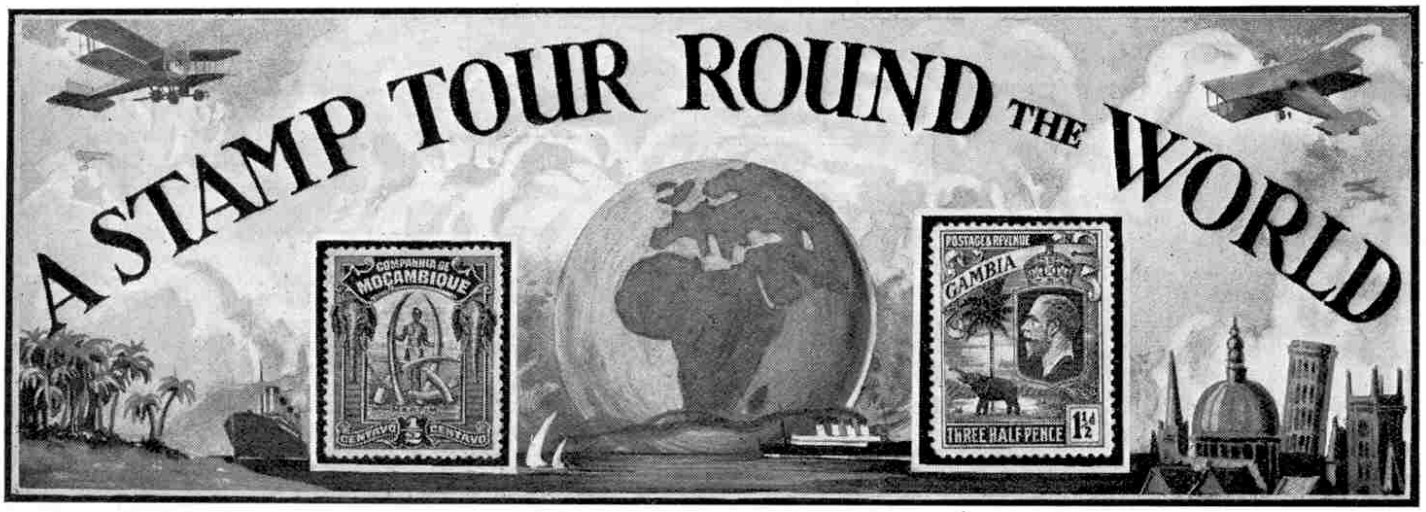


X. THE CAPE, ST. HELENA and MOROCCO

WHEN we have completed our visit to the Victoria Falls, we fly in a south-westerly direction over the Kalahari Desert and across the Orange River, well known to stamp collectors, until we enter the province of the Cape of Good Hope. We eventually reach Cape Town, the capital, an illustration of which is shown in the 1d. stamp depicting a view of Cape Town and Table Mountain as seen from Table Bay. This stamp was issued in January 1900, and was designed by Mr. Sturman. The watermark is a single-lined anchor and the perforation is 14 holes every two centimetres.

Beautiful Scenery at the Cape

Another view of Table Bay showing the mountain had been issued previously. This design, which showed the figure of Hope standing in the centre leaning on an anchor, was the work of Mr. Mountford and was issued in October 1893, with the same watermark and perforation as the stamp already described. These two stamps form a very attractive addition to a collection of the Cape.

Table Mountain forms the northern end of a range of hills that continues southwards into the cape itself. The side of the mountain overlooking Table Bay, at the foot of which is Cape Town, rises as a huge wall over 3,500 ft. in height and two miles in length. At the eastern side of the mountain is the Devil's Peak (3,300 ft.) and at the western side the Lion's Head (2,100 ft.), both of which may be seen in the 1d. value issued in 1893 and described above.

Table Mountain is well known throughout the world for its beautiful scenery, and looking seaward the view from the summit is truly magnificent.

The Great Congo

At Cape Town we regain our ship, which has passed round the Cape while we have been flying inland, and we now sail northwards until the mouth of the great Congo river is reached. Here we anchor our liner in the harbour of the town called Banana, which—to use the words of a famous song—has no bananas! This town stands near the mouth of the river and is one of the finest natural harbours on the west coast of Africa. It affords ample shelter for vessels of the greatest size.

We now board our aeroplanes again so that we may fly up the river until we reach Matadi, a town situated on the left bank of the Congo, 85 miles from its mouth. Matadi is at the highest part of the river that ocean-going vessels can reach, and is the starting point for the railway to Stanley Pool. At Matadi the river is about half a mile in width and the tall cliffs that have hemmed it in higher up its course here sink away and allow it to broaden out.

A view of Matadi was shown on the 5c. values of the 1894 (illustrated on this page), 1910 and 1915 issues, which were engraved and printed by the London firm of Waterlow and Sons, Ltd. The views were taken from the diorama of M. M. R. Mols and P. van Engelm shown in Antwerp (Belgium) in 1894.

The Congo was formerly known as the Zaire and is the second largest river in the world, only being excelled by the Amazon. It is over 3,000 miles in length and drains an area estimated at nearly one and a half million square miles.

Falls Named after Famous Explorer

David Livingstone, one of the first explorers of the Congo, commenced a survey at its source and until his death firmly believed that it was the same river as the Nile. In July 1877, however, H. M. Stanley, whose name will always be associated with this river, was successful in showing that the Congo of Livingstone was the same river as the Zaire of the Portuguese. Thus the identity of the river was finally established and an epoch marked in the political, commercial, and geographical history of Africa.

The Stanley Falls, to which we now fly, mark the division between the upper and middle Congo. They extend along a curve of the river for nearly sixty miles and begin a few miles south of the equator. They consist of seven cataracts and are not of any great height. The last is only about 10 ft. in height, but the river at this point is so suddenly narrowed and the volume of water is so great, that they are more imposing than many cataracts of far greater height. The Stanley Falls were pictured on the 10c. values of the three issues already mentioned.

French Equatorial Africa

We now fly from here to the French Colony of Gaboon on the west coast of Africa, about 1,000 miles away. Our course lies entirely along the equator, for both Stanley Falls and Libreville, the capital of the Gaboon, are practically on this line. The Gaboon is one of the colonies into which French Equatorial Africa (known as French Congo previous to 1910) is divided. The other colonies are Middle Congo, Oubangui-Chari, and Tchad. The last two of these are spelt in various ways and Gaboon is also sometimes spelt Gabun.

All these colonies issued their own distinctive stamps between 1910 and 1924, but in the latter year all were superseded by the stamps then issued under the new combined title for the whole area—French Equatorial Africa.

In 1910, Gaboon issued a view of Libreville town (illustrated here) and in 1900 the whole district under the title of French Congo issued a view of a grove of cocoanut palms growing in the vicinity. Libreville, which has a population of about 3,000, stands at the mouth of the river Gaboon and is a fairly important coaling station for ships.

An Island Prison

Leaving Equatorial Africa and sailing in a south-westerly direction, we come to St. Helena, famous in history as being the last home of Napoleon Bonaparte. This famous man was "detained" here by the British government from 1815 (after the battle of Waterloo) until his death in May 1821.

(*Continued overleaf*)

A Stamp Tour Round the World—

(*Continued from page* 299)

There is now a very small and decreasing population at St. Helena and there is only one town.

Two views of Jamestown have been pictured on St. Helena stamps. The ½d., 2d., and 1/- values of the King Edward issue, the ½d., 2d., 3d., and 1/- values of the 1912 and the 1d. and 1½d. values of the January 1922, King George issues, show the Government House, while the remaining values of the same series show the wharf. This is an open roadstead on the leeward side of the island at St. James's Bay. The invention of preserved foods rendered it unnecessary for ships to call at St. Helena for new supplies of food. Also, the opening of the Suez Canal has been another factor in lessening the amount of trade done by the island.

The Beautiful Stamps of Morocco

From St. Helena we turn northward and following the great sea-route from the Cape to Europe pass by Ascension, through the Canary Islands and arrive at Morocco in the north-west corner of the great continent.

The French Post Office established in this country has been responsible for some of the most beautiful view stamps that have ever been issued. J. de la Nézière has the credit of having designed them, while A. Mignen, A. Desarrois, A. Delzers and C. Coppier have engraved the various values.

First issued in 1917, perforated 13½ to 14, the series of seventeen values from 1c. to 10fr. makes a magnificent page in the stamp album. In 1923 the series was reissued with the same views but re-drawn and printed by the new heliogravure process by the Helio Vaugirard and perforated 13½. These stamps are even more handsome than the earlier issue, the new method of printing being ideal for this class of work. They may be distinguished from the earlier issue by the words Helio Vaugirard at the foot below the frame.

In the meantime a series from 25c. and 2fr. had been issued for the aeroplane post in 1922 showing a view of Casablanca from the air. This also was designed by J. de la Nézière and printed by the Helio Vaugirard.

Casablanca, or Dar el Baida meaning "the white house," is the port to which our ship makes its way on arrival at Morocco. It is the wool and grain port for the central parts of Morocco and is third in importance of the towns on this coast.

The stamp already mentioned, which is illustrated here, clearly shows the harbour wall and the wharves. These have been constructed since 1907 to afford sheltered accommodation for ships at all states of the tide. Previous to this time the roadstead had been exposed to the north-west winds and ships anchored therein were consequently not well protected from storms.

NEXT MONTH:—

THE MEDITERRANEAN.

"*Tête-bêche*" Stamps

Tête-bêche stamps are always of great interest to collectors. "*Tête-bêche*" signifies a stamp printed upside-down with reference to its neighbour.

Until about 1890, plates for printing stamps consisted of a large number of separate blocks, or "*clichés*" as they are called, each containing the impression of one stamp, and all held together in a frame. In these circumstances it sometimes occurred that one of the stamp-blocks fell from the frame and was replaced upside-down in error. Nowadays, with improved printing methods, it is not often that this occurs, and with the closer inspection of all printed sheets it is rarely that an accidental *tête-bêche* makes its appearance.

All stamps that are made up into booklets are now printed in sheets of a special form. These have half the stamps one way up and the remainder the other. Why these are so arranged will be seen from the accompanying diagram, which represents two rows of such a sheet. The stamps A and C are normal, while B and D are inverted. The spaces 1, 2 and 3 form the paper through which passes the stitching to bind the books.

Imagine a sheet of stamps composed as shown, but having twenty rows instead of only two. A sheet of covers for the booklets is taken and laid on the table, then a sheet of advertisements is laid on top, followed by a sheet of stamps, then another sheet of advertisements, and so on until the other cover is reached. Four rows of stitching are now run up the sheet, one at 1, two at 2, and a fourth at 3. Afterwards the bound sheets are cut between A and B, the two rows of stitching in Fig. 2 and between C and D, and also between every two horizontal rows. Thus 40 books of stamps are made out of each bound sheet.

Usually these special sheets are not sold complete, but only cut up and bound in the booklet form. Sometimes, however, as recently in the Union of South Africa, there is an alteration in postage rates and a value previously used in the booklet is no longer so required. These special sheets are often sold over the counter and then *tête-bêches* may be purchased in the ordinary course, as in the case of the pair illustrated.

1	A	A	A	B	B	B	2	C	C	C	D	D	D	3
1	A	A	A	B	B	B	2	C	C	C	D	D	D	3

Electricity—(*cont. from page* 289)

and the lever L is touching contacts Q T; that is, suppose it is in the "spacing" position. Further, suppose that a dot comes over rod B. This rod will immediately rise into the upper hole and thus, through crank D, rod G and collar J, throw the lever L over to the "marking" position, as already described.

The rod X then removes the rod B from the hole and the tape is moved forward one hole. This brings the second hole of the "dot" over rod A, which will enter it, and, through crank C, rod H and collar K will return the lever L to the "spacing" position. Thus a short reversal of current will have taken place in the line circuit, recording a dot at the receiver.

If, on the other hand, a dash had been punched in the tape, B would have entered the first hole as before and sent the current reversal to line. The rod B would be removed from the hole, but the tape would have to be propelled forward twice before the other hole came over the rod A and allowed it to return the lever L to "spacing." Thus a longer reversal of current would have taken place, recording a dash at the receiver.

This somewhat elaborate mechanism thus translates the perforations in the tape into short and long reversals of current, which in turn operate the receiver and cause short and long ink marks to be made on its roll of tape. The ink-marked tape is handed to operators who transcribe it into written characters on telegram forms, which are then despatched to their destinations.

In Fig. 2 is illustrated a complete station set equipped for working on the Wheatstone automatic system. On the extreme right is shown the receiver. Next to it at the back is shown the galvanometer that is connected in the line circuit to indicate whether or not the set is working correctly. In front of this is a transmitting key for working by hand when necessary, and with this is associated the sounder in its screen on the extreme left. Between the hand key and the sounder is the transmitter and behind this is the "artificial" line, consisting of adjustable condensers and resistances, the use of which was described last month.

In the past four articles we have traced the fascinating story of the land telegraph from the early attempts of Charles Morrison in 1753 to the elaborate systems of to-day. We have seen how the pioneers overcame their difficulties one by one and we have followed the working of the many different circuits.

Very great advances have been made during the past century and one wonders what will happen during the next hundred years. Wireless is the line telegraph's most immediate menace, but it is scarcely probable that it will entirely replace the line telegraph owing to the small number of different wave-lengths available. Until some super-sensitive yet constant tuning circuit is evolved, the line telegraph will undoubtedly maintain its supremacy for medium distance signalling.

In the next article in the Electrical series we shall commence the wonderful story of the Submarine Telegraph. First we shall describe the difficulties, failures and conquests of the pioneers. Then we shall pass on to a description of how the cables are constructed and laid, and finally we shall describe how the various pieces of apparatus operate.

Wonders of Wembley

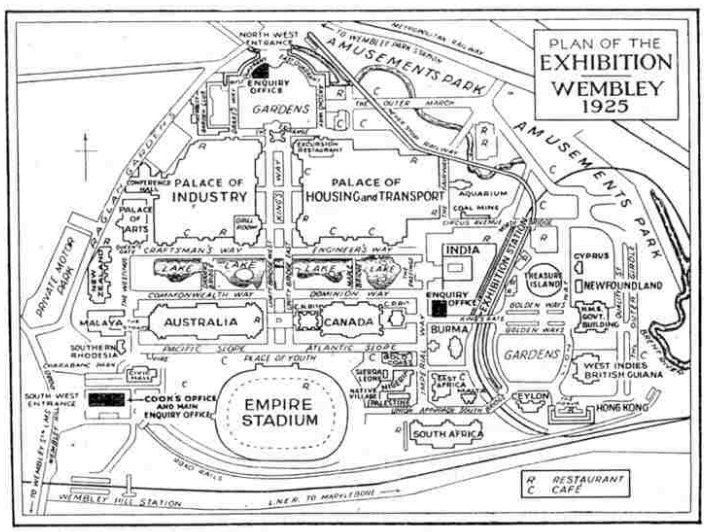
New Attractions of the 1925 British Empire Exhibition

THE great Exhibition at Wembley has opened for its "second innings." Once more an ever-increasing crowd streams through its pavilions and fills the broad walks and avenues from "Drake's Way" to South Africa, and from New Zealand to the "Outer Girdle."

The Transport Exhibit

Those who visited Wembley last year will find many new attractions—indeed, this year's Exhibition promises to more than equal in interest that of 1924. One thing that Meccano boys may be inclined to regret, however, is the passing of the great Palace of Engineering. This year the building is now known as the Palace of Housing and Transport and although the latter section is undoubtedly of fascinating interest, Housing, which is just now a subject of vital importance to the welfare of the country, has not, perhaps, quite the same thrill for Meccano boys as Engineering.

An area of 60,000 sq. ft. is devoted to the exhibit. Visitors are shown the latest devices by which the modern house may be built without detracting in the least from the beauty of the countryside, while in the Transport section an elaborate motor exhibit shows how cars and trucks are produced and assembled in every detail.



Plan of the 1925 Exhibition

Wonderful Working Models

In the British Government building, which again occupies its imposing site at the end of the Golden Ways, the exciting events of the famous Zeebrugge raid are again re-enacted.

Wonderful new working models are on view in the Palace of Industry where the exhibits of home industries include chemicals, printing, wool, jewellery, pottery and domestic utilities. The pavilion, as a whole, provides a splendid monument to the romance of trade. As one passes through it, the story is unfolded of man's ingenuity in devising wonderful methods by which raw materials are turned into food, clothing, or articles of luxury, without which our modern civilisation would be impossible.

In the Canadian pavilion a huge diorama—a series of pictures let into the walls of the main building—may be seen. Said to be the largest scenic effect of the kind ever produced, it is illuminated by over 2,000 lights and there are working models throughout.

Last year the Palace of Arts attracted two million people during the six months that the Exhibition was open, and it is fully believed that it will prove equally as popular this year.

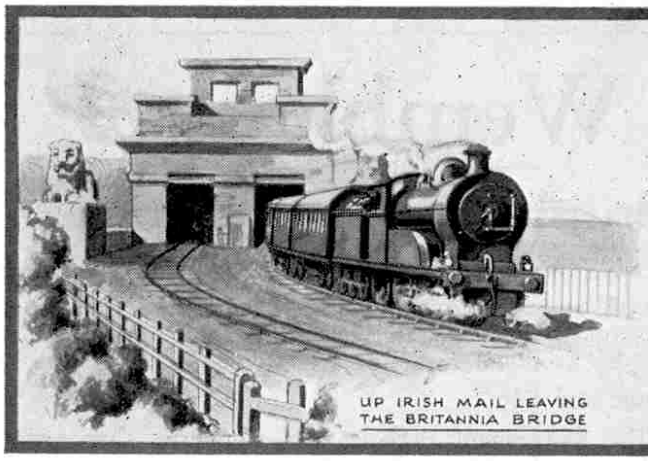
Frolic and Fun

The Amusement Park is more wonderful than ever. "Treasure Island" is veritably a children's paradise, with perfect miniature steam railways, swings, roundabouts, and other such fascinating things, and it is inhabited with marvellous people whom every child who reads a story-book would instantly recognise! Even real-life kings and queens have been seen there, although no one was more surprised than little Joan Mollison of Ealing, when told that the "kind gentleman" who lifted her up into the seat beside him on the miniature railway was the King of England. It may be easily understood why she was quite overcome with shyness when she realised afterwards that hundreds of people had been watching her all the time as she rode with the King, followed a few coaches behind by the Queen with a coach-load of fortunate children whose faces were wreathed in smiles.

Modern locomotives form an important feature of the Transport exhibition. The Great Western Railway shows the "*Pendennis Castle*," which took part in the recent important loco tests described elsewhere in this issue, while the London, Midland and Scottish Railway is represented by one of their splendid "Baltic" tank locos described in our April issue. The London and North Eastern Railway sends one of the new "Mikado" mineral engines, the "*Flying Scotsman*" Pacific Loco, and the latest in luxurious sleeping cars; the Southern Railway a 2–6–0 engine of the "810" class and a Pullman Car, and the Metropolitan Railway an electric locomotive of the latest design, with side panels removed to disclose various mechanical details.

A machine that prints, counts and numbers tens of thousands of railway tickets per hour forms another very interesting exhibit.

One section in the Palace of Industry provides a striking display of the important part that gas plays in manufacturing, as well as illustrating the wonderful manner in which it is nowadays used in overseas homes. A stall in this exhibit looks something like a village "general" store, for it is covered with a variety of products, from shoe-laces to salmon tins. Gas was necessary to the manufacture of all these objects, and is used in about 3,000 trades.



UP IRISH MAIL LEAVING THE BRITANNIA BRIDGE

Railway News of the Month

L.M.S. Rolling Stock

No less than 2,591 new passenger coaches and 30,000 wagons and trucks for goods traffic have been ordered from the various works owned by the L.M.S. and by private firms at Nottingham, Birmingham, and Leeds. The passenger coaches are mainly to be vestibuled saloons, or corridor vehicles, and include 235 vestibuled third-class coaches, 35 having brake compartments, to be built almost entirely of steel, the only wood necessary being Australian "Karri," practically non-inflammable. Forty kitchen cars of a similar construction will be used in connection with this stock.

* * * *

Wembley Railway Exhibit

One of the most interesting exhibits at this year's Exhibition will be a complete working model railway, exhibited by the combined railway companies. The model will show all the details of signalling and train control. Other interesting exhibits by the railway companies will include a Pullman car, a sleeping saloon, and a 1,200 h.p. electric locomotive. Of particular interest will be the double-line junction with crossover road with a signal box for working it. A loco, brake van, goods wagon and passenger coaches form the rolling stock for this exhibit.

* * * *

New Railway for Canada

A new railway, 230 miles in length, is to be built at an estimated cost of £600,000 in North Western Quebec, to connect the National Trans-Continental Line with the direct lines to Ottawa and Montreal. The railway, which will open up some ten million acres of undeveloped land, will be known as the Southern Abitibi. It will connect up Amos with Mont Laurier and Maniwaki, from where connection will be made over existing lines with Montreal and Ottawa.

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L.M.S. Loco under Test

Besides the Midland type compound locos being tested on the old L. & N.W. line, tests of various locos are being carried out on the northern part of the Midland Section between Settle and Carlisle. The Horwich "Dynamometer" car is being used to keep a record of the work done on various trains by the locos under notice. These are 4–4–0 super-heater compounds of the Midland design, a Caledonian 4–4–0 superheater, and two superheated 4–6–0 L. & N.W. locos, one a two-cylinder "Prince of Wales" class, the other the powerful four-cylinder loco "Sir Francis Dent" of the well known "Claughton" class.

Re-numbering of Locomotives

The L.M.S. is re-numbering its 10,000 locomotives and as British railway locos are classified and numbered according to power within their groups, each of the present divisions of the L.M.S. is being regarded as a separate entity. There are 35 companies—8 constituent and 27 subsidiary—in the L.M.S. group and each division is to have its own block of locomotive numbers.

These are Midland Division, 1—4999. Western Division A, 5000—9999. Western Division B, 10,000—13,999. Northern Division, 14,000—17,999.

The L.M.S. owns 10,344 locomotives, which figure will be substantially increased as a result of the £14,000,000 development scheme referred to in our last issue. Many years must elapse, however, before all the numbers in the present allocation are exhausted.

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L.N.E.R. Locos

During 1924 the several works of the L.N.E.R. built 204 new locomotives, private firms completed orders for 44 express locos, and 125 heavy 2–8–0 goods locos—built to Great Central Railway designs during the war for foreign service with the British army—were bought.

The passenger locos constructed included 24 of the Great Central 4–4–0 "Director" type, three of the North Eastern "Pacific" type, and 40 of the Great Northern "Pacific" type.

There is now at work a stud of 57 "Pacifics," 52 being of Mr. Gresley's design, and five of Sir Vincent Ravel's "North Eastern" type. The latter have been named after famous cities on the N.E.R. section.

Some 295 new locos including 74 for passenger service, will be built this year. Darlington Works are to build 10 of the G.N. "1000" type express goods or mixed traffic locos 2–6–0 type in addition to a batch of 50 already under construction there. They are three cylinder locos with a boiler 6 ft. in diameter, and can take their turn with the "Pacifics" on 500-ton expresses if necessary.

Other locos to be built here are five North Eastern type 4–8–0 tank locos for goods traffic; 15 express 4–4–0 type, probably Great Central "Director" type; and 43 goods locos of a new 0–6–0 class.

Gorton Works (Great Central Section) has an order for 50 six-coupled tank locos of Great Eastern Railway design for local passenger trains. A Manchester firm has an order for twelve 0–6–2 tank locos, and a Newcastle company one for 13 Great Central 4–6–2 type fast tank locos.

Economy of Longer Trains in U.S.A.

According to American estimates, the use of cheaper coal and longer trains has saved something like £20,000,000 during the past twelve months. Old engines have been gradually replaced by modern locomotives, pulling heavier loads with scarcely any increase in the amount of coal burned. Classes are arranged on many of the Railways where employees are taught by experts how to economise in fuel. The economy in fuel alone for the first half of the year is estimated at about £3,000,000.

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Improvements on G.W. System

The G.W.R. is arranging to carry out extensive improvements on its Devon and Cornwall sections. These include the extension of the locomotive shops at Newton Abbot; the re-arrangement of the Plymouth engineering depot.; a steel girder bridge, of 60 ft. span, to replace the present stone bridge over the Laira Old Road at Plymouth; an embankment to take the place of the present viaduct at Truro; the extension of the present Newquay branch line from Blackwater Junction to Chacewater; and the reconstruction of Paignton Station to deal with the increased passenger traffic.

* * * *

Preventing Rail Corrosion

The Delaware, Lackawanna and Western Railroad (U.S.A.) spray the permanent way once a year with a mixture of 45% asphaltum, and 55% crude oil, in order to prevent the corrosion of the rails, keys and bolts. A truck carrying the spraying apparatus, which includes a steam driven air compressor, is pushed in front of a train of tank trucks containing the mixture. The trucks are all supplied with steam heaters for the purpose of heating the oil, which is forced through strainers to the sprays by means of compressed air. The sprays are mounted one on each side of each rail, and the train travels at about 25 m.p.h.

The cost of keeping the track free from corrosion is less than £1 per mile per annum.

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G.W.R. Record

The G.W.R. claim as a record a run recently made by one of the new "Castle" class locomotives, the "*Carnarvon Castle.*" The train was the 11.15 a.m. Paddington to Bristol and the distance of 106.7 miles was covered in 98 minutes. It should be mentioned, however, that this is a slip service and consequently has an advantage over the usual "start to stop" run with the complete train, the scheduled time for which is 106 minutes.