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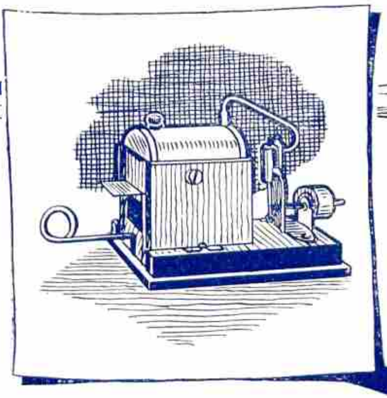

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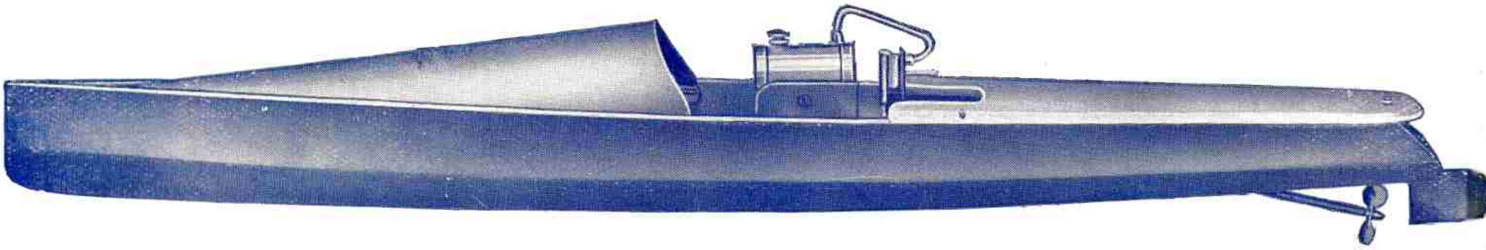

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MECCANO MAGAZINE

PUBLISHED
IN THE INTERESTS
OF BOYS

Our Cover

OUR cover this month shows a huge ladle being filled with molten steel from one of the furnaces at the works of Messrs. Armstrong, Whitworth Limited, Newcastle-on-Tyne. The original photograph was kindly supplied to us by this irm and they mention that it is the most striking photograph that they have ever een, and was obtained only after many hundreds of attempts. Our artist has worked this photograph up into a picture in colours, and I think my readers will gree that the result is very striking. he subject is, of course, related to our article *"The Story of Iron and Steel,"* which is arousing considerable interest among my readers, as the contents of my mail-bag testifies. It is a wonderful sight o see molten metal coming from the urnace, and the spectator cannot help but admire the genius of the engineers who have devised the huge machines and mechanical appliances for handling the white-hot metal. When we see how easily he workmen handle great quantities of lowing metal, we understand what a great art engineering plays in the life of everyone. his is made even more clear by the detailed description in our article of the ifferent processes by which steel is made.

From Readers

Last month I invited Meccano boys to contribute some interesting experiences or facts in the form of short articles, and I have pleasure in announcing this month a new feature that will will be included as often as space permits. This page, which will be headed *"From Our Readers,"* will be devoted solely to interesting articles rom readers, and I shall be pleased to receive contributions. The articles may eal with anything of general interest, uch as a new idea for making something; method of doing something in a new manner; an account of some unusual ccurrence or incident, or details of an intersting visit. Illustrations may be sent, if desired (either drawings or photographs), nd those articles that are published will be paid for at our usual rates. As previously mentioned, no reader need hesitate to send an article because he may not be very good at composition. If necessary I will have the articles put into shape, ready for publication. I take this opportunity of also reminding my readers that I am always pleased to consider photographs of anything of interest to Meccano boys—and particularly engineering subjects—for publication in the Magazine. Half-a-crown is paid for any photographs published.

The Great Exhibition

The British Empire Exhibition at Wembley continues to form the topic of conversation among tens of thousands of people, and rightly so, for the Exhibition is the most wonderful demonstration that has ever been held to show the vastness of our Empire. Last month we announced a special essay competition for those who visit Wembley, and full particulars will be found on our competition page again this month. In our next issue I am hoping to publish an article by Mr. H. Lansley describing the Exhibition. Mr. Lansley will be remembered as the editor of a very successful Meccano boys' paper, *"The Meccano Engineer."* If you are interested in Wembley and the wonderful sights there to be seen, you must not miss this account of a Meccano boy's visit to wonderful Wembley. In connection with the Empire Exhibition I should like to draw the attention of my readers to the special Photographic Competition announced in this issue.

An Interesting Model

In one of our recent issues I published an article on my interview with Mr. Constantinesco, the inventor of the Torque Converter, and in our April number I described how this wonderful new invention can be constructed in Meccano. This issue includes a special article from one of our readers, describing some interesting experiments with this Meccano model of the Converter. I hope that every Meccano boy will closely study these experiments, for I feel that the Torque Converter is an invention with a very great future. It behoves every Meccano boy to thoroughly grasp the principles on which this invention is based and there can be no better means of doing this than by constructing the model in Meccano. In fact, so realistically does this model work that Mr. Constantinesco, the inventor, has asked us to make for him Meccano models showing the Torque Converter fitted to a Motor Chassis, a Pile Driver, a Winch, and a Tank. We understand that some of these models will be exhibited on the inventor's stand at Wembley, and I think all will agree that this is a high tribute to the efficiency of the Meccano model of this very elaborate invention. I hope to give some further particulars of the application of the Converter to models other than the chassis in a future issue of the *"M.M."* In the meantime, Mr. Knowles's article gives a good indication of the instruction that may be obtained from experimenting with the model of the Converter.

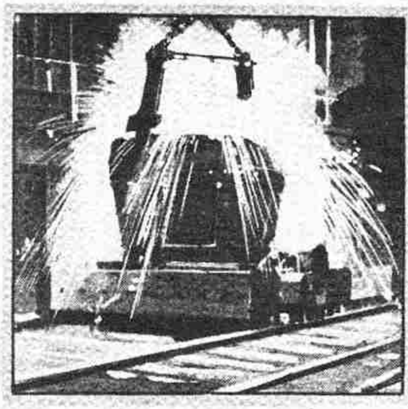
COMPLETE YOUR "M.M." FILES

Those who wish to make up complete sets of *"M.M.'s"* will be interested to hear that we have in stock a few copies of recent issues.

All Magazines up to and including December, [illegible] are out of print. A few dozen copies remain of each number from January to December, 1922, and copies of each of the 1923 issues are also available, with the exception of September and October. Copies will be sent post free, price 3d. each, but early application should be made, as the number available is very small.

Sold Out

For many months past we have been unable to supply dealers and newsagents with as many copies of the *"M.M."* as they have ordered. As I have frequently explained in these pages, we print only sufficient Magazines to meet the orders received. Immediately before we go to press the orders in hand are collected and the total number on order is the number of Magazines printed. After publication we invariably receive additional orders, but these we are not able to execute. The consequence is that there is all-round disappointment—dealers are disappointed, readers are disappointed, and I am disappointed because I never like anyone else to be disappointed! The moral of all this is: "Place a standing order for the *'M.M.'* and place it *now,*" either with your regular Meccano dealer, with your local newsagent, or direct with this office. (Subscription rates are given on page 204.)



The Story of Iron & Steel

III. STEEL-MAKING: THE BESSEMER PROCESS

In our previous articles we have seen how pig-iron is made in the blast-furnace from iron ore, and how wrought or malleable iron is made in the reverberatory furnace from pig-iron. We have now to describe the various processes for making steel, the most valuable commodity in the world.

Early Methods

The process of converting iron into steel was known among the Eastern nations long before it was introduced into Europe. In the Middle Ages the process appears to have been well known in Germany, but at that period very little steel was produced in England. Consequently almost all the steel used in this country was imported from Germany.

Even at that early period Sheffield had acquired a reputation for the manufacture of various useful articles from iron and steel. By degrees the Sheffield manufacturers ceased to import steel from Germany and began to make it themselves. For this purpose they used bars of high-grade Swedish iron. These bars were packed with charcoal in an air-tight vessel and subjected to a high temperature for from eight to twelve days, the exact period of heating determining the temper of the resulting steel. The bars were then taken from the vessel and broken up into pieces of convenient size. The steel produced in this way was known as "blister steel," on account of the fact that the bars were covered with blisters caused by chemical reaction while they were in a plastic or soft condition.

The short bars of blister steel were then hammered lightly to flatten the blisters, and afterwards a number of them were placed together in a welding furnace and welded into a solid mass. Steel made by this process was called "shear-steel," from its special suitability for making tailors' shears. It was also largely used for making clock springs.

Crucible Steel

For a long period shear-steel was the only kind of steel manufactured in this country, but in 1740 a great advance was made by Benjamin Huntsman, a Sheffield clockmaker. One great defect of shear-steel was that it contained weld lines, and Huntsman realised that it would be a great improvement if steel of equal quality could be made without the necessity of passing it through the welding process. After much thought he hit upon the idea of breaking the bars of blister steel into small pieces and melting them in a crucible, afterwards pouring the molten metal into an ingot mould and hammering or rolling it to the required size. This method entirely eliminated the weld lines and produced steel of very fine quality.

A Secret Stolen

Huntsman did not patent his process, but preferred to keep it secret, and with this object he carried on work only at night, with a staff of men all sworn to the strictest secrecy. The other Sheffield steel-makers became alarmed at Huntsman's success, and they determined to find out the secret of his process.

Sir Henry Bessemer

One cold and stormy winter night an iron-founder disguised himself as a tramp and knocked at the door of Huntsman's works, begging for shelter. The workmen took pity on him and gave him a warm corner near the furnace, where he pretended to go to sleep. He was really very wideawake however, and as the men went on with their work the supposed tramp took careful note of the construction of the furnace and of the manner in which the process was carried out. Some hours later the tramp thanked the workmen for their kindness and left, taking with him Huntsman's cherished secret. Before long a rival steel works was making crucible steel.

The process thus commenced continues in use to-day, and by means of it the finest tool steels are made.

The Bessemer Process

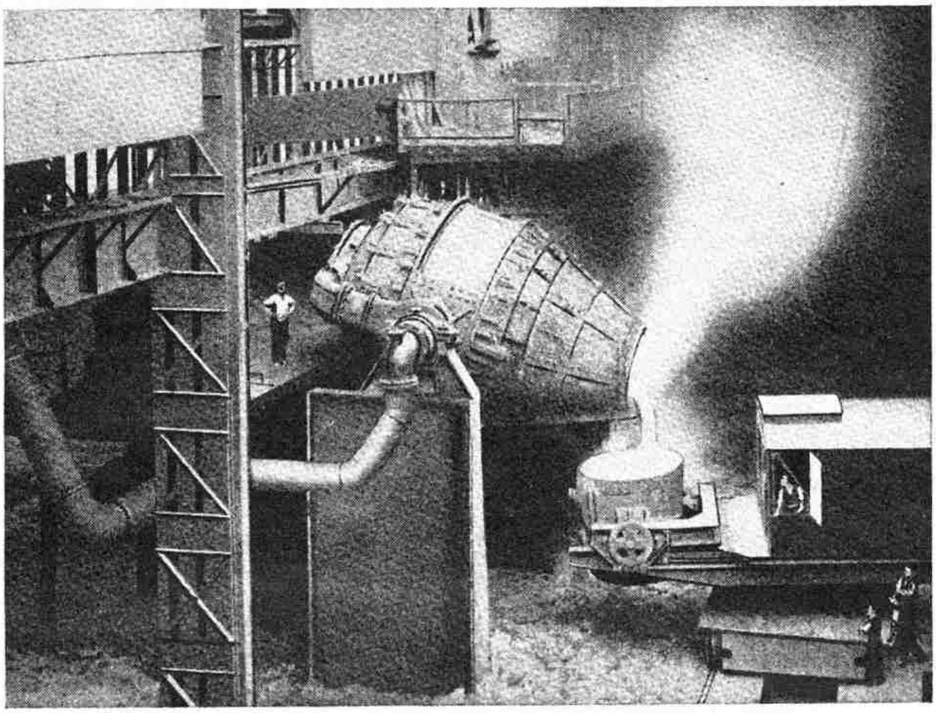
For more than 100 years the crucible process remained the only method of making high-class steel. The next change was brought about by Henry (afterwards Sir Henry) Bessemer.

Bessemer was born in England, of French parents, on 19th January, 1813, at Charlton, in Hertfordshire. From his boyhood he was always experimenting with something or other, and he became specially interested in the casting of metal. Among his ambitions was that of producing heavier projectiles for guns. One day, while discussing this matter with an army officer, the latter remarked that it was little use making heavier projectiles until some stronger material could be found for making the guns. This remark caused Bessemer to turn his attention to trying to produce a metal that would combine the hardness and rigidity of cast iron with the toughness of malleable iron.

Early Failures

Cast iron is converted into malleable iron by the elimination of its impurities—carbon, silicon, phosphorus and manganese—which, as we have already seen, is done in the reverberatory furnace. Bessemer came to the conclusion that the same result could be obtained much more quickly by forcing a blast of air through molten pig-iron. The scheme was tried in 1856, but though malleable iron was produced, it was found to be worthless on account of the amount of phosphorus it contained. This difficulty was overcome by using pig-iron containing very little phosphorus. Steel could be made from this iron by means of the blowing process, but here another serious trouble was encountered. It was found impossible to obtain steel of uniform quality on account of the difficulty of gauging the extent of de-carbonisation during the blow.

For a while this drawback appeared to be fatal to the success of the process, but the problem was solved by Robert Mushet, a Scotsman. His idea was to drive out almost the whole of the carbon and then to add to the molten metal exactly the correct amount of carbon to make steel of the desired quality. The carbon was added in the form of *spiegeleisen* or "mirror-iron," a form of pig-iron containing known quantities of carbon and manganese. This iron derives its name from the fact that when broken it forms crystalline plates of very brilliant appearance. Mushet's idea worked excellently, and through it the success of Bessemer's method was assured.



A Bessemer Converter Pouring its Molten Contents into Giant Ladle

Converting Iron into Steel

The Bessemer process is carried out in what is called a "converter." This consists of a vessel shaped as shown in the diagram on this page, and suspended on trunnions so that it may be swung into either a horizontal or vertical position, the swinging being controlled by hydraulic mechanism. The converter has an outer casing of malleable iron plates and an inner lining of ganister, which is a compact and hard variety of sandstone. At the bottom of the converter several tuyères carry the air-blast through the lining into the interior. These tuyères act in a similar way to those in the blast-furnace, but in this case the blast is driven through at a much higher pressure—about 25 lbs. per square inch.

The pig-iron is first melted in a cupola furnace—except in cases where the iron comes direct from the blast-furnace—and is then poured into the converter while the latter lies in a horizontal position. The blast is then turned on and the converter is swung into a vertical position. This brings the metal over the tuyères, and the air blast passes through the whole mass of metal with a loud roaring sound.

A Wonderful Sight

A very brilliant spectacle follows, for a fierce flame issues from the neck of the converter. At first this flame is pale in hue, but rapidly grows brighter and brighter, until it becomes dazzling. Showers of sparks stream out, accompanied by fragments of molten slag.

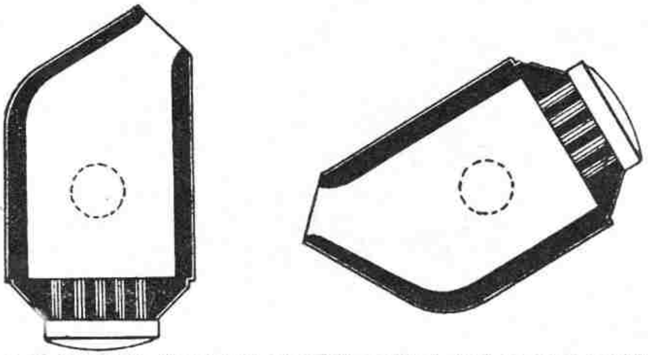


Diagram of Bessemer Converter showing vertical and pouring positions

The process is carefully watched by the "blower," an expert workman whose long experience enables him to tell from the variations of the colour of the flame exactly how matters are going on inside the converter. Sometimes the metal becomes too hot during the process, and then the blower gives an order for cold scrap iron to be thrown in to reduce the temperature. Presently the flame begins to drop and becomes quieter, and this is a sign that the last of the carbon is burned away and that no flame-producing substance is left. Exactly at the right moment the blower signals for the converter to be swung down on its side, and the blast is shut off. The necessary amount of molten *spiegeleisen* is then added, and the whole mass of molten metal is poured into a huge bucket or ladle.

Steel Ingots

When the steel is to be used at once for making castings it is taken direct to the foundry, otherwise it is run from the ladle into "ingot moulds." These moulds are made of cast iron and are about six feet high, being about 16 inches square at the top and broadening out gradually towards the bottom. They are open both top and bottom, and stand upon an iron plate.

By means of a truck on which it is carried, the ladle containing the molten steel from the converter is brought over each mould in turn. Then a hole at the bottom is opened and the metal pours out until the mould is filled. The moulds are then allowed to stand until the ingots—as their contents are called—have a solid shell outside, although they are still liquid inside. An overhead travelling-crane is then brought over the rows of moulds, a chain is lowered, and two hooks at its end catch the "lugs" of each mould and lift it off the ingot.

The Soaking-Pit

If these ingots are to be used immediately they are lowered into a "soaking-pit," consisting of a chamber large enough to hold an ingot easily, lined with firebrick and fitted with a lid. This operation, with an electric overhead crane, was the subject of the cover of the May "*M.M.*" The object of the soaking-pit is to bring the ingot to a uniform temperature throughout. If this were not done the ingot would be hard outside and soft inside, and therefore unfit for passing through the rolling mills. In these soaking-pits the ingot gives off heat to the firebrick, until the whole chamber and the ingot are at the same temperature.

The ingots are now ready for the rolling mills, and their subsequent treatment will be described in a later article.

Process Completed

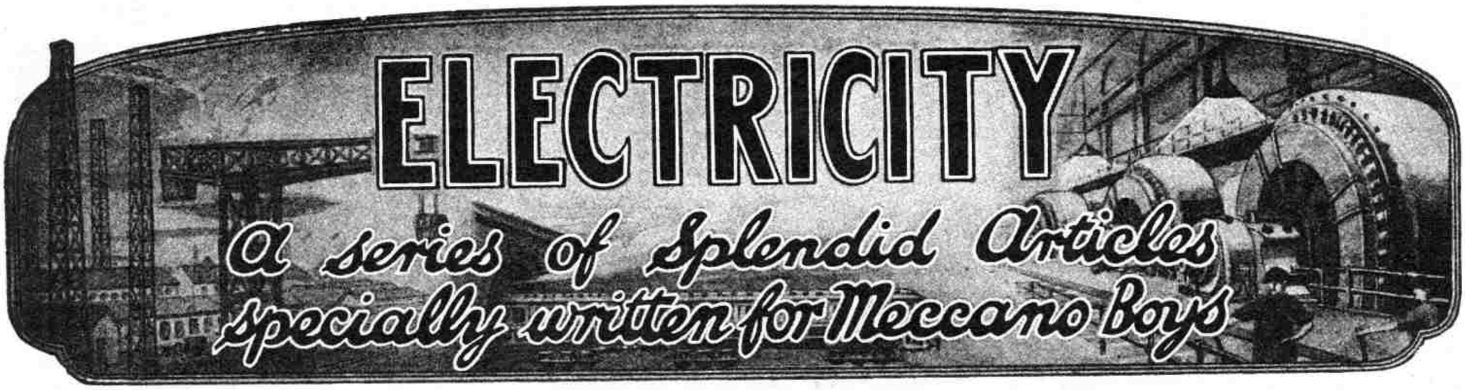
The process we have just outlined is the original Bessemer "acid" process, requiring a converter lining of ganister, which is an acid oxide. As we have seen, however, this process was limited to iron ore containing very little phosphorus, and as such ore forms only a small proportion of the total ore in the world, it became necessary to find some means of adapting the process to deal with ore containing a large quantity of phosphorus.

Mr. G. J. Snelus carried out experimental work with this object, and found that if the converter was lined with a "basic" material the phosphorus could be removed. A basic material may be explained as being a metal in combination with ogygen. It was left to Mr. S. Gilchrist Thomas, a London magistrates' clerk who had made chemistry his hobby, to solve the problem in conjunction with Mr. P. C. Gilchrist, an ironworks chemist. Their solution consisted in lining the converter with "dolomite," a mineral consisting of the carbonates of calcium and magnesium. This enabled highly-phosphoric ores to be used with complete success for steel making.

Decline of Malleable Iron

The introduction of the Bessemer process brought about a great change in the

(*Continued on page 202*)



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V. MAGNETS AND MAGNETISM

IN certain parts of the world there exists a peculiar kind of iron ore which has the power of attracting iron. If a piece of this ore be suspended so that it swings freely it will always turn to the north. This ore is called "lodestone," and its strange power is due to what is called "magnetism."

The origin of the name magnetism is uncertain, but according to one old story a shepherd named Magnes, who lived in Asia Minor, was one day tending his sheep on a mountain side and happened to touch with the iron tip of his crook a piece of dark-coloured rock. To his great astonishment he found that the rock held his crook so firmly that he could scarcely pull it away. This rock was formed of lodestone, and the name magnetism is said to have come from the shepherd's name, Magnes. Another explanation is that the name is derived from Magnesia, also in Asia Minor, where lodestone is found in large quantities. The name lodestone itself comes from the Saxon word *laeden*, which means "to lead," and refers to the lodestone's power of always pointing to the north if free to do so.

Artificial Magnets

Lodestone is a natural magnet. We can make artificial magnets out of pieces of steel by rubbing them with a piece of lodestone, and these magnets attract iron and turn to the north exactly as lodestone does. A piece of iron may be magnetised in the same way, but there is a very important difference to be noted—iron quickly loses its magnetism, whereas steel retains it. The softer the iron the quicker it loses its magnetism, and the harder the steel the better it retains its magnetism. Consequently, a specially hard quality of steel is used for making artificial magnets, but nowadays such magnets are not made by rubbing them with lodestone, but by means of an electric current, as we shall see later. Magnets are made either in the form of a straight bar or of a horseshoe, as illustrated in the diagram on the next page.

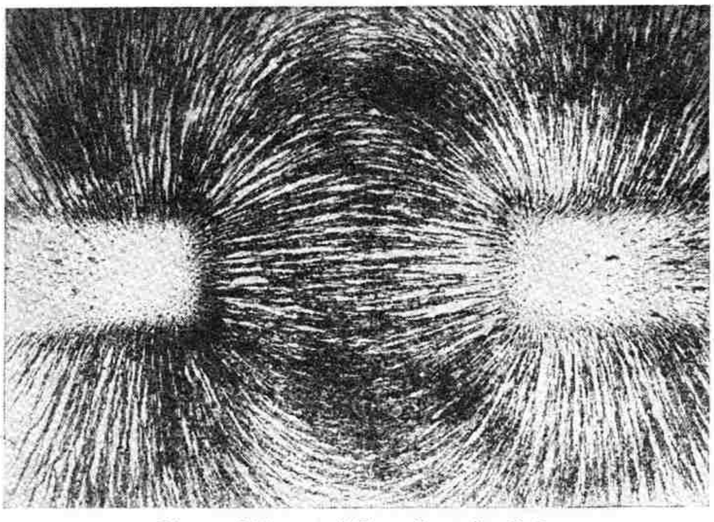
Some Interesting Experiments

A number of very interesting experiments may be made with two bar magnets and a small quantity of iron filings. If we roll a bar magnet among iron filings we find that the filings do not cling to it equally all over, but cluster thickly at each end of the magnet, few or none clinging to the middle. These two points, at which the magnet attracts iron most strongly, are called the "poles" of the magnet.

Magnetism, the subject of this article, plays a very important part in the operation of electrical mechanism of nearly every kind. We recommend our readers to carefully follow the explanation of the subject, for without some knowledge of the principles of magnetism it is impossible to understand the working of dynamos, motors, electric bells, and a host of other machines and appliances.

If we suspend a bar magnet from its centre by means of a sort of stirrup of copper wire attached to a thread, it will take up a position pointing north and south. The end which points to the north is called the "north pole" of the magnet and the other end the "south pole." The north pole of a magnet is usually marked with the letter N, or in some other way. If we bring each end of another magnet in turn near each end of the suspended magnet, we find that the two north poles or the two south poles repel one another, but that a north pole attracts a south pole, and vice versa.

These experiments show us that both poles of a magnet attract unmagnetised iron, but that similar poles of two magnets repel one another and opposite poles attract one another. Our readers will remember that this is exactly what happened in our earlier experiments with the charged glass rods, when "like repelled like" and "unlikes attracted."



Lines of Force of Two Opposite Poles

For experimental purposes it is useful to have a number of small magnets, and these are easily made out of steel knitting-needles or sewing-needles. Place the needle on the table and draw one pole of a bar magnet along it from end to end several times, always starting at the same end of the needle, and lifting the magnet quite clear of the needle at the end of each stroke.

Magnetic Induction

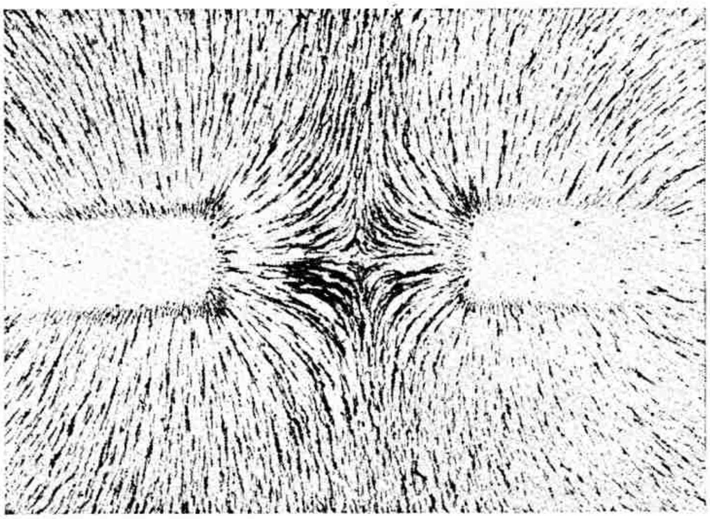
A piece of soft iron may be magnetised by a magnet without actual contact, by what is called "magnetic induction." Place a short piece of soft iron on the table close to some iron filings. Then bring one end of a bar magnet near one end of the iron, and the iron will immediately attract the filings, showing that it is now magnetised. As soon as the magnet is taken away the piece of iron loses its power to attract filings, showing that its magnetism has gone. It is very interesting to repeat this experiment with a sheet of glass, paper, or wood between the magnet and the piece of iron. These substances do not interfere in the least with the action of the magnet, but if a sheet of iron is used the experiment will not work, for iron has the power to "screen" or prevent the action of magnetism.

Invisible Lines of Force

Spread a thin layer of iron filings over a sheet of cardboard, and watch the result when a magnet is moved to and fro just beneath the sheet. The effect is very amusing. The filings stand up when the magnet approaches them, and follow it about as if pulled by invisible strings. As a matter of fact, the magnet really does act by means of invisible strings, which are known as "lines of force." These lines of force proceed from the magnet in certain definite directions, and although invisible in themselves, we are able to see them at work, as it were, in a most fascinating manner.

Place a magnet underneath a sheet of glass and sprinkle iron filings thinly and evenly over the glass. The best way of handling the filings is to put them into a little muslin bag and shake the bag gently. Then tap the sheet of glass very lightly with a pencil and the filings will immediately arrange themselves in a most wonderful manner. The filings become magnetised by induction, and when the gentle tap frees them for an instant from the friction of the glass they take up certain positions, according to the direction of the magnetic force acting on them. In this way we obtain a map showing the general direction of the lines of magnetic force.

By using different combinations of magnets a great many different maps may be made in this way. The illustration on page 176 shows the lines of force of two opposite poles of two bar magnets, and it will be seen that the lines appear to stream across from one pole to the other. The illustration on this page shows the lines of force of two similar poles, and in this case it is very remarkable how the lines from the two poles turn aside as if pushing each other away. Equally interesting maps can be made with a horseshoe magnet.


Lines of Force of Two Similar Poles

Keepers for Magnets

Magnets left with their poles unprotected gradually lose their magnetism. For this reason a horseshoe magnet has its two poles connected by a piece of soft iron, and bar magnets are usually kept in pairs, with a strip of wood separating them, their opposite poles being together, and across the ends a piece of soft iron, called a "keeper" (see diagram below).

It is necessary to remember that magnets lose a great deal of their magnetism if they are knocked or allowed to fall. Allowing the keeper to slam on to a magnet is also injurious, but pulling off the keeper vigorously is good for the magnet.

Magnetic Dip

Let us now magnetise a needle and suspend it by a thread so that it is free to swing either horizontally or vertically. We notice that it not only comes to rest in a north and south direction, but also tilts slightly with its north end downwards. If we could take our needle to some place south of the equator, it would still point north and south, but it would tilt with its south end downwards. The angle that the tilting needle makes with the horizontal is called the "magnetic dip."

The Earth a Great Magnet

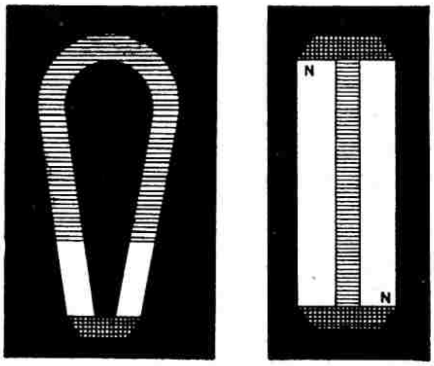
The explanation as to why a suspended magnet always takes up a position pointing north and south was found by Dr. Gilbert, of Colchester, physician to Queen Elizabeth. In the year 1600 he announced his great discovery that the earth itself is a huge magnet, having its poles near to the geographical north and south poles.

We have seen that similar magnetic poles repel one another, and yet the north pole of a magnet turns towards the north magnetic pole of the earth. Evidently, in order to get this attraction, one of these poles must really be a south pole, and it is customary to regard the earth's north magnetic pole as possessing south magnetism, and the south magnetic pole as possessing north magnetism. So we may look upon the north-pointing pole of a magnet as a true north pole, and the south-pointing pole as a true south pole.

The earth's magnetic influence also accounts for magnetic dip. North of the equator, in England for instance, the north magnetic pole of the earth is nearer than the south magnetic pole. Thus its influence is stronger, and a freely suspended magnet dips downwards towards the north. If we take our magnet to a place where the earth's south magnetic pole is the nearer, the magnet will dip downwards towards the south. Could we place our suspended magnet immediately over either of the earth's magnetic poles, it would take up a vertical position; and at the earth's magnetic equator, where the influence of the two poles is equal, the magnet would not dip at all.

The Mariner's Compass

The most valuable application of the peculiarity of a magnet pointing north and south is in the compass. We are all familiar with the ordinary pocket compass, consisting simply of a magnetised needle, pivoted so as to swing freely over a card marked with the 32 points of the compass. For use on ships, however, a much more elaborate arrangement is necessary. The single needle of the land compass is replaced by a compound needle consisting of several thin strips of steel, magnetised separately, and suspended side by side. Such a needle is infinitely more reliable than a single needle.



Horseshoe and Pair of Bar Magnets

The needle and the compass card are placed in a kind of bowl made of copper. In order to keep this bowl in a horizontal position, no matter how the ship may be rolling, it is supported on "gimbals" consisting of two concentric rings attached to horizontal pivots and moving in axes at right angles to one another. There are also liquid compasses, in which the card floats on the surface of dilute alcohol.

The earth's magnetic poles do not coincide with the geographical poles, and, therefore, a compass needle seldom points exactly north and south. The angle between the magnetic meridian and the geographical meridian is called the "declination," and—as Columbus discovered in 1492—this varies in different parts of the world. In order that navigators may know the exact declination at any part of the world, special magnetic maps are made in which all places having the same declination are joined by a line.

Electric Current and Magnetised Needle

We have already mentioned that artificial magnets are made by means of an electric current, and now we must explain how this is done. If we take a freely-swinging magnetised needle, such as a compass needle, and hold over it a copper wire, nothing happens; but if we send an electric current through the wire, the needle is at once turned to one side, or deflected. As soon as the current is stopped, the needle returns to its north and south position. Further, iron filings cling to the wire while the current is flowing, but drop off when the current is stopped. These facts show us that the wire becomes a magnet during the passage of the current, and loses its magnetism when the current ceases. A spiral of insulated wire through which a current is flowing shows all the powers of a magnet, and, in addition, it has the peculiar power of drawing or sucking into its interior a rod of iron. Such a spiral is called a "solenoid," and will be familiar to those of our readers who possess a Meccano Electrical Outfit.

Electro-Magnets

If we wind a number of turns of insulated wire round a rod of soft iron, and pass a current through the wire, the rod becomes a magnet, but loses its magnetism when the current stops. A magnet made in this way—that is, by the passage of an electric current—is called an "electro-magnet," and it has all the power of an ordinary steel magnet, but in a very much greater degree. In subsequent articles we shall describe some of the many industrial applications of powerful electro-magnets.

If we substitute a bar of steel for the iron, it becomes magnetised by the current in the same way, but, unlike the iron, it retains its magnetism after the current ceases. This enables us to make steel magnets of much greater strength than those produced by rubbing with another magnet. Such steel magnets are called "permanent magnets," for they retain their magnetism; whereas electro-magnets, in which soft iron is used, only possess magnetism as long as the current flows.

Detecting and Measuring Electric Currents

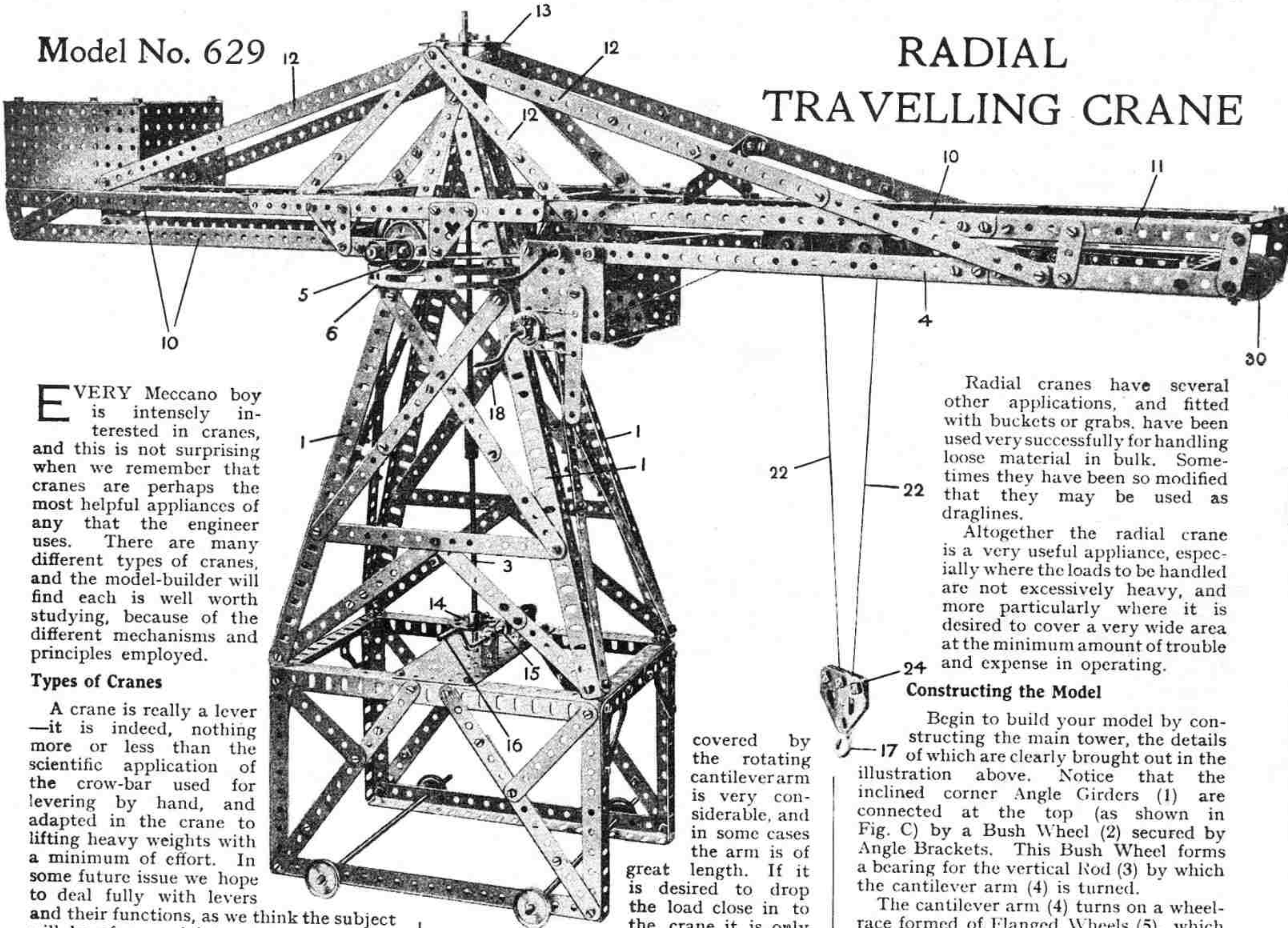
The deflection of a magnetised needle by a current of electricity provides us

(*Continued on page* 179)

A NEW MECCANO MODEL

Model No. 629

RADIAL TRAVELLING CRANE



EVERY Meccano boy is intensely interested in cranes, and this is not surprising when we remember that cranes are perhaps the most helpful appliances of any that the engineer uses. There are many different types of cranes, and the model-builder will find each is well worth studying, because of the different mechanisms and principles employed.

Types of Cranes

A crane is really a lever—it is indeed, nothing more or less than the scientific application of the crow-bar used for levering by hand, and adapted in the crane to lifting heavy weights with a minimum of effort. In some future issue we hope to deal fully with levers and their functions, as we think the subject will be of general interest to our readers.

Different requirements necessitate special cranes, each designed so as to be most serviceable under the special conditions imposed. There is, for instance, the comparatively small dock-side crane that runs astride the wharf and does not require a great deal of leg-room. Where space is not so important the base of the crane can be designed differently, which is fortunate, for a large base is necessary to give stability in the case of the hammer-head cranes used in our ship-building yards. These giant cranes lift boilers or big guns into position with the greatest ease.

Radial Travelling Cranes

Our new model, which we here illustrate and describe, is a Radial Travelling Crane of the cantilever type. This type of crane is used on the Panama Railways at the docks for handling freight. They stand well back from the quay-side, lift their load from the hold of the ship and then swing round and dump the load on the ground behind the docks.

Radial cranes are also used extensively in iron and steel yards and in timber yards, where it is necessary to drop loads over a large area. The ground covered by the rotating cantilever arm is very considerable, and in some cases the arm is of great length. If it is desired to drop the load close in to the crane it is only necessary to run the travelling bogie inwards along the arm. This enables the load to be dropped at any point between the base of the crane and the end of the arm, and anywhere within the circle through which the arm may be moved.

Other Applications

A modified form of the radial crane is used in ship-building, and mounted on steel trestles alongside the vessel that is being built. In these cases the cranes move on wheels which run on a track laid on the steel trestles.

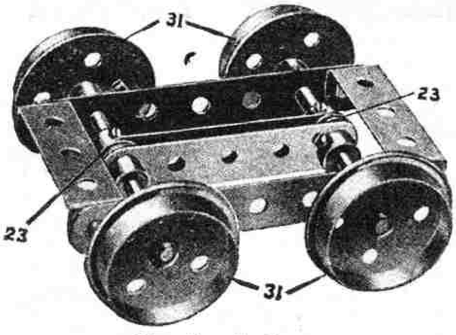


Fig. A. Trolley

Radial cranes have several other applications, and fitted with buckets or grabs, have been used very successfully for handling loose material in bulk. Sometimes they have been so modified that they may be used as draglines.

Altogether the radial crane is a very useful appliance, especially where the loads to be handled are not excessively heavy, and more particularly where it is desired to cover a very wide area at the minimum amount of trouble and expense in operating.

Constructing the Model

Begin to build your model by constructing the main tower, the details of which are clearly brought out in the illustration above. Notice that the inclined corner Angle Girders (1) are connected at the top (as shown in Fig. C) by a Bush Wheel (2) secured by Angle Brackets. This Bush Wheel forms a bearing for the vertical Rod (3) by which the cantilever arm (4) is turned.

The cantilever arm (4) turns on a wheel-race formed of Flanged Wheels (5), which run on a Circular Girder* (6) supported by four 1″ × ½″ Angle Brackets (7) bolted to the corner Girders (1). The cantilever is built up (as shown in Fig. B) from two 9½″ Angle Girders (8) braced by two 5½″ Angle Girders (9) overlapped nine holes. From these, 12½″ Angle Girders (10) extend at one side, and to similar Girders (10) at the other side are connected 5½″ Girders (11).

Rotating the Arm

The inclined Strips (12) are connected at the top, by means of Angle Brackets, to a Face Plate (13) secured to the vertical Rod (3). At the foot of the Rod (3) is a 1½″ Gear Wheel (14) engaged by a Worm Wheel (15) operated by the Crank Handle (16) and in this way the cantilever arm is swung round, the wheels (5) riding on the Circular Girder (6).

The load carried from the Hook (17) is raised or lowered by the Crank Handle (18), a ½″ Pinion (19) on which engages a 1½″ Gear Wheel (20) on a Rod (21) on which is wound a Cord (22). This Cord passes over a ½″ Pulley (23) to the block (24) and back over another ½″ Pulley on the trolley, and is secured to the 3½″ × ½″ Double Angle Strip (25) at the outer end of the cantilever arm.

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* The Circular Girder, No. 143, is a new part, which is announced on page 195.

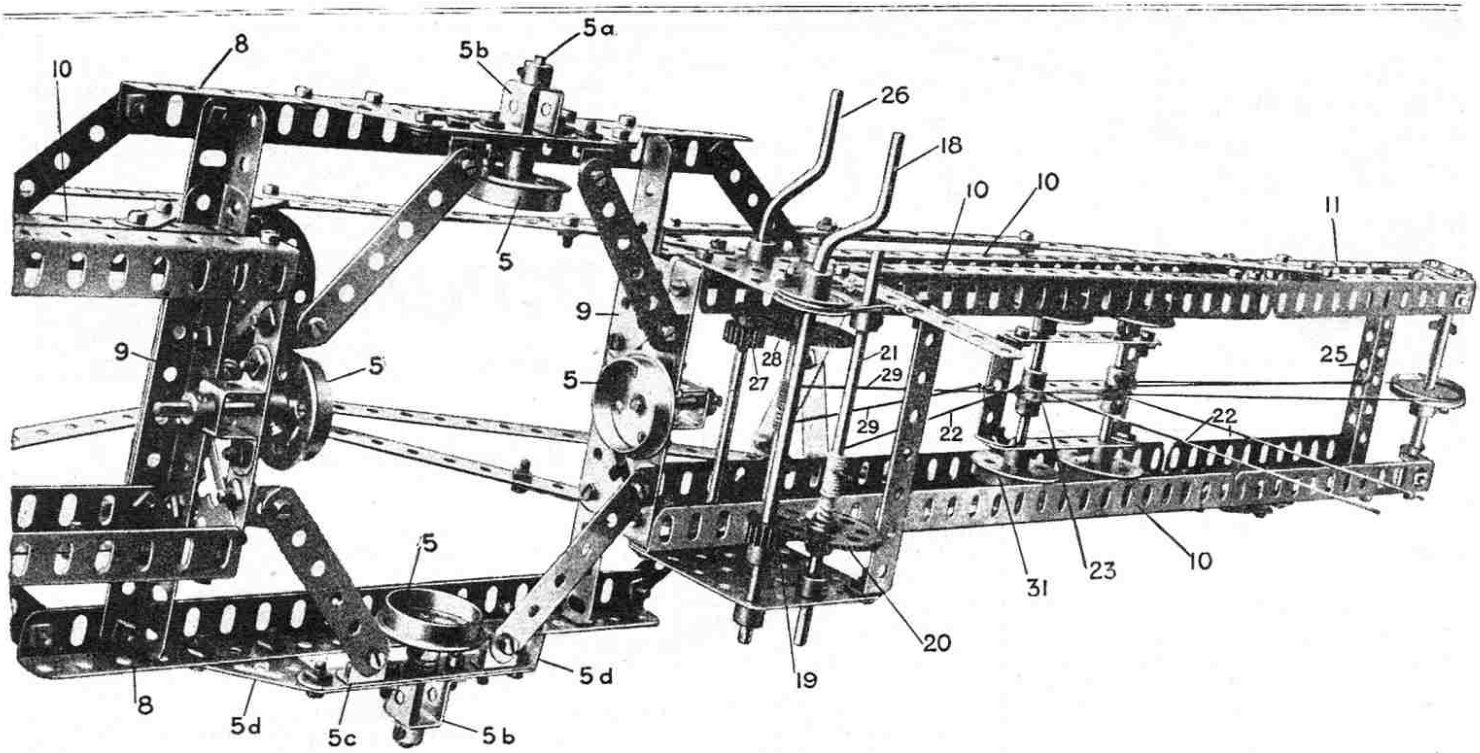


Fig. B. Details of the Cantilever Arm

Consequently, when the trolley is caused to travel along the cantilever arm the load remains suspended at a constant height—an important point and an interesting detail.

The Movement of the Trolley

The trolley is caused to move to and fro along the cantilever arm by the action of the Crank Handle (26). On this a ½" Pinion (27) engages a 1½" Gear Wheel (28) on a rod on which is wound the Cord (29), the opposite ends of which are connected to the opposite ends of the trolley. The Cord (29) passes round a Pulley (30) at the outer end of the jib. By turning the Crank Handle (26), therefore, the Cord (29) winds on and off its rod, and moves the trolley to and fro, its Wheels (31), as shown in Fig. A, running on the Angle Girders (10).

The Wheels (5) are connected to 1½" Rods (5a) which are journalled in Double Bent Strips (5b) bolted to 3½" Strips (5c) carried from the Angle Girders (8) by Corner Brackets (5d).

Parts required :—

6 of No. 1
2 „ „ 1b
28 „ „ 2a
23 „ „ 3
18 „ „ 4
2 „ „ 5
8 „ „ 6
6 „ „ 6a
12 „ „ 7
6 „ „ 8a
18 „ „ 9
22 „ „ 12
4 „ „ 12b
1 „ „ 13
2 „ „ 13a
1 „ „ 14
1 „ „ 15
1 „ „ 15a
3 „ „ 16
2 „ „ 16b
4 „ „ 18a
3 „ „ 19
8 „ „ 20
5 „ „ 22
3 „ „ 23
1 of No. 24
2 „ „ 26
3 „ „ 27a
1 „ „ 32
2 „ „ 35
292 „ „ 37
61 „ „ 37a
10 „ „ 38
1 „ „ 40
4 „ „ 45
1 „ „ 46
2 „ „ 48
4 „ „ 48b
2 „ „ 52
1 „ „ 52a
1 „ „ 53a
1 „ „ 57
19 „ „ 59
1 „ „ 63
2 „ „ 72
4 „ „ 108
1 „ „ 109
60 „ „ 111b
1 „ „ 118
2 „ „ 126
8 of No. 133

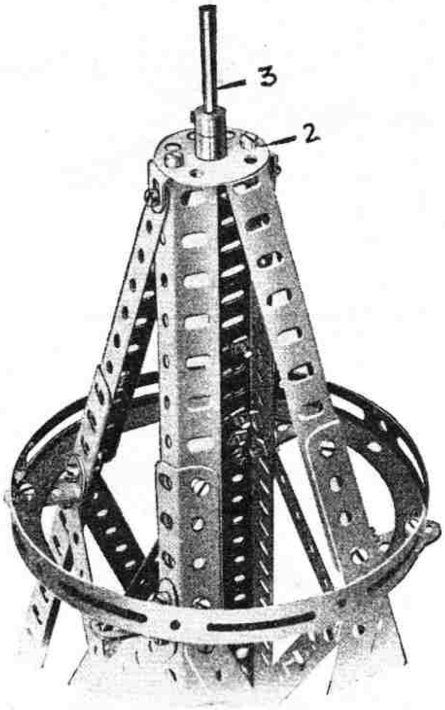


Fig. C. Details of Top of Main Tower

How to Build the Meccano Chassis

The Meccano Chassis is a triumph of model-building. At the British Industries Fair it attracted the attention of H.M. the King and was the centre of marked interest to thousands of other visitors to the Meccano exhibit. Fitted with three-speed gear box (with reverse) differential gear, elliptical springing and other modern refinements, the Chassis is an accurate reproduction of the "real thing." So perfectly does it illustrate the main mechanical features of a modern motor car that it is in use at several schools of motoring for demonstration purposes. Full instructions for building this Chassis in miniature are contained in the special leaflet now ready price 4d. post free.

Electricity *(continued from page 177)*

with a simple means of detecting such a current. An instrument called a "galvanometer" is used for this purpose, and in its simplest form it consists of a magnetic needle, very delicately poised, surrounded by a coil of many turns of wire. The effect of the coil is to make the current pass many times round the needle, and this increases the amount of deflection.

If we make a galvanometer with a long coil of very thin wire, having a high resistance, the amount of current flowing through it will depend upon and be proportional to the electro-motive force. Such an instrument, if properly graduated, will measure the voltage of the current, and is called a "voltmeter." On the other hand, if we provide our galvanometer with a short coil of very thick wire the resistance will be practically nil, and by means of a graduated scale the amount of current flowing—that is, the number of amperes—may be measured. An instrument of this kind is called an "amperemeter," or "ammeter."

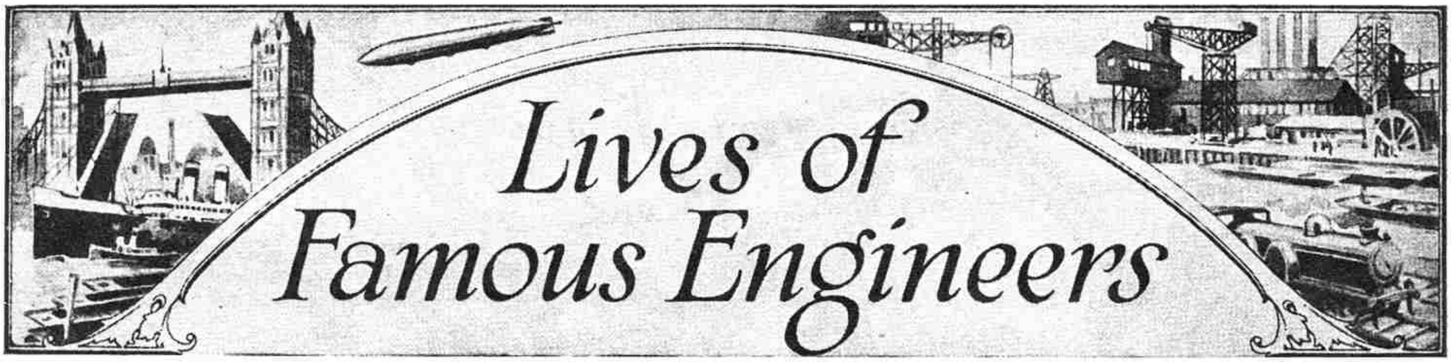
These three instruments, as described, are the very simplest types, and in actual scientific and engineering work more elaborate forms are used to obtain greater accuracy and sensitiveness.

NEXT MONTH:—

DYNAMOS AND MOTORS

£5 for a Model Dragline

We would remind our readers of the novel Model-Building Competition in which prizes of £5 (cash) and £5 5s. 0d. (goods) are being offered for the best model of a Dragline. Full particulars were announced on page 164 of the June "M.M." Closing date 30th September next.



Lives of Famous Engineers

VI. ROBERT STEPHENSON: Builder of Railways and Bridges

IN our article last month we described the rise of Robert Stephenson to a position of great eminence as a railway engineer. We must now turn to his work as a bridge builder.

The remarkable growth of railways during the lifetime of the two Stephensons necessitated a corresponding amount of bridge building, for the railways had to be carried across many rivers, roads, and deep valleys. A new style of building became necessary, for most of the existing bridges were incapable of bearing the strain of heavy railway trains travelling at a high speed.

The railway engineer was also faced with another difficulty. Unlike the road engineer, who could divert his road so as to cross a river or valley at the best and easiest point, the railway engineer had to follow the line of his railway, and therefore, as a rule, had little choice in regard to the position of his bridges. He had to take the ground as it came, good or bad, and consequently he was often faced with the necessity of devising entirely new methods of construction. Yet another problem was the necessity for building bridges over rivers and busy thoroughfares without interrupting the existing traffic.

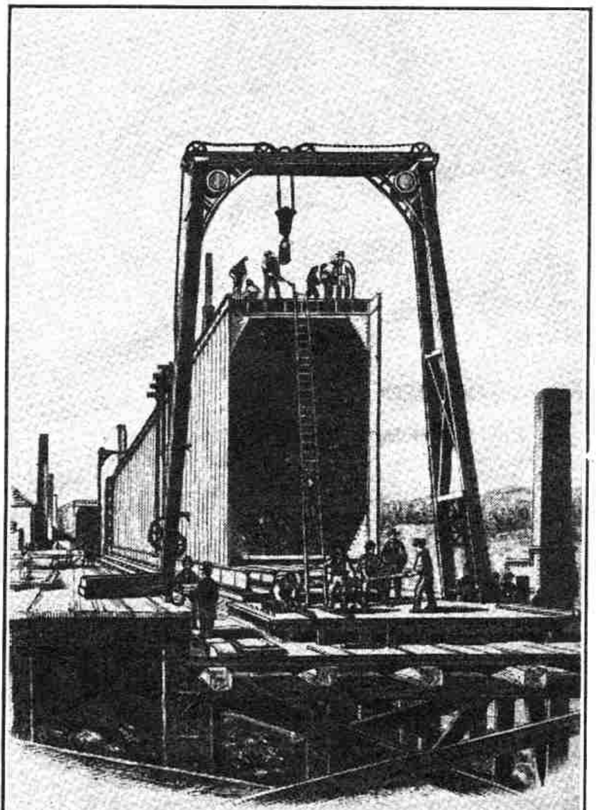
Iron Replaces Stone

One result of the new conditions was the great use made of iron. In the earlier iron bridges the old arch form was used, the only change being the substitution of iron for stone. It was found, however, that in many cases this type of bridge did not allow sufficient headway, a difficulty that caused George Stephenson, in building the Liverpool and Manchester Railway, to adopt the simple iron beam for crossing roads and canals. This type of bridge was followed by the use of arched beams, held firmly together by horizontal ties to resist the thrusts. Robert Stephenson built a number of bridges of this kind on the original London and Birmingham Railway, and followed these by the magnificent High Level Bridge across the river Tyne.

Newcastle High Level Bridge

This bridge had to cross the ravine between Newcastle and Gateshead, with the river below, and the local authorities insisted that it should carry a road for ordinary vehicles and foot passengers as well as for the railway. The length of the bridge and viaduct from Gateshead station to the Newcastle terminus is about 4000 ft., and the bridge passes over the roofs of the houses on both sides of the valley. In order to obtain a solid foundation for the piers enormous piles had to be driven, and for this purpose a Nasmyth steam hammer was used. It is probable that this was the first occasion on which a steam hammer was employed for bridge pile-driving. The powerful, rapid strokes of the hammer produced such an intense heat that on some occasions the head of the pile actually burst into flames!

The bridge combines the two principles of the arch and suspension, the railway passing over the back of the ribbed arches as usual, while the carriage road and footpaths are suspended from the arches and form a long gallery. There are six arches, each of 125 ft. span, and the two approaches to the bridge are formed of iron pillars and bearers in conformity with the arches. The bridge, which is one of the finest examples of its type, was opened on 15th August, 1849.



Building the Main Tubular Girder for the Britannia Bridge

Crossing the Menai Straits

In 1838 George Stephenson surveyed a line for the construction of the Chester and Holyhead Railway. He proposed to make use of the existing suspension bridges built by Thomas Telford across the Conway estuary and the Menai Straits, but in the case of the latter bridge he recommended that the trains should be drawn across by horses so as to avoid setting up serious oscillations in the structure. Apparently the idea of constructing a rigid bridge across the Straits was not then contemplated. Soon afterwards Robert Stephenson took over the construction of the line, and he decided not to use the existing bridges, but to build new ones more suitable to railway traffic.

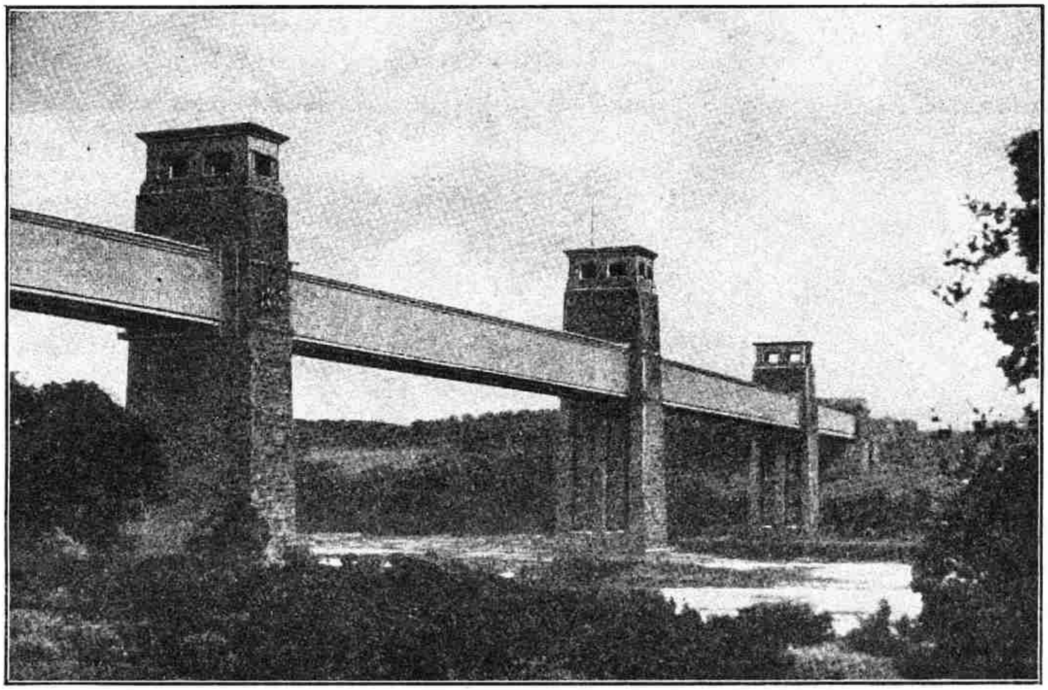
The problem in regard to the Straits was to throw across such a wide chasm a bridge of sufficient strength to carry the heaviest trains with a good margin of safety, and at the same time of sufficient height to avoid interference with navigation. Robert Stephenson soon selected for his bridge a site about a mile south of the suspension bridge, where the Britannia Rock lies almost in mid-channel. The width of the Straits at this point is about 900 ft., but the rock offered a secure foundation for a central pier.

Stephenson first proposed to construct an arch bridge with two main spans of 450 ft. each, but the Admiralty rejected this plan on the ground that navigation must not be interrupted at all, and even the erection of temporary scaffolding to support the bridge during construction could not be allowed. Finally, Stephenson decided upon a bridge consisting of a hollow beam or tube, through which the trains should run.

Britannia Tubular Bridge

The bridge, which is known as the Britannia Tubular Bridge, consists of giant tubes built of riveted boiler plates, supported on the abutments and on three towers, the centre tower being built on the Britannia Rock. These tubes form two independent continuous tubular beams, each 1511 ft. in length and weighing 4680 tons. The land tubes were built in position on a falsework of timber, but the main tubes were built on platforms at high-water mark on the Carnarvon side and floated between the piers on pontoons, ready to be raised by hydraulic presses.

On 20th June, 1849, the first tube was afloat, and the pontoons swung out into the current, controlled by guide ropes coupled to capstans on shore. A great crowd of spectators lined both shores of the Straits, watching the proceedings intently. As the pontoons approached their destined place between the piers, the force of the current became so strong that one of the capstans was uprooted, and the tube was in great danger of being carried away by the stream. In this emergency the engineer in charge of the uprooted capstan threw the spare coil of rope into the field behind the capstan. The crowd, men and women and children, rushed to the rope and held on, and the tube was checked in its dangerous progress. Finally the pontoons were manœuvred into the correct position.



The Britannia Tubular Bridge

Stephenson's Forethought Averts Disaster

It now remained to raise the tube to its final position. Stephenson was away in London while the hydraulic presses were being fixed, and when all was ready his engineers wrote to him saying they could raise the tube in two days at the most. Stephenson replied at once that they must not attempt anything of the kind. They must raise the tube inch by inch, and must build up masonry beneath it as it rose. This instruction prevented very serious consequences, for one day, while the hydraulic presses were at work, the bottom of one of them burst. The cross-head and chains, weighing over 50 tons, crashed down on the press, and the tube dropped upon the packing beneath it. Although the tube actually fell less than nine inches, it completely crushed solid castings weighing several tons, and if it had not been under-built the result would have been disastrous. Nobody was hurt, but this accident cost an extra £5000.

The remaining tubes were brought into position without further accidents, and on 5th March, 1850, the bridge was put through a severe test by three coupled locomotives and 24 loaded coal wagons. Afterwards, when a heavy train of several hundred tons crossed at 35 miles an hour, the bridge sagged only half an inch, an amount scarcely 1/25th of that allowed within the danger point.

The Conway Tubular Bridge (illustrated in our last issue) was built on very similar lines to the Britannia Bridge, and therefore does not call for special mention.

Bridging the St. Lawrence

On the death of his father, who left his very considerable fortune to him, Robert Stephenson found himself a wealthy man, and, in fact, he was the first engineer millionaire. He determined to retire very largely from professional work, but he found it impossible to cut himself off entirely from new enterprises. The greatest of his later undertakings was the magnificent Victoria Bridge over the River St. Lawrence, at Montreal, in Canada.

Up to the middle of last century the St. Lawrence river was unbridged from Niagara to the Atlantic, a distance of some 900 miles. With a steadily-increasing population, the necessity arose for a bridge across the river to enable the Grand Trunk Railway system to be extended. In 1852 the Canadian Government requested an English firm of contractors to report on the possibility of building a bridge, and Mr. A. N. Ross, who had superintended under Stephenson the construction of the Conway Tubular Bridge, visited Canada for that purpose. He recommended bridging the river just above Montreal, and advised a tubular bridge on the same lines as the Conway and Britannia Bridges. He returned to England to confer with Stephenson, and the result was the plan of the Victoria Bridge, of which Stephenson was the designer and Ross the joint and resident engineer.

Dangers of the Undertaking

At the point chosen for the bridge the river is a mile-and-three-quarters in width, so that the task of bridging it was very great on account of the length alone. The local conditions added immensely to the difficulty, however, for the river runs very rapidly, as much as eight or nine miles an hour at high water, so that the building of piers was not at all easy. In summer the difficulty was increased by the huge rafts of logs that were floated down the river to the sawmills at Quebec, for these rafts were constantly colliding with the partly-finished piers.

The greatest danger of all, however, was experienced in spring at the time when, after the long winter, the ice from higher up the river, from its tributaries and from the vast lakes, begins to be driven down-stream towards the sea. The pressure from behind is so great that the ice piles itself up against any obstacle, frequently reaching a height of 30 or 40 ft. The strain placed upon the piers by these piled-up masses of ice is tremendous, and the anxiety of the engineers during their construction may be imagined. However, the piers were skilfully built on a foundation of solid rock, and proved capable of withstanding the strain.

The works in connection with the bridge were commenced on 22nd July, 1854, and the bridge was finished and taken off the hands of the contractor on 17th December, 1859. Stephenson, however, did not live to see its completion, his death having taken place about two months previously.

The Victoria Bridge was altered considerably in 1897, when the piers were lengthened and Stephenson's great tubes were replaced by steel trusses. A double railway track was provided in the new bridge, in addition to carriageways and footways.

Stephenson's Last Works

Stephenson also applied the tubular system in a modified form in two bridges across the river Nile at Damietta, in lower Egypt. The modification in these bridges is that the road is carried upon the tubes instead of within them.

The larger of the two, near Benha, contained eight spans or openings of 80 ft. each, and two centre spans, formed by a large swing bridge. The total length of the swing beam was 157 ft., and there was a clear waterway of 60 ft. on each side of the centre pier. The foundations for this bridge had to be sunk 33 ft. on account of the shifting nature of the soil.

These bridges were the last of Stephenson's great engineering works. His health began to fail, and he died on 12th October, 1859, in his 56th year. He was buried in Westminster Abbey by the side of another famous bridge builder and road maker, Thomas Telford.

NEXT MONTH:—

BRINDLEY

First English Canal Engineer

Brandes
Limited
Superior
Matched Tone
Radio Product

SIGNALLING TO AMERICA

Marconi Transmits his First Signals Across the Atlantic

Marconi, pondering over the experiments of Hertz with electric waves, saw clearly the wonderful possibilities that were opened up, and from that moment his life's ambition was fixed. He determined to solve the problem of wireless communication, and he succeeded. He had many big difficulties to face, but he tackled them all with dogged persistence and overcame them one by one by means of his remarkable inventive ability. Thirty years ago Marconi was unknown; to-day his name is a household word all over the world.

IN last month's Magazine we described how Marconi tackled the problem of wireless communication, and solved it in regard to messages transmitted over comparatively short distances and at a slow speed. A great deal remained to be done, however, before the conquest of the Atlantic became possible.

As soon as Marconi realised that he had pushed the coherer detector to its limits, and that it could never be made a success for long-distance commercial work, he turned his attention to other possible forms of detectors. After a great deal of experiment he produced the Magnetic Detector, an instrument working on a principle entirely different from that of the coherer.

The Magnetic Detector

The magnetic detector consisted of an endless band of soft iron wire mounted on pulleys driven by clockwork and so arranged that the band passed close to the poles of two horseshoe magnets. As the band passed from the influence of one magnet to that of the other, its magnetism became reversed. The change did not take place instantly, however, owing to the fact that even soft iron has some magnetic retaining power, and therefore resists slightly the attempt of one magnet to reverse the effect of another. The moving band passed through two small coils of wire, one connected with the aerial and the other with a sensitive telephone receiver.

When electric waves fell upon the aerial of the receiving station, minute, rapidly-oscillating currents passed through the first coil, and had the effect of making the band reverse its magnetism. The sudden moving of the lines of magnetic force induced a current in the second coil, and a click was produced in the telephone receiver. The clicks continued to follow one another rapidly as long as electric waves were reaching the receiving aerial, being broken up into Morse signals according to the manipulation of the key of the operator at the transmitting station.

Using this improved apparatus, Marconi succeeded, in January, 1901, in transmitting signals from St. Catherines, in the Isle of Wight, to the Lizard, in Cornwall, a distance of about 155 miles.

First Long-Distance Station

Soon afterwards the first long-distance wireless station was established at Poldhu, in Cornwall, and Marconi commenced experiments with a view to signalling across the Atlantic. As his apparatus required more power than had been available in previous experiments, he installed a dynamo driven by an oil engine. The current generated by the dynamo at 2000 volts was raised to a pressure of 20,000 volts by means of transformers, and was then used to charge a number of condensers. These condensers consisted of glass plates coated on each side with tinfoil and immersed in oil, and were really nothing more than huge Leyden jars.

By the end of November everything was ready at Poldhu for the great experiment, and Marconi crossed the Atlantic to make the necessary arrangements on the other side. The place chosen for the attempt was Signal Hill, a bold bluff overlooking the sea near St. Johns, Newfoundland, and here the receiving instruments were set up in a room in a Government building. A large kite was to be used to carry the aerial wire, but for some days it seemed as though the weather was determined that the kite should not be flown. Under the stimulating encouragement of Marconi, however, the little band of workers persisted in their efforts, and finally the weather improved, and the kite was raised to the desired height.

The Atlantic Conquered

The great test took place on Thursday, 12th December. Marconi had given instructions to the operators at Poldhu to commence sending three dots—the Morse signal for the letter "S"—at 3 o'clock in the afternoon, and to continue to send at intervals until 6 o'clock. Taking his seat before the apparatus, with a telephone receiver to his ear, Marconi listened expectantly, and exactly at the appointed time the signal came—"br-br-br"—faint but unmistakeable. Again and again the letter "S" was repeated across the 1800 miles of ocean, and Marconi knew that his great ambition was realised—he had bridged the Atlantic.

News of the success of the experiment was immediately flashed back by cable to the anxiously-waiting operators at Poldhu, and we can imagine the great enthusiasm with which the message was received.

A Notable Voyage

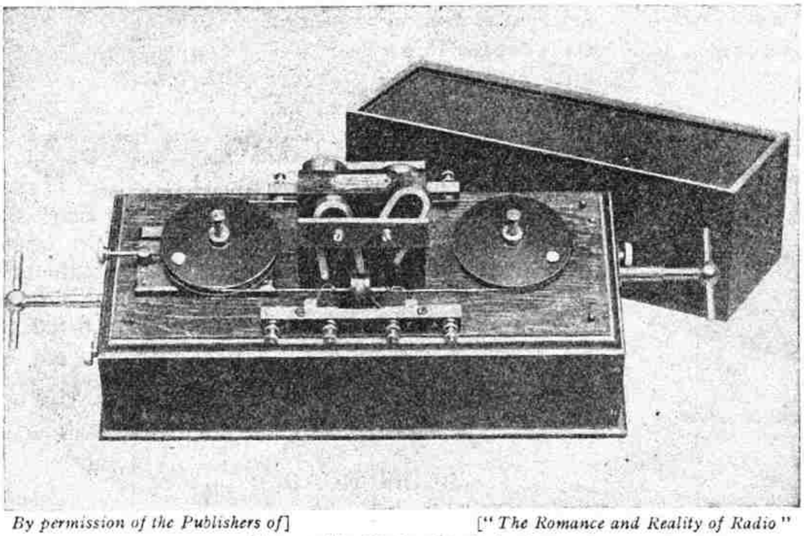
At first the general public were inclined to doubt this wonderful wireless story, but early in the following year Marconi put an end to all doubts by the brilliant success of his experiments on the liner *Philadelphia* on a voyage to New York. This vessel was specially fitted with a complete apparatus for wireless transmission and reception, and as soon as she was clear of the English coast communication was established with the station at Poldhu.

Messages were exchanged between ship and shore at regular intervals up to a distance of 150 miles, but beyond that distance the ship could not send messages, as she had reached the limit of her transmitting range. Poldhu, however, still kept on sending, and day after day, as the ship travelled westwards, messages arrived with unfailing regularity. As the distance between ship and shore increased the signal strength decreased, but readable signals were received up to 2099 miles.

Range Greater at Night

This voyage of the *Philadelphia* effectually disposed of all the arguments of those who had declared trans-Atlantic wireless communication to be impossible. At the same time the fact was established that the range of a transmitting station is much greater at night than during the day. On this occasion station signals were received during the day up to a distance of 700 miles. At night, however, strong signals were received at 1500 miles, and even at 2099 miles the signals were quite readable.

Eight years later Marconi had a better opportunity of investigating this matter while on a voyage to South America. In this case the



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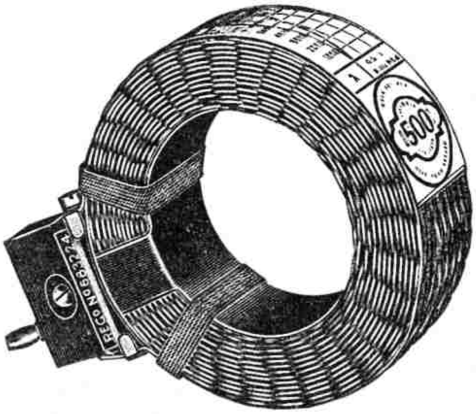
Marconi's Magnetic Detector

(Continued on page 185)

HONEYCOMB INDUCTANCE COILS

(De Forest Patent No. 141344).



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—HIGHER EFFICIENCY ATTAINABLE—

The introduction of the three intermediate sizes of HONEYCOMB DUOLATERAL INDUCTANCE COILS, particulars and wavelengths of which are given in the Table below, will be specially welcome to those radio enthusiasts who have hitherto experienced difficulty in tuning to certain stations within the British Broadcasting wavelengths owing to peculiar aerial characteristics.

These new coils are additional to our standard range of HONEYCOMB DUOLATERAL INDUCTANCE COILS (Nos. 25 to 1500), and by affording a greater degree of overlap when used in conjunction with the British Broadcasting coils (Nos. 25 to 75), they enable certain stations to be received with less values of parallel capacity and consequent increase in efficiency.

Coil No.	Maximum wavelength (closed circuit) when used with condensers of the values indicated.			Price.
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30	220	280	430	**5/-**
40	300	370	550	**5/2**
50	500	640	830	**5/4**

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All coils are supplied with either plug or gimbal type of mounting.

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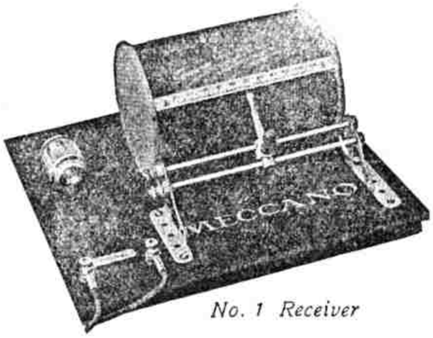
Listen with a Meccano Receiver

No. 1 Meccano Crystal Receiver

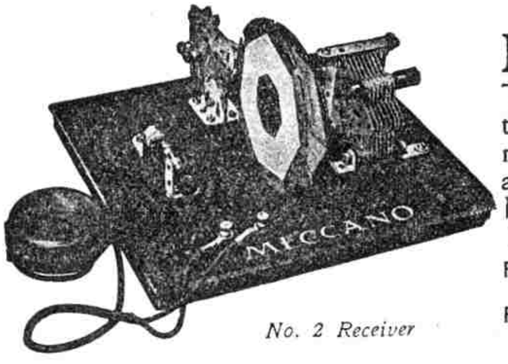
With a good aerial this set will receive telephony up to about 25 miles from a broadcasting station, and Morse signals up to a distance exceeding 100 miles. The set, which may be used with a broadcasting licence obtainable from any Post Office at a cost of 10/-, will receive on wave-lengths from zero to approximately 1,000 metres.

R.S. 1—Receiving Set, tested and guaranteed (without headphones), price **15/-**

Meccano Double Headphones, 4,000 ohms resistance, **15/-**



No. 1 Receiver



No. 2 Receiver

No. 2 Meccano Crystal Receiver

This set is of the constructional type and is specially adapted to the requirements of those who wish to carry out simple experiments. Its range is the same as that of No. 1 set described above, and it receives on wave-lengths of approximately 300-500 metres. It may only be used with a constructor's licence, which costs 15/-, and is obtainable from any Post Office.

R.S. 2—Complete Set of Parts, in strong carton, including single telephone 2,000 ohms resistance, price **25/-**

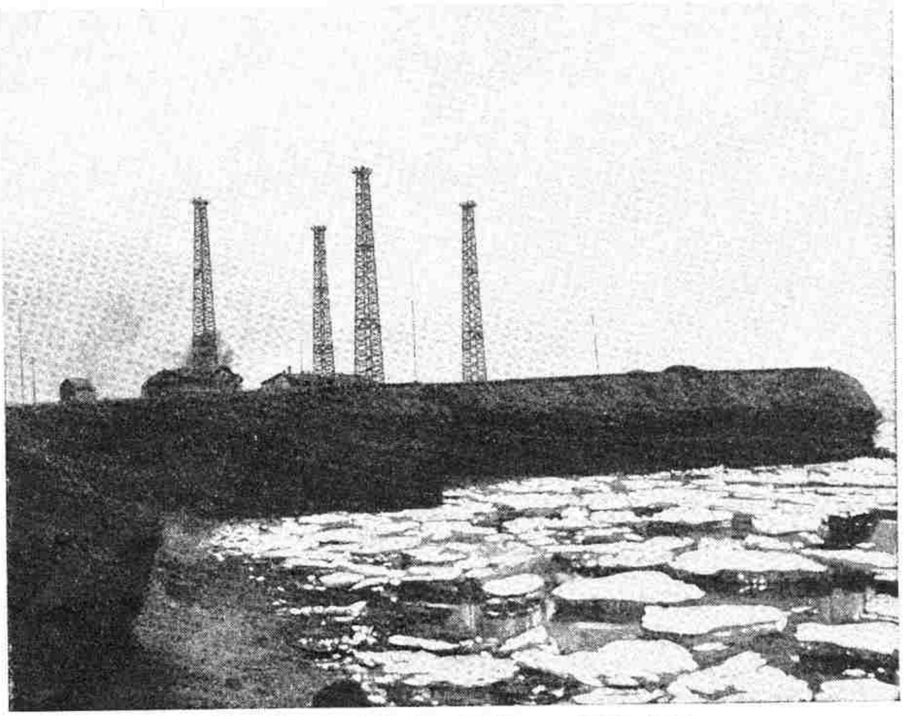
R.S. 2a—Complete Set of Parts, in strong carton, without telephone, price **15/-**

Meccano Double Headphones, 4,000 ohms resistance, **15/-**

MECCANO LIMITED **BINNS ROAD** **LIVERPOOL**

"Signalling to America" *(cont. from p. 183)*

signals were being transmitted from Clifden, and up to 4000 miles they were received successfully both by day and night. Beyond that distance, however, signals were only received at night. At Buenos Aires, 6000 miles from Clifden, no signals were received during the day, but at night they came through, not only from Clifden, but from Glace Bay also.



The Marconi Wireless Station at Glace Bay

Wireless Waves Travel Best Over Sea

Marconi's experiments on the *Philadelphia* also afforded additional evidence of the curious fact that wireless waves are transmitted more easily over sea than over land. Non-conductors of electricity allow electric waves to pass freely, but good conductors resist the passage of the waves. The land, as compared with the sea, is a poor conductor, so that the electric waves penetrate it and lose a great deal of their energy. Sea-water, on the other hand, being a good conductor of electricity, opposes the passage of the electric waves, and prevents them from losing energy by penetrating the ocean and being absorbed by it.

The relative distances to which electric waves may be transmitted over land and over sea vary in different places, but generally speaking, waves transmitted over the ocean will travel five times as far as the same waves transmitted over the land.

Trans-Atlantic Stations

Towards the end of 1902 three powerful stations for trans-Atlantic wireless were erected—at Clifden (Galway, Ireland), Glace Bay (Cape Breton, Nova Scotia), and Cape Cod (Mass., U.S.A.). On 21st December three messages of considerable length were exchanged between Poldhu and Glace Bay, and on the next day Marconi sent the following wireless telegram to King Edward at Buckingham Palace:—*"On occasion of first wireless telegraphic communication across Atlantic Ocean may I be permitted to present, by means of this wireless message transmitted from Canada to England, my respectful homage to His Majesty the King."* A month later congratulatory messages were exchanged between King Edward and President Roosevelt.

First Ocean Newspaper

Trans-Atlantic wireless telegraphy was now an accomplished fact, and communication by this means quickly became general. Early in 1903 "*The Times*" contracted with Marconi for regular transmission of news from Canada and the United States to London, and a year later the first ocean newspaper, the "*Cunard Daily Bulletin,*" was published on R.M.S. *Campania*, and contained news items received by wireless from Poldhu.

Many great improvements have been made in wireless apparatus and methods since that time, and these will be dealt with in future articles as space permits.

Talking to Australia

Marconi's Latest Achievement

On Sunday, 1st June last, Senator Marconi carried out tests in wireless telephony to Australia with striking success. A non-directional short wave system was used, and the speech transmitted was clearly heard by Mr. E. T. Fisk, managing director of the Amalgamated Wireless of Australasia, who listened on an ordinary valve set at his home near Sydney. The power used in this transmission, which was purely experimental, was only 20 k.w.

Senator Marconi afterwards stated that when the "beam" or directional system was employed with the same waves that were used in this non-directional test, telephony and high-speed telegraphy between England and Australia and many other distant parts of the world would be available.

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You can build larger and more ambitious models by purchasing an Accessory Outfit, for by doing so you greatly increase its scope. The particulars below show how you may build up your equipment by easy stages, until you are the proud owner of a No. 7 Outfit.

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Complete Outfits

No. 00	3/6
No. 0	5/-
No. 1	8/6
No. 2	15/-
No. 3	22/6
No. 4	40/-
No. 5 (In well-made carton)	55/-
No. 5 (In superior oak cabinet with lock & key)	85/-
No. 6 (In well-made carton)	105/-
No. 6 (In superior oak cabinet with lock & key)	140/-
No. 7 (In superior oak cabinet with lock & key)	370/-

PRICE LIST
Accessory Outfits

No. 00a	1/6
No. 0a	4/-
No. 1a	7/6
No. 2a	8/6
No. 3a	18/6
No. 4a	15/-
No. 5a (carton) ...	50/-
No. 5a (wood) ...	80/-
No. 6a	210/-

This illustration shows a No. 3a Outfit which converts a No. 3 into a No. 4 Outfit.

No. 00a OUTFIT

Costs 1/6, and converts No. 00 into a No. 0 Outfit. With it an additional 27 models may be built, making a total of 70 models in all.

No. 0a OUTFIT

Costs 4/-, and converts No. 0 into a No. 1 Outfit. With it an additional 36 models may be built, making a total of 106 models in all.

No. 1a OUTFIT

Costs 7/6, and converts No. 1 into a No. 2 Outfit. With it an additional 57 models may be built, making a total of 163 models in all.

No. 2a OUTFIT

Costs 8/6, and converts No. 2 into a No. 3 Outfit. With it an additional 43 models may be built, making a total of 206 models in all.

No. 3a OUTFIT

Costs 18/6, and converts No. 3 into a No. 4 Outfit. With it an additional 53 models may be built, making a total of 259 models in all.

No. 4a OUTFIT

Costs 15/-, and converts No. 4 into a No. 5 Outfit (carton). With it an additional 43 models may be built, making a total of 302 models in all.

No. 5a OUTFIT (Carton)

Costs 50/-, and converts No. 5 into a No. 6 Outfit (carton). With it an additional 51 models may be built, making a total of 353 models in all.

No. 5a OUTFIT (Wood)

Costs 80/-, and converts No. 5 into a No. 6 Outfit (wood). The parts are exactly the same as in the carton Outfit mentioned in the preceding panel, but the cabinet is in wood.

No. 6a OUTFIT

Costs 210/-, and converts No. 6 Outfit into a No. 7 Outfit (oak cabinet). This Outfit builds every one of the 393 models illustrated in the Complete Manual.

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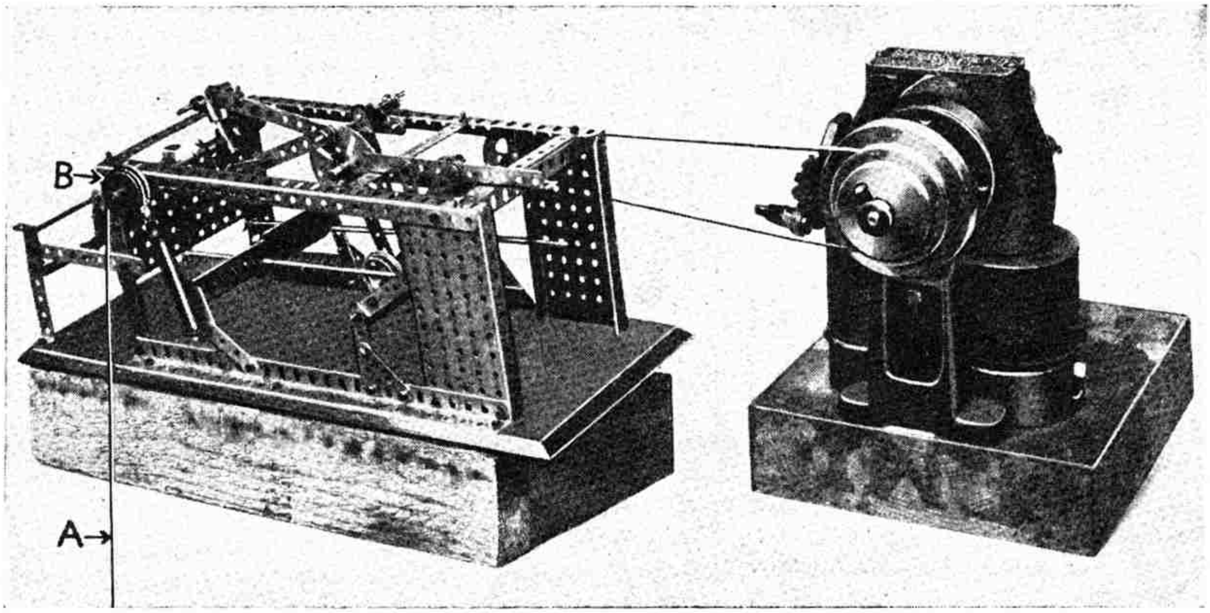
EXPERIMENTS WITH
THE TORQUE CONVERTER

A Special Article Contributed by A. V. Knowles



Mr. Knowles' Experimental Model of the Torque Converter, showing B, Pulley Wheel on Main Shaft; A. Piano-wire Carrying Weights

I HAVE written the following notes under the impression that readers of the "*M.M.*" will be interested in some experiments I have carried out with my Meccano model of the Constantinesco Torque Converter, details of which were described in the April issue.

I found it quite easy to assemble this model from the instructions given, although I subsequently made a few modifications to suit my own purposes. For instance, as I built my model for demonstration purposes only, I did not place it in a chassis. Instead I mounted it on a small stand with a wooden baseboard, and then coupled it to a small electric motor of about one-fifth horsepower.

A Difficulty Overcome

At first some difficulty was experienced on account of the top hole of the Face Plate—carrying the strips to the ratchets—constantly falling over, instead of keeping a mid-position stroke. This trouble was practically entirely eliminated, however, by lengthening the pendulum. This was done by attaching the pendulum weights to a strip from the Face Plate. A longer pendulum requires more power to move it than a short one, and consequently the ratchets gain speed more quickly. By increasing the length of the pendulum, however, we decrease the stroke of the ratchets, and this naturally decreases the back-axle speed. The length of the pendulum, therefore, effects the acceleration and maximum speed.

Increasing the pendulum weight (retaining the original length of pendulum) gives exactly the same effect as increasing the length of the pendulum. As the heavier pendulum requires more power to move it, it consequently produces better acceleration.

The Meccano Model demonstrating the principle of the Constantinesco Torque Converter has aroused widespread interest. Many enthusiasts have built the model, and we believe the accompanying account of experiments with it, sent to us by a keen Meccano user, will be of interest.—*Editor.*

Taking Readings

In my experiments I tried to get some "readings" by lifting various weights through certain distances. After many unsuccessful attempts, however, I abandoned this method, except for demonstration purposes. Instead I fitted up a small rope-brake to the end of the ratchet rod, and this idea worked splendidly. By running the model with different loads on the load pillar, I hoped to get some good results by taking the following readings:—Load on load pillar (= W); Spring balance reading (= w); Revolutions of ratchet rod (= N).

By applying the Rope-Brake Formula:—$\text{H.P.} = \frac{2\pi RN\,(W-w)}{33{,}000}$ (R = Radius in feet of Brake Wheel) I hoped to obtain results to compare with the input of the motor $(\text{H.P.} = \frac{V \times A}{746})$

Causes of Failure

With the assistance of a few friends I took a series of readings with loads on the pillar ranging from 2 lb. to 9 lb. When we came to work out our results for comparison we had a sad blow, however, for the model appeared to be giving us only about .5 per cent. efficiency! That is to say, although our motor was giving us about 1/5 h.p. we were getting only 1/1,000 h.p. at the load pillar!

Naturally we were rather disappointed at first, but when we came to think the matter over we realised that in dealing with such very small powers as those we were using, the slightest error in our readings would make a big difference. No doubt the intermittent action of the ratchets also caused a big error. We remembered, too, that the friction of the model would undoubtedly absorb a very much larger proportion of the power input than would be the case on a similar apparatus of larger dimensions and greater input.

An Interesting Demonstration

I have recently had the pleasure of demonstrating the Meccano model of the Torque Converter to the members of the Thornycroft Engineering Society. First of all I did a little "brake-testing," showing that the rod moved slower and slower as more load was placed on the brake.

I next wound some cord around the shaft carrying the eccentric and attached

(*Continued on page* 191)


STEAMSHIPS
THEIR HISTORY AND THEIR DEEDS
BY
G. GIBBARD JACKSON

FROM OUR READERS

This page is reserved for the publication of articles from our readers. Contributions are invited on any subject of general interest, and further particulars are given at the foot of the page. See also the Editor's remarks on page 173 of this issue.

A Meccano Boy Tells How Wembley was Built

THE year 1924 will always be remembered as the year of the great Empire Exhibition. All over the British Empire, and probably it would be no exaggeration to say all over the civilized world, people are talking of the marvels of Wembley.

The Exhibition is, of course, unique in many respects, and among the features that distinguish it from other previous exhibitions is the fact that it is not housed in temporary lath and plaster structures, but in permanent buildings of massive proportions. The amazing thing about these buildings is that they have all been erected in two years. How has this been done? The answer that at once suggests itself is—by means of an enormous army of workmen. This, however, does not account for the remarkable speed of building, and the secret lies in the use of reinforced concrete or ferro-concrete as it is called.

We Meccano boys are all familiar with the appearance of concrete, and possibly most of us know that it consists of sand and small stones bound together with cement. It is made by mixing the sand and stones thoroughly with cement and water until each stone is covered with wet cement and then, when the mixture dries, it sets into a solid rock-like mass.

Concrete as a building material has many advantages. It does not rust like iron or decay like wood and it needs no protection in the form of painting. It does not gradually deteriorate like so many other materials, but it appears actually to become stronger as it gets older. At the same time, however, concrete has one weak point. It is very strong in resisting a crushing stress, that is to say, a weight pressing directly down upon it, but it offers only feeble resistance to tension or a bending stress. On account of this weakness concrete alone is of little use for beams.

A beam supported at its ends and carrying a weight undergoes compression in its upper part and tension in its lower part. This fact may be demonstrated very simply. Take a wooden lath and cut grooves on both sides of it, as shown in the accompanying diagram. Then support the lath at its ends on two books or boxes, and place a weight on it at the centre. If the grooves are carefully examined it will be seen that those on the top close up while those underneath open out, thus showing that the top of the lath becomes shorter when it bends, and the bottom becomes longer.

As concrete strongly resists compression it would do very well for the upper part of a beam, but owing to its small resistence to tension it would be of very little use in the lower part. In order to overcome this difficulty the concrete is reinforced with steel, which supplies the tension-resisting power. The steel, in bars or in some other form, is embedded in the concrete while the latter is wet. When the concrete dries it grips the steel very tenaciously, and the resulting structure combines the qualities of the two materials.

Ferro-concrete, so called from the Latin word *ferrum*, meaning "iron," has revolutionised modern building practice, and its use is now so general that it has been proposed to call this the "Ferro-concrete Age."

"PENGLAM."

The Big New Zealand Tunnel

A Great Engineering Feat

Throughout the length of the South Island of New Zealand there runs a great range of mountains called the Southern Alps, which at their topmost limits reach a height of 12,349 ft. above sea level. On one side of these mighty mountains lies the smiling province of Canterbury, while on the other side is the timber country of Westland. These Alps have always been an obstacle to communication between the two provinces. Years ago the Maoris braved the dangers of the mountain passes in their search for greenstone, and later, when gold was found in Westland, white men from Canterbury risked their lives to reach the goldfields. About 60 years ago a road was built across the mountains by way of a rocky defile, known to-day as Arthur's Pass.

As time went on, the need of some easier and quicker means of communication between the two provinces became more acute, and it was decided that a railway must be built. In due course a line was begun, and little by little it crept from both sides up the mountain range. The higher it reached, the greater became the engineering difficulties. Many short tunnels were made and lofty steel viaducts constructed across foaming torrents. At last there remained only a comparatively short distance to be dealt with, but within that space was the most difficult part of the whole undertaking. Fifteen years ago miners commenced—first on the western side and shortly afterwards on the eastern—the enormous task of cutting their way through the solid rock. Drilling machines were used for boring holes, and then great masses of rock were blasted away with dynamite. In this way the miners gradually forced their way into the heart of the mountain.

During the War, work on the Otira tunnel, as it is called, was hindered by scarcity of men, and it was not until ten years after the tunnel was commenced that one day the miners working on the eastern side heard the sound of blasting on the western side. Next the drilling machines were heard through the wall of rock still remaining, and a few weeks later a workman on the eastern side suddenly saw the pick-axe of a workman on the other side coming through the rock. When the barrier was finally cut through, the men on one side shook hands with their fellow-workmen on the other side.

The accuracy of the engineers' plans and calculations for this tunnel was remarkable. In a distance of over five miles the difference in level of the two headings was only 1⅛ in., and the difference in direction only three-quarters of an inch.

Although the tunnel cuts off the top of the mountain, it runs up a fairly steep slope from the western to the eastern side. A steam engine puffing up this incline would fill the tunnel with smoke, causing discomfort to travellers on the train, and for this reason electric locomotives are employed.

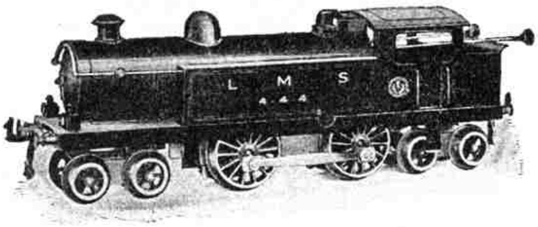
HAROLD GRIFFITHS (New Zealand).

To Contributors

Many of the letters that the Editor receives every day contain at least one point of general interest, which, if written out in the form of a short article, would appeal to readers of the "*M.M.*" We invite our readers to submit such articles for this page, and if of general interest they will be published as opportunity permits. The articles may deal with such subjects as new ideas for making something; new methods of doing things; accounts of some unusual occurrences or incidents, such as what it feels like to be in a sand-storm, or to win a cup on sports day, each of which experiences formed the subject of two recent letters.

Articles should not be longer than 500 words, and they should be written as neatly as possible and on one side of the paper only. Those articles that are published will be paid for at our usual rates. If desired, illustrations may be sent, either drawings, photographs, or rough sketches. No reader should hesitate to send in an article because he may not be very good at composition or cannot sketch any diagrams necessary to illustrate it. If he states the facts clearly and sends rough drawings we will have his article put into shape, if necessary, and finished drawings made by our artists ready for publication.

Hornby No. 2 Tank Loco



This magnificent Tank Loco is a splendid addition to any train system. A glance at the above illustration shows how beautifully this Loco is designed. It is thoroughly representative of the latest type of its class. Measuring 11½ in. in length, it embodies all the characteristics of the Hornby Trains. Suitable for 2 ft. radius rails only.

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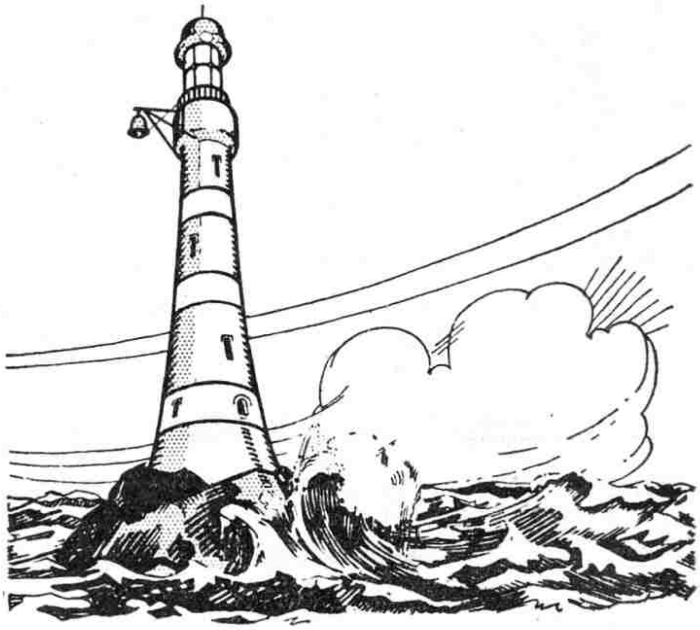

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Nothing in nature is so powerful and destructive as a raging sea. But the mountains of water dash vainly against the lighthouse because of the strength and solidity of its foundations.

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