MAY, 1924

MECCANO MAGAZINE

For Boys

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VOL. IX No 5

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MECCANO MAGAZINE

PUBLISHED
IN THE INTERESTS
OF BOYS

THIS issue of the "*M.M.* comes to you in the first of a new series of covers. The special character of these covers, which I think will appeal to all my readers, is unique, and I do not think there has been anything like them in any other magazine.

Our New Covers

Each month in future our cover will, as far as possible, illustrate one of our special articles. This month's cover, for instance, shows an electric crane handling a huge ingot of steel, cast from one of the giant furnaces in the background. The cover is intended to illustrate the serial article, "*The Story of Iron and Steel,*" that commences in this issue. If my readers could see some of the splendid covers that have been arranged for our future issues I am sure that their eyes would sparkle and there would be numerous exclamations of delight! The designs in hand include further wonderful photographs in connection with the steel industry, and also designs for bridges, giant cranes, and other similar structures in which "*M.M.*" readers are more particularly interested. It is my intention to make the "*M.M.*" the leading magazine for intelligent boys, and it is in keeping with this intention that the publication should have unique covers, which I feel sure everyone will admire.

I often wish that my readers could look over my shoulder as I go through my morning mail. Every day they would see hundreds of letters from enthusiastic readers in every corner of the earth, and written in all manner of queer languages! Some of my correspondents ask me questions on a variety of subjects, many of which are not connected with Meccano, nor even with engineering. Others criticise past issues and make suggestions for new articles for the future. Both these kinds of letters help me, for I welcome criticism and suggestions. As I think I have previously explained on this page, it is a very difficult matter to please 100,000 readers, and as far as possible the subjects dealt with in each issue follow the demands of the majority.

Helpful Suggestions

In editing a magazine it is very necessary to look well ahead, and no doubt it would surprise many of my readers to know that preparations for the issue of almost every magazine are made some months before the particular issue is due to appear. This is why magazine artists often are engaged in designing Xmas covers, with ice and snow scenes, in the sweltering days of August! Some day I hope to tell in the pages of the "*M.M.*" the story of how a magazine is printed and published, and my readers will then be better able to understand the difficulties that confront editors. It is because of these difficulties and this forward preparation that, although a large number of readers have asked for various new features, I am not able to introduce these new features for some little time. I have already been able to commence a cycling page in response to the insistent demands from my readers, and this page I hope to continue, at any rate during the summer months. To those impatient ones who keep writing to me on the subject, I would say that I am hoping to arrange for the inclusion of a regular page on railway topics before very long. Meantime, I am able to promise in the near future another Nature article by Master Moore-Hills, who has already contributed to our pages.

Preparing Beforehand

This month we conclude the article on the Life of George Stephenson, and next month we hope to say something about his son, Robert, who was no less famous an engineer than his illustrious father. It is true that Robert Stephenson had not to fight poverty and want, as was the case with his father, but nevertheless he was faced with many difficulties, and in our next issue we shall tell how he overcame some of them. Our next instalment of the article on Electricity will deal with the electric current, primary cells and accumulators—subjects of great interest to all Meccano boys. We shall follow this with articles dealing with magnets and magnetism, accompanied by details of some further interesting experiments.

Good Things in Store

Several fine new models have been perfected by the model-building staff of Meccano Ltd. during the past few months. In this issue we publish a description of the first of these—a Reaping Machine. This description will be followed by others as space permits. The models dealt with will include a very fine example of a Radial Crane; Weighing Dockside Crane (which weighs its load as it hoists, and automatically shows the weight on a scale); Horizontal Steam Engine. High and Low Pressure Steam Engine; a very efficient model of Platform Scales, which will actually weigh, and many other models of interest. Advanced model-builders will be pleased to hear that the model of the High-Speed Ship-Coaler has now been revised and that I am hoping to publish full instructions for building this splendid model in the near future.

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, 1921, are out of print. A few dozen copies remain of each number from January to December, 1922 (with the exception of November), and copies of each of the 1923 issues are also available. Copies will be sent post free, price 3d. each, but early application should be made, as the number available is very small.

Our £250 Championship Competition closed last month for entries in Great Britain, and closes for the Colonies on the 31st instant. As there are thousands of entries to be examined the judges will probably be kept busy for two or three months. We shall, of course, announce the results in the "*M.M.*" as early as possible, and every entrant will receive a copy of the Magazine in which the results are published. In the meantime I would remind all readers of the special model-building competition that has been arranged in connection with the series of articles on Steam Shovels and Draglines that appeared in our recent issues. Full particulars of this contest were announced on page 89 last month, and I hope that a large number of readers will endeavour to win the £5 cash prize offered by Messrs. Ruston & Hornsby Ltd. for the best Meccano model of their giant Dragline.

Our Competitions

I. FROM THE STONE AGE TO THE IRON AGE

ALTHOUGH all Meccano boys are familiar with steel—for they use it every time they build a model—how many of them realise the absolute dependence of the whole world upon steel? From the knife that we use at the breakfast table to the mighty guns of our battleships, steel plays its all-important part in the daily life of everyone. If the supply of steel came to an end, not only would the Meccano factories have to close down—terrible thought for a Meccano boy!—but so also would every other factory.

The great variety of purposes to which iron may be applied makes it of more value to the world than all the other metals together. Iron has been well called "The soul of every other manufacture."

The Importance of Iron

Steel is made from iron, and so iron is all-important to home life and industry. Just imagine for a moment what would happen if it became possible to cause all iron to disappear in an instant, by some fierce newly-discovered ray. Think what would happen in your own home. Iron bedsteads would vanish, the gas-oven, kitchen range, bars of the fire-grate, iron pans in the kitchen—all would disappear, together with a host of other things too numerous to mention. The great mains bringing gas and water to the house would melt away, and supplies would be cut off. Where could we sleep? How could we cook our food? Where should we obtain water?

If such an occurrence caused all this trouble in our home, we can imagine what terrible disaster it would bring to the world itself. Indeed it would mean that the whole of our civilisation would immediately collapse. Our industries would be brought to a standstill, and trade and transport would receive their death blow.

Stone Age to the Iron Age

The Story of Iron and Steel is a wonderful romance. In order to fully appreciate it we must go back to prehistoric times, to the earliest men of whom we have found any trace. The history of civilisation may be divided into three great epochs, according to the nature of the tools used in each. First there was the Stone Age, in which the use of metals was almost unknown, implements and weapons being made chiefly from bones, stone and flints. Then followed the Bronze Age, in which bronze, a metal composed of copper and tin, began to be employed and gradually came into general use. Bronze made possible a great advance, for it could be fashioned into a variety of weapons and tools, to which considerable hardness could be given. Finally came the discovery of the art of smelting and working iron, and so the Iron Age, in which we now live, came into existence.

The reason why iron was the last of the metals to come into general use is that, although one of the most widely diffused metals, iron is never found in a pure state except in meteorites. Considerable skill is required to recognise the ore, and then to separate the metal from the materials surrounding it. The art of smelting and working iron came from the East, and the metal is frequently referred to in the Bible. It is quite possible that iron was discovered by the accidental heating of a mass of ore in a fire.

Photograph] [*Messrs. Dorman, Long & Co. Ltd.*

Working at the Face in an Iron-ore Mine

Iron in Ancient Britain

We know very little about the early history of iron in Britain. It is fairly certain, however, that the metal was known to the natives at the time of the Roman invasion, but the stories of British chariots armed with swords or scythes must be regarded as entirely imaginary. Not only was iron too scarce to make such horrible weapons, but there were no roads suitable for chariots!

The Roman invaders quickly began to smelt iron on a fairly large scale, wherever they came across the ore. They had keen powers of observation, as is illustrated by the fact that ancient workings have been discovered in several districts, such as North Yorkshire and Northamptonshire, proving that the Romans were well acquainted with certain beds of iron ore of which we knew nothing until some 80 years ago.

The chief iron mines worked by the Romans were in the southern counties and on the borders of Wales; it is very interesting to learn that the Romans had forges in the Forest of Dean and in South Wales some 1800 years ago, and that from these forges they sent the metal to Bristol to be made into weapons.

The Smith Family

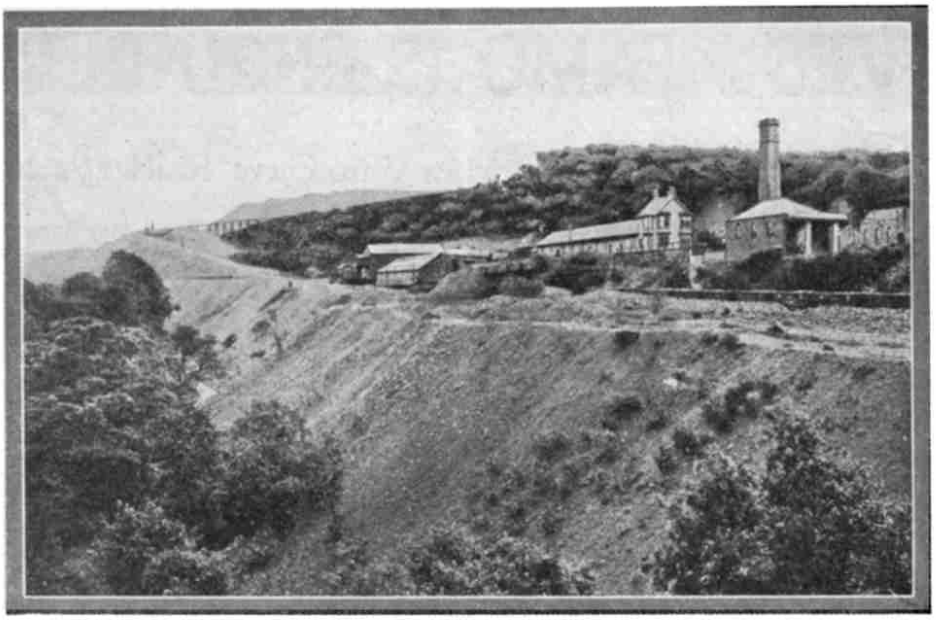
Have you ever wondered why there are so many people named Smith? At the time of which we have just been writing, and for a long period afterwards when nations were almost continually at war with one another, there was a large number of smiths. These men forged weapons and armour for the warriors and were held in the highest esteem, being, indeed, very important men in the days when the results of battle depended to a large extent on the quality of the weapons and the armour they forged. It is easy to understand that the name of Smith, or its equivalent in other languages, became common when surnames came into use. The families of to-day named Smith are descendants of these smiths of olden days.

Ironworks in Sussex

To trace the early history of iron in detail would require

more space than we can give in the "*M.M.*" Except for stating that the metal continued to be worked in an increasing number of districts, we will make a big jump forward to the 14th and 15th centuries.

During this period the supply of English iron was not only insufficient to meet the demand, but the home-produced metal was also more expensive and of poorer quality than foreign iron. The English market at this time was therefore mainly supplied with iron and steel from Spain and Germany. Later a revival in iron manufacture took place in Sussex, where there were large quantities of ironstone and also an abundance of wood for smelting the ore. This revival reached its height in Queen Elizabeth's reign, when supplies were so abundant that England began to export iron in the form of cannon. A startling result of this was that the Spanish ships were found to be fighting us with guns of our own manufacture! As a consequence, the export of iron ordnance was prohibited, although the smuggling of Sussex guns to Spain continued on a large scale for a long tine.



Photograph] **An Iron-ore Mine** [*Messrs. Dorman, Long & Co. Ltd.*

Smelting by Coal

Presently people awoke to the fact that the Sussex ironmasters were rapidly using up all the trees of the great forests, and it was feared that before long there would be no fuel left within reach of London, for at this time wood was used as fuel, coal being practically unknown. The result was that in 1581 an Act was passed prohibiting the conversion of wood into charcoal for the making of iron within 14 miles of the Thames. At a later period further restrictions on the use of timber were imposed, and the effect was to nearly kill the iron industry.

In 1620, Dud Dudley, son of Lord Dudley, of Dudley Castle in Worcestershire, took out a patent for the smelting of iron with coal. His method was successful, but the great iron smelters, jealous of his success, spread reports about the poor quality of his iron, and so persecuted him that finally he had to give up the struggle.

At last the increasing demand for iron, and the decreasing supply of timber for smelting, forced the ironmasters to turn to coal. Abraham Darby, of Coalbrookdale, in Shropshire, was the first to make a financial success of smelting by coal, and made a fortune by casting iron pots for use in cooking. It is interesting to note that the first iron bridge ever erected was made at the Coalbrookdale works by a grandson of the founder.

The success of Abraham Darby, and of others who followed his example, convinced even the most old-fashioned ironmasters that the days of smelting by timber were over, and the manufacture of iron improved steadily and rapidly, one technical improvement following another as the ironworkers gained experience.

Iron Ore Mining

Iron ore is found in very many parts of the world, including Great Britain, Norway, Sweden, Spain, Germany, Russia and the United States. In some places the ore lies close to the surface of the earth; in others it lies deep down, and the method of getting it varies accordingly.

Some of the most striking examples of iron mining on a huge scale are to be found in the Lake Superior region of the United States, where ore of excellent quality occurs in enormous quantities in six ranges. The most important of these six, the rich Missabe range, extends for 112 miles. Its importance lies in the fact that the ore is found close to the surface and is obtained by a sort of quarrying operation known as "open-pit" mining. This is a considerably less expensive method than the mining with shaft and tunnel which becomes necessary to obtain the deeper-lying ore of the other ranges.

In open-pit mining the layer of earth overlying the ore is stripped off. This is a tremendous task, involving the removal of millions of tons of earth, which must be dumped on the nearest land having no ore below it, but the operations are assisted by giant steam shovels, as described in recent issues of the "*M.M.*" When the ore deposit is reached, the steam shovels are used to cut their way into it, and as they are capable of digging out a mass of ore weighing sixteen tons at every cut, they are of great assistance to the miners. The shovels make one cut every minute, so that they each handle 960 tons of material every hour, which is dumped into waiting trucks, thus speeding-up the work very considerably.

During about eight months of the year the shovels work without ceasing, day and night, and the amount of material they cut is almost incredible. Perhaps the most remarkable example of their work is at Hull Rust mine on the Missabe range, where they have excavated a gigantic hole over 300 ft. in depth, three-quarters of a mile wide, and 2¼ miles long! In 1916 this mine produced over seven-and-a-half million tons of ore.

NEXT MONTH:—

BLAST FURNACES:
Cast and Wrought Iron.

Interesting Paragraphs

New Niagara River Bridge

A new bridge is soon to be constructed over the Niagara River, near the Falls, by the American Bridge Company, of Philadelphia. The structure, which is to take the place of the present cantilever bridge, will be of the steel arch type, having a span of 640 ft. and a double rail-track.

* * * *

Motor Railway Engines in America

The Chicago Great Western Railway is making a significant addition to its rolling stock. Fifteen trains will shortly be provided with motor engines in consequence of results obtained with four trains so equipped for suburban service, which have been making a mileage of 100 to 150 a day. The trains are to be used in the thickly-populated district of Iowa.

Tempering of Steel Drills

A South African mining engineer, Mr. Donovan, has invented a furnace that enables drills to be re-heated for hardening purposes at the rate of 150 to 200 per hour. The invention is based on the principle that steel or iron when it reaches a certain temperature becomes de-magnetised and is no longer subject to the pull of a magnet. When the steel reaches the required temperature it is automatically withdrawn from the furnace and rings a bell as it comes out to warn the attendant that it has been sufficiently heated.

* * * *

Dr. W. H. Hatfield, of Sheffield University, states that four types of stainless steel are now produced, and that stainless steel has been used to make enormous turbine blades. It may be drawn so finely that hypodermic needles are now largely made from it.

IV. GEORGE STEPHENSON, the Man Who Gave Railways to the World.

THE conquest of Chat Moss, described in our last issue, was only one of many difficulties that Stephenson encountered in laying the line from Liverpool to Manchester. Remembering his motto, "Persevere," he surmounted them all, and nothing could turn him from the path that he had mapped out for himself and his work.

A Great Achievement

In practice, if he could not surmount obstacles he tunnelled beneath them, as in the case of the ridge of sandstone that threatened to prevent the line from Manchester reaching Liverpool. Through the great mass of rock at Olive Mount, Stephenson drove a cutting. The excavation of Olive Mount Cutting—which, by the way, is only a few minutes' walk from the Meccano factory—would be considered a formidable task, even to-day. In Stephenson's time, without skilled workmen or modern labour-saving devices, the achievement was all the more remarkable, and the work is undoubtedly one of the most wonderful engineering feats in history. The cutting extends over two miles through solid red sandstone. Nearly 500,000 cubic yards of rock were removed, and in places the walls in the cutting rise to a height of over 100 ft. Anyone who stands on one of the bridges that cross the cutting cannot help but pay tribute to the imagination of the man who conceived this great work and admire the perseverance and skill by which he carried his plans to a successful issue.

Stephenson's Good Example

The conquest of Olive Mount was not the end of Stephenson's troubles, however, for between the cutting and Liverpool is another ridge of rock through which it was necessary to cut a tunnel one-and-a-half miles in length. The excavation of this tunnel proved to be a matter of great difficulty, but in blasting and hewing the rock Stephenson's colliery experience was of great service. On several occasions water penetrated into the workings, and when wet sand was encountered it became necessary to prop and under-pin the roof.

On more than one occasion the workmen gave up work, refusing to continue with so dangerous a task. Stephenson was always ready to share danger with his men, however, and taking off his coat and picking up a spade he made his way into the workings. His good example immediately reflected itself upon his men and they followed him into the tunnel to continue with their task.

Trains Without Locos

So far we have dealt only with the civil engineering aspect of the Liverpool to Manchester railway, but we must now say a few words about the mechanical side. In these times we naturally associate locomotives with railway lines, but in the early days such an association would have been somewhat premature. In the case of the Liverpool and Manchester Railway it was not at first contemplated that many passengers would be carried. The original idea was to convey raw materials and merchandise between the two towns, and therefore the question of how the trains would be moved was not of such importance as it would have been had the railway been catering for passenger traffic alone.

The directors of the railway held several board meetings to discuss the form of power to be used. Some suggested that the trains should be hauled by ropes, actuated by a number of stationary steam engines placed at regular distances along the line. Others were in favour of employing horses to draw the wagons, as had been done in the early railways at the collieries in the north of England. Celebrated engineers, when asked to report on the matter, admitted that they had no confidence in the future of the locomotive. Some, indeed, would not even take the trouble to examine the details of the locomotives installed with success on the Stockton and Darlington Railway by Stephenson.

In giving their opinion these engineers were probably actuated by jealousy, which no doubt arose from the fact that professional engineers did not favour the idea of a one-time engineman appearing before Parliament in the rôle of a leading engineer in support of the Railway Bill. As it was, the directors could get nothing but contradictory opinions from the experts, and these did not help them to come to a final decision.

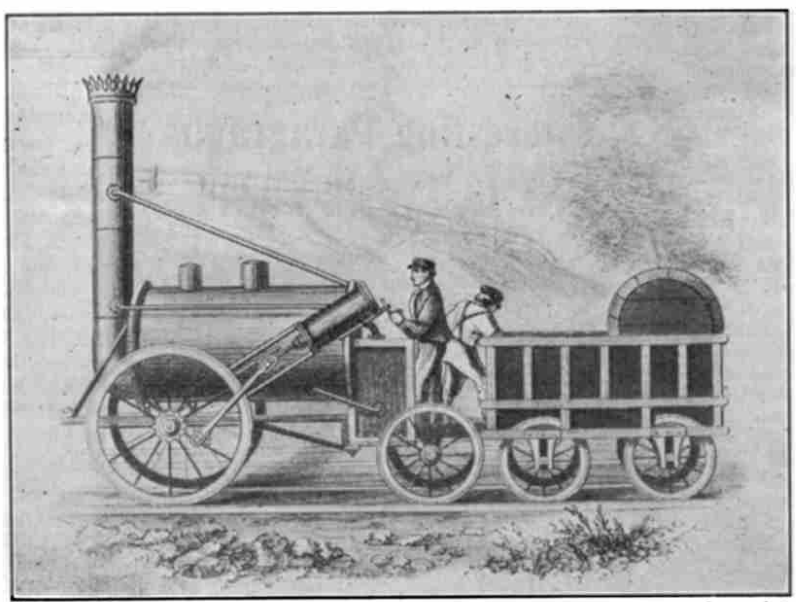
Stephenson Favours the Loco

Stephenson himself had not the slightest doubt on the question of the type of power that he considered would be the most satisfactory. He persevered in advocating that locomotives should be employed on the new railway. He had scarcely any supporters, and both the engineering profession and public opinion were dead against him. This did not deviate him from his purpose, however, and his persistent earnestness and his arguments at last had their effect.

The directors determined to stimulate enterprise by offering a reward of £500 for the locomotive that most satisfactorily performed certain tests, one of which included the maintainance of a speed of ten miles an hour.

The Famous "*Rocket*"

Stephenson's son, Robert, whose life we shall deal with at greater length in one of our future instalments, had recently returned from South America, and both father and son determined to build a locomotive for the competition. Together they produced the "*Rocket*," a name that became famous, for this engine was destined to make history. The "*Rocket*" included many improvements upon Stephenson's earlier engines, and when finished



From an old [*engraving*

Stephenson's Famous Locomotive "*The Rocket*"

underwent a trial on the lines at Stephenson's old work-place, the colliery at Killingworth, near Newcastle. The "*Rocket*" was equipped with a steam blast, and a cylindrical boiler six feet in length, with 25 copper tubes each three inches in diameter. These tubes were surrounded by the water of the boiler, the heated air passing through them on its way to the chimney. The fire-box, immediately behind the boiler, was surrounded by water, and the cylinders were placed obliquely on each side of the boiler with the piston rods connected directly to the cranks on the front wheels. The tender carried a water cask as well as a supply of fuel, and engine and tender and load of water weighed only 4¼ tons. The initial tests proved satisfactory, and the "*Rocket*" was taken to Carlisle and shipped to Liverpool, to await the great day.

The £500 Competition

The official trials were to be held at Rainhill, a village a few miles east of Liverpool, and as the date of the contest drew near there was great excitement. Engineers, scientists, and mechanics from all parts of the country arrived to witness the event on which such great results depended. The ground was thronged with thousands of spectators, all wildly excited, and horses and carriages were drawn up alongside the track.

The following engines were entered in the competition:—"*Novelty*" (constructed by Braithwaite and Ericsson); "*Sanspareil*" (Hackworth); "*Rocket*" (Stephenson); "*Perseverance*" (Burstall) and "*Cycloped*" (Brandreth). Several other engines had been constructed in different parts of the country, but they were not ready in time and consequently did not appear.

Unsuccessful Competitors

The trials remind one of the story of the "Ten Little Nigger Boys." By the conditions of the contest each engine was to make 20 journeys over two miles of railroad at a speed of ten miles an hour. One by one the competitors were accounted for and retired from the field, leaving Stephenson's "*Rocket*" the victor.

Even before the competition began, the "*Cycloped*" was disqualified, and we are able to imagine how the Stephensons must have smiled to themselves when it was found that instead of the loco being driven by a steam engine it depended for its motive power on a horse in a frame—a kind of "squirrel-wheel" or tread mill!

The four remaining engines made preparations to get up steam, and with their usual thoroughness, the Stephensons had their engine ready first. It was by no means a favourite, however, but as it was ready it was ordered out for an experimental trip, which it performed satisfactorily. On the following day the bellows that forced air through the furnace of the "*Novelty*" gave way, even before the judges arrived on the ground, and the "*Novelty*" retired. The "*Sanspareil*" was equally unlucky, for a defect developed in its boiler.

George Stephenson

From a painting by H. W. Pickersgill, R.A., in the National Gallery)

In the meantime the Stephensons again brought out the "*Rocket*," and with 30 passengers it travelled along the line at a speed of 30 miles an hour, to the amazement of the spectators. The "*Rocket*" was tried again on the third day, steam being raised from cold to a pressure of 50 lb. to the square inch in just under an hour. A weight of 13 tons was hauled backwards and forwards for a total distance of 35 miles in a period of one hour 48 minutes, including stoppages.

The Victorious "*Rocket*"

In the meantime the "*Novelty*" had been patched up and was again tried on October 10, but soon after commencing to run she burst a pipe from the forcing pump. The "*Sanspareil*" had also been repaired, but now she was found to be 4 cwt. over the weight limit. The judges allowed her to run, however, but before she had completed eight journeys her water pump went wrong and she came to a standstill.

While all this was taking place the engineers in charge of the "*Perseverance*" had been using strenuous efforts to get their engine into working order, but they had been unsuccessful in getting it to move at more than five miles an hour and so it was withdrawn from the competition. On the following day, when the result was to be announced, Braithwaite and Ericsson pleaded hard for another trial for the "*Novelty*," but on this being granted they had no better luck, for the engine broke down again.

There was now only the "*Rocket*" left in the competition, and as it had more than conformed to all the stipulated conditions the Stephensons were accordingly awarded the prize of £500 and, naturally, both father and son were delighted. The competition had a far wider importance than the triumph of the "*Rocket*" over its competitors; it established the efficiency of the locomotive for all future railways, and showed that a new power had arrived. The turning point of this vital matter was Stephenson's combination of the steam blast and the multi-tubular boiler.

We have not space in which to deal at length with the many other activites and achievements of George Stephenson, and must close our article on this great man with but a brief reference to his later years.

Stephenson was afterwards associated, along with his son, Robert, in the building of many other railways, for they were now recognised as the leading railway engineers in England. George Stephenson's life was an extremely busy one at this period, for in addition to his railway undertakings he took a leading part in coal-mining developments in the Chesterfield district. In order to be near these mines he removed to Tapton House, near Chesterfield, and this became his home for the remainder of his life.

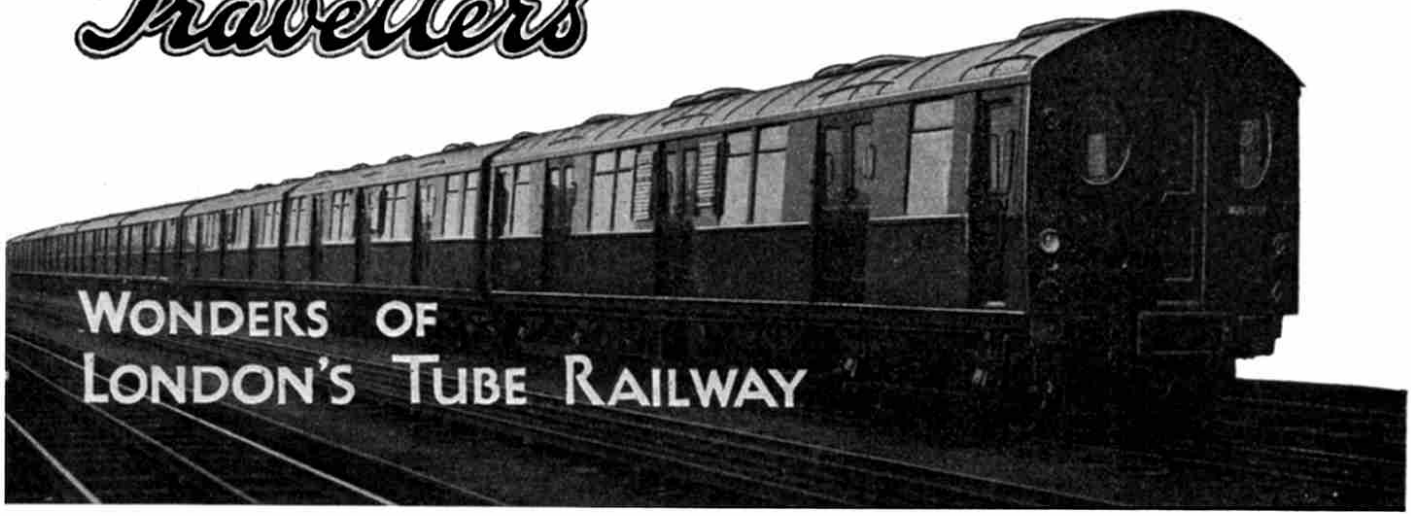
In 1840 he announced his intention of withdrawing from further professional work, as he felt the need of rest. From this time he lived quietly and peacefully at Tapton until his death in August 1848, at the age of 66. It is pleasing to find that in his later years this great man, one of the greatest engineers the world has known, found his chief pleasure in walking in the country lanes around his home. It was his delight to study Nature and more particularly birds and their nests, a habit that he had acquired during his youth when whiling away his time, keeping the cows off the colliery rail-road.

(THE END)

Photograph by courtesy of] [*Newcastle Chronicle*

Monument to George Stephenson at Newcastle-on-Tyne

Millions of Underground Travellers



WONDERS OF LONDON'S TUBE RAILWAY

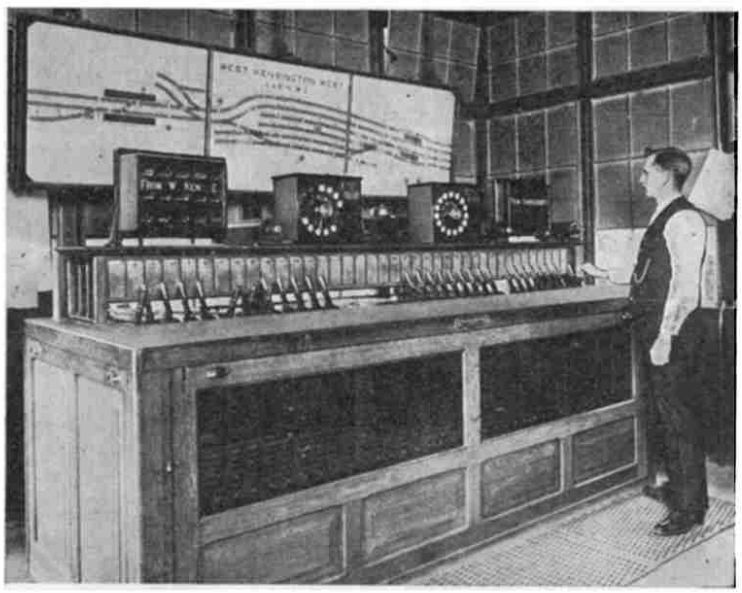
The working of the London Underground Railways differs in many respects from that of ordinary surface railways. In this connection perhaps the most noticeable feature is the great amount of work done by wonderful automatic devices. In our last issue we described the Passimeter—a machine that is almost human—and those wonderful time savers, the travelling staircases. In the concluding instalment below we describe some even more remarkable devices for saving time and labour.

FROM the roof of the Tube stations are suspended large signs, one of which was shown last month in the illustration of Charing Cross Tube Station. Normally each sign is blank, but shortly before a train is due the sign lights up from the inside and the destination of the train is shown in illuminated white letters. Some signs show the destination of the next three trains.

Time-Saving Indicators

As each train passes out of the station the illuminated names on the sign disappear, their place being taken by new names showing the destination of the next train. These electric indicators are operated from the signal cabins, and save a great deal of time and confusion. They need no explanation, as their meaning is plain even to strangers to London, and they make it unnecessary for passengers to worry the station officials, who have quite enough to do without answering innumerable questions.

Another type of electric indicator is shown at the foot of the next page. In this type the names of the various stations on the line are permanently on view and the trains' destinations are indicated by illuminated numbers, which appear and disappear on the board as the trains arrive and depart. In our illustration the indicator shows that the first train to arrive will be an Inner Circle train, the next train to Bow Road, and the next one to Barking. Immediately the Inner Circle train has come and gone, the figures will rearrange themselves. Figure 1 will appear opposite Bow Road, figure 2 opposite Barking, and figure 3 opposite the destination of the train following that to Barking.



The Signal Cabin at West Kensington, showing electro-pneumatically operated signals. Note how in this system the familiar cumbersome levers are replaced by the miniature levers here shown.

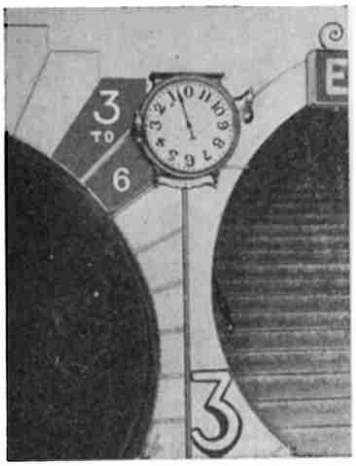
An Ingenious Clock

At the end of each Tube platform is a "Headway Clock," illustrated on the top left of the next page. This clock has only one hand, and this moves in the opposite direction to that of the hands of an ordinary clock. The hand shows in minutes and seconds the interval of time between the train in front and its successor. During the rush hours, when business people are all hurrying home after their day's work, there may be as many as forty trains on one line in an hour. At such periods it is very necessary that the trains shall keep exact time, so that they do not over-run their sections and approach each other too closely.

The headway clock indicates clearly to the driver of each train his position in regard to the train in front, and it also shows him at a glance whether or not he is behind or in advance of his scheduled time. This very ingenious device also makes a permanent record on paper of the progress of each train, and the time it departs from the station, so that the driver's time sheet may be examined and checked off later.

In Case of Accident

Another safety device is the special telephone, with which the driver of any train is able to communicate with the nearest



The Headway Clock

station without leaving his cab, in case of accident. He does this by connecting the instrument to a pair of wires that run along the tunnel walls. These wires also serve another purpose, for by connecting them together power is instantly cut off from the conductor rail, and the tunnels are illuminated by a special emergency lighting circuit.

Thus, should the train break down in a tunnel, the driver is able to illuminate the tunnel to enable the passengers to walk through to the nearest station, at the same time ensuring their safety from electrocution by cutting off the current in the third rail. He is also able to telephone to the nearest station to report the breakdown and state his exact position, so that assistance may be sent at once.

Automatic Signalling

With so many trains on the track we are easily able to understand that signalling on the Tube is of even greater importance than on an ordinary railway. In many instances, however, the duties of the signalmen are made lighter by automatic devices. In passing a signal, a train immediately sets it at danger, in which position it remains until the train has passed into the next-section-but-one of the line.

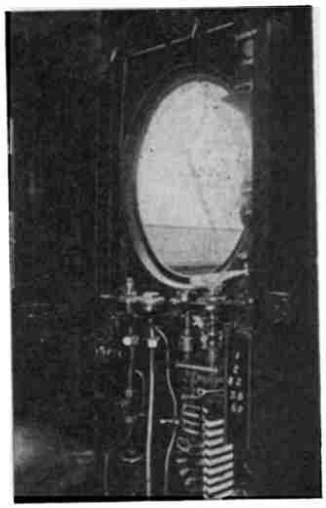
In addition to this automatic signalling, there are signal cabins to control junctions and certain sections of the line. The illustration at the foot of the previous page shows the cabin at West Kensington, and our readers will at once notice the absence of the long levers, generally associated with a signal box. Instead, miniature levers electrically operate the pneumatic signalling apparatus. At the same time the signalman has in front of him a map of the section under his control, and an ingenious arrangement illuminates that portion of the line on which a train is travelling. The signalman is thus able to see at a glance the exact position of any train in his section.

The signalmen are very carefully trained in the specialised duties they have to perform. They attend lectures and special film displays, and are required to pass through several examinations before being allowed to take charge of a signal cabin.

One Man Controls over 2,300 h.p.

The "make-up" of Tube trains differs according to requirements, but the usual train consists of about eight coaches. Instead of having the motive power at the front, as in ordinary railway practice, the power is distributed over the length of the train, in order to give smooth starting and rapid acceleration. The cars containing the electric motors devote only a comparatively small portion of their space to the motor.

The horse-power required to drive a train is considerable. For example, our heading shows a train in which there are twelve motors, each of 195 h.p., giving a total of 2,340 h.p. This enormous power is entirely under the control of the driver, and in order that the safety of the train may be ensured, control is effected through a device shown in the accompanying illustration. This is known as the "dead-man's handle," and consists of a knob at the top of the controller that regulates the supply of current to the motors. The knob must remain depressed during the whole time that the motors are running. If the pressure is relaxed, even for a second, the current is automatically cut off and the brakes are applied. Thus, should a driver be taken ill at his post, or have a sudden seizure, the train is prevented from running away, and disaster is averted.

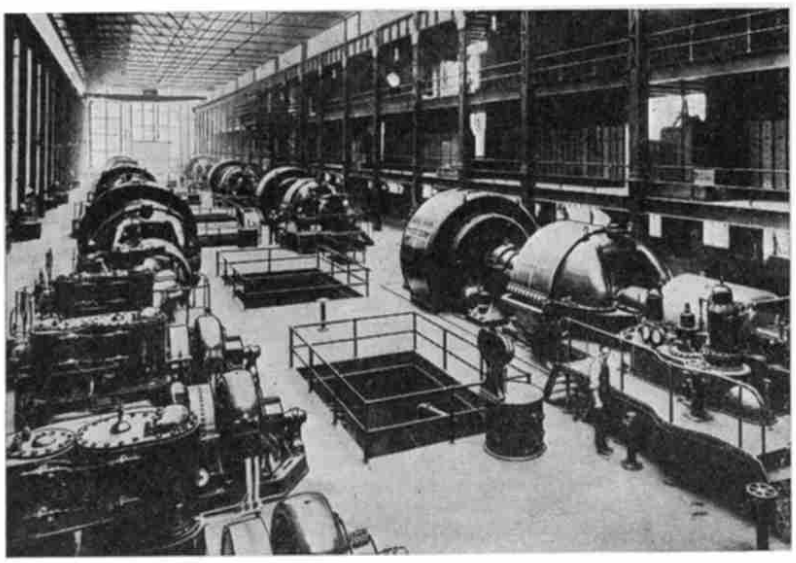


The "Dead Man's Handle"

For Absent-Minded Drivers

The "dead-man's handle" covers only one danger—that of the driver falling ill at his post. It does not eliminate absent-mindedness, which might cause an accident through a train being allowed to run past a signal set at danger. To guard against this eventuality there is a safety device called the "Trip-Cock," which automatically brings to a standstill a train that over-runs a signal. The trip-cock works in conjunction with the signal, and consists of an arm which, when the device is in action, strikes another arm on the train, instantly applying the brakes throughout the whole length of the train.

So efficient is this device that a train at full speed is brought to a standstill within its own length!



Turbo-Generators at Lots Road Power Station, Chelsea

The Power House

As is only to be expected, enormous power is required to operate London's underground railways. This power is derived from the huge generating station at Lots Road, Chelsea. This power house, one of the largest in the world, is very conspicuous on Thamesside by reason of its four great chimneys. Here, giant steam turbines, running at some 2,000 revolutions a minute and developing over 100,000 h.p., drive the dynamos that generate electric current at a pressure of 11,000 volts. A noticeable feature about turbo-generators, as these turbine-driven dynamos are called, is their smooth and silent running. So smoothly do they run indeed, that anyone watching these softly purring monsters finds it difficult to realise that they are generating power to move millions of underground travellers.

Over 700 tons of coal are required each day to feed the furnaces of the 68 boilers generating steam for the turbines. This coal comes up the Thames in barges, which are unloaded by electrically-operated gantry cranes. The coal is stored in enormous bunkers, one of which is capable of holding 8,000 tons.

Electric Platform Indicator

The Tragedy of a Snowball

To look at this gigantic power house, whether from the outside or the inside, one would think that nothing short of an earthquake could upset its operations. Yet it was once completely thrown out of its stride by a very trivial incident. One Christmas time a small boy threw a snowball through a window

(Continued on page 134)

BUILD YOUR OUTFIT INTO A No. 7

WITH

MECCANO
ACCESSORY OUTFITS

For convenience, Meccano parts are sold in nine Outfits of varying size, numbered 00 to 7. The quality and finish of the parts are of the same high standard throughout the series, but as the Outfits increase in size they contain larger quantities and greater varieties of parts. Each Outfit may be converted into the one next higher by the purchase of an Accessory Outfit. Thus, if a No. 2 is the first Outfit bought, it may be converted into a No. 3 by adding to it a No. 2a. A No. 3a would then convert it into a No. 4, and so on up to No. 7. In this way, no matter with what Outfit you commence, you may build up by degrees to a No. 7 and so be able to make *all* the many hundreds of models shown in the Books of Instructions.

PRICE LIST

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/-

No. 7 Outfit. Builds all the models in the Complete Manual, and many others. Packed in beautifully-finished oak cabinet with lock and key.

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/-

MAKE YOUR OUTFIT BIGGER AND BETTER

No. 6 Outfit. Builds 360 models. No. 6a, costing 210/-, converts this Outfit into a No. 7 Outfit, with which all the models in the Complete Manual may be built.

PURCHASE AN ACCESSORY OUTFIT

Meccano Ltd.

BINNS ROAD

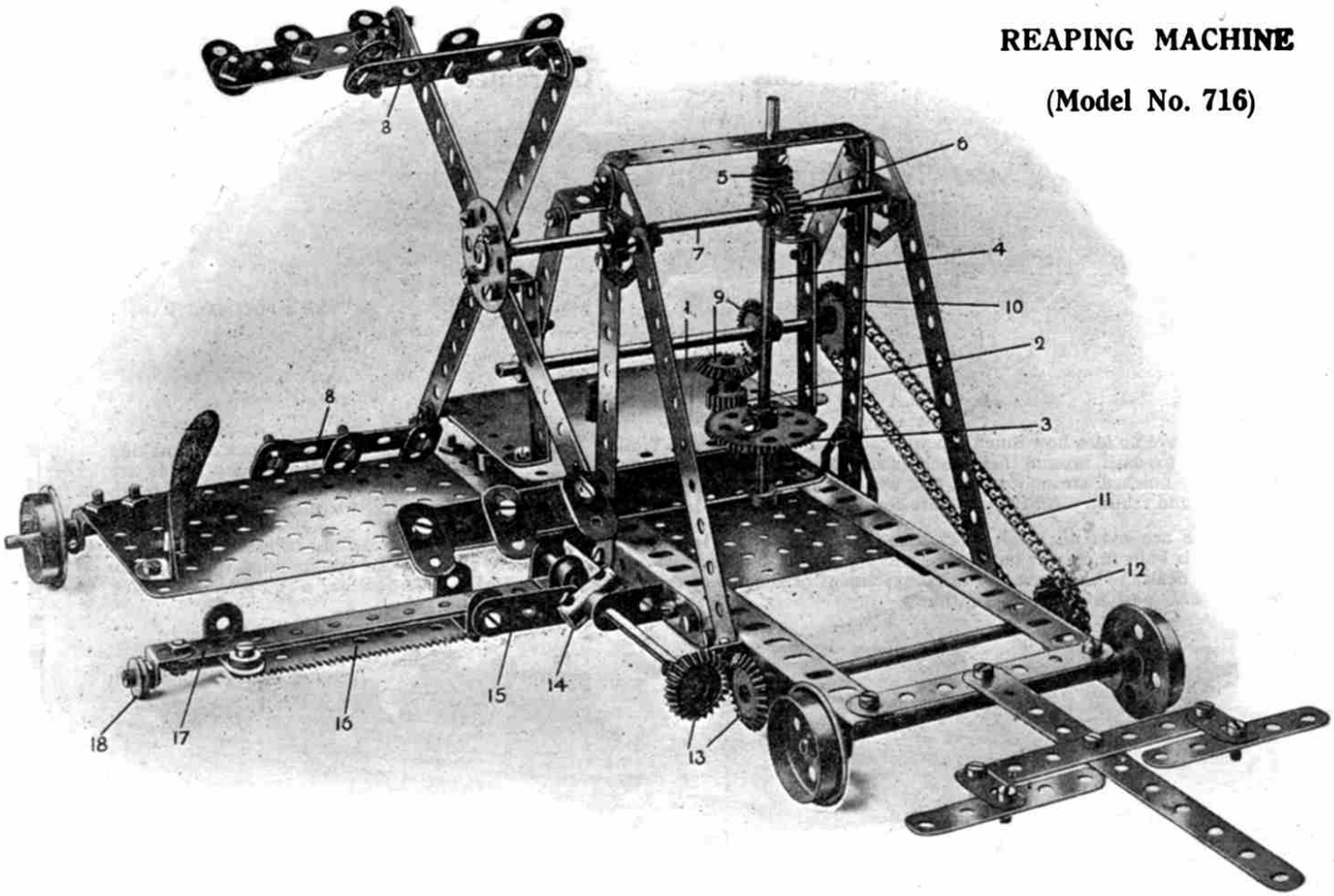
LIVERPOOL

Accessory Outfits are obtainable from all Meccano Dealers.

A NEW MECCANO MODEL

REAPING MACHINE

(Model No. 716)



This new Meccano model of a Mowing and Reaping Machine is specially interesting, not only as a model but also as a reminder of the progress made in methods of reaping since the days of the sickle and the scythe. Great advances have been made in recent years, and it is a far cry from Bell's first reaper to the giant steam-harvesters of to-day.

FROM very early times up to the 19th century the sickle provided the only means of reaping corn. The reaper grasped a number of stalks with one hand, and cut through them close to the ground with a sweep of his sickle. From a modern point of view this process was ridiculously slow. Considerable improvement was effected when the scythe supplanted the sickle, for this implement enabled a man to mow at least ten times as much grain in a day as was possible with the sickle. To-day, however, neither sickle nor scythe take any part in reaping operations, except on a very small scale. Their place has been taken by wonderful machines that have made possible the cultivation and reaping of the great grain fields of the world.

First Reaping Machines

The first reaping machine was invented about 1831 by a Scotsman, the Rev. Patrick Bell, of Carmylie, Forfarshire, and his original machine is now in the South Kensington Museum. Bell's reaper was quickly followed by two others, the inventions respectively of Obed Hussey and Cyrus W. McCormick, both Americans.

The cutting arrangements in these American machines worked on the principle of a reciprocating sickle, and consisted of a set of saw blades oscillating backward and forward through slots in toothed pieces of metal fixed at intervals along a horizontal bar. The action is practically the same as that of a pair of scissors having one blade fixed and the other free to move.

In order to prevent the corn from falling in front of the blades after it was cut, McCormick patented (in 1834) a device known as a "reel." The reel is still in use, and on modern machines consists of a round frame with horizontal slats so distributed that, as the reel rotates, they bend over the corn in front of the sickle at the instant of cutting, thus causing the cut stalks to fall behind the blades.

One of the great difficulties that faced the early inventors was the removal of the cut stalks from the track of the sickle, for if they remained where they fell they would be trodden upon by the horses when the next swath was cut. In Bell's machine this difficulty was overcome by a kind of canvas apron travelling constantly over rollers, which deposited the cut stalks in safety on one side of the machine. This travelling apron is still in use on modern machines.

Machine Binds Its Own Bundles

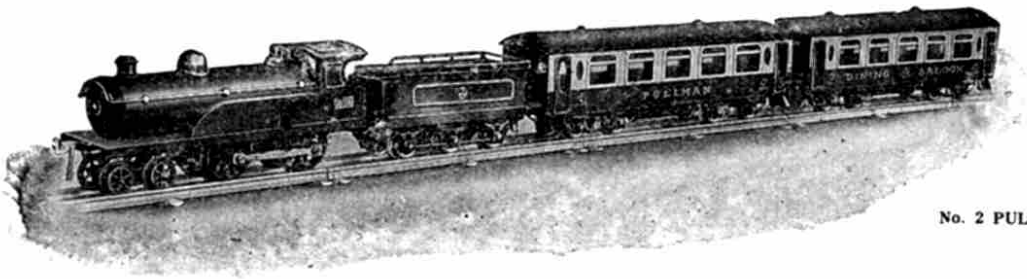
Reaping machines were later improved by the addition of a platform upon which men could stand and bind the cut corn into bundles as they received it from the travelling apron, instead of having to walk behind the reaper to do the binding. This improvement saved a great deal of time, but it was superseded about 1873 by a machine that did its own binding. At first wire was used for tying bundles, but it was quickly found that it was not

(Continued on page 123

FOR YOUR NEXT BIRTHDAY PRESENT CHOOSE

HORNBY CLOCK WORK TRAINS

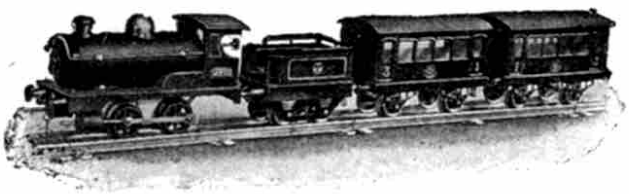
The Trains with the Guarantee



No. 2 PULLMAN TRAIN

You have no idea how much fun you can have with a Hornby Train. Shunting, coupling-up the rolling stock and making up trains to dash around their track as realistically as the real thing, will give you hours of pleasure. Hornby Trains are beautifully finished, strongly made, and will last for ever. One of their most remarkable features is that they may be taken to pieces and rebuilt. All the parts are standardised and any lost or damaged part may be replaced with a new one.

There are over 40 train accessories—stations, signals, lamps, a variety of wagons, level-crossings, turntables, etc., each of which is built in correct proportion and beautifully finished. New accessories are added to the system from time to time. Ask your dealer to show you the latest specimens or send to Meccano Ltd., Binns Road, Liverpool, for a full price list which will be sent (post free) on application.



No. 1 PASSENGER TRAIN

No. 1 GOODS TRAIN

HORNBY TRAIN PRICES

No. 1

Goods Set	25/6	Wagons ... each	3/9
Passenger Set	35/-	Tenders ... ,,	3/6
Locos ... each	16/-	Passenger Coaches ,,	6/6

No. 2

Goods Set	45/-	Wagons ... each	3/9
No. 2 Pullman Set	70/-	Tenders ... ,,	4/-
Locos ... each	30/-	Pullman Cars ,,	16/-

HORNBY TANK LOCOS

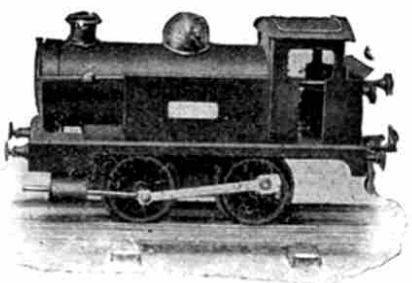
No. 2

The Hornby No. 2 Tank Loco is a powerful model embodying all the characteristics of the Hornby Train. It is 11¼" in length and is fitted at both ends with a special bogey. Beautifully finished in colours; lettered L.M.S. and L.N.E.R., with reversing gear, brake and governor. Suitable for 2 ft. radius rails only.

Price 32/6

Guarantee

Hornby and Zulu Trains are tested, and their efficiency is guaranteed. A form of guarantee is furnished with each loco, and we undertake to repair, or replace at our option any loco that fails to run satisfactorily from any cause other than misuse, within 60 days of purchase.



No. 1

The Hornby Tank Loco No. 1 is a strong and durable loco capable of any amount of hard work; richly enamelled and highly finished; fitted with reversing gear, brake and governor.

Gauge 0, in black only 12/6

FROM ALL MECCANO DEALERS

New Meccano Models (*cont. from page* 121)

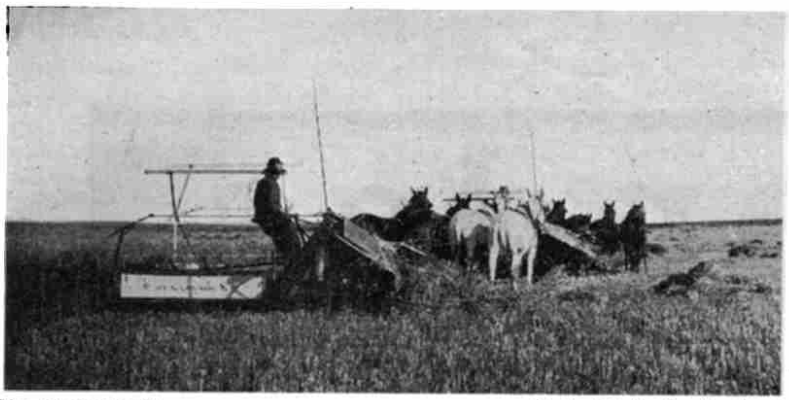


Photo by courtesy of [*Supt. of Emigration for Canada*

A Reaper at Work in Canada

satisfactory. Small pieces of wire became mixed with the threshed grain, and even with the flour, giving rise to serious possibilities. Hemp twine was then substituted for wire, with excellent results.

A modern self-binder cuts the corn, picks up a bundle of it, passes a cord around it and ties the cord with a knot, finally depositing the finished bundle either on the ground or on a platform on the machine. All this is done automatically, and the mechanism requires no attention.

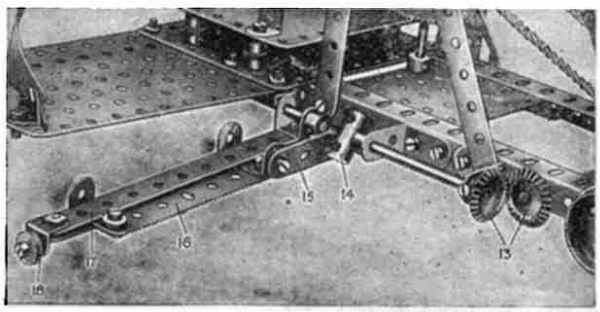
Wonderful Steam Harvesters

After being cut, the corn has to be passed through a process called threshing, by which the grain is separated from chaff and straw. Formerly threshing consisted of beating the ears with an implement called a flail, and this method is often mentioned in the Bible. Threshing in this manner was very slow, however, and was quite useless for harvesting on a big scale, and so threshing machines came to be invented. The first really practical machine was that of a Scottish machinist, Andrew Meikle, produced about 1813, and soon improvements were added until the wonderful machines of to-day were evolved. The early threshing machines were worked by teams of horses, but later steam power was utilised with greatly improved results.

It was found that the vast harvesting operations of Canada and the United States could be still further speeded up by combining the processes of reaping and threshing. This is done by means of a "steam-harvester." A traction engine takes the place of horses, the grain is cut but not bound into bundles, and a travelling apron carries it to the threshing mechanism. The whole process is thus automatic and continuous.

The Meccano Reaper

The illustration on the previous page shows a Meccano model (No. 716) of a Reaping Machine, which may be constructed with the assistance of the following details. The spindle of the Meccano clockwork motor (1) carries a pinion (2) engaging a gear wheel (3) on the rod (4) at the top of this rod (4) is a worm (5) driving a ½" pinion (6) on a rod (7) which carried the arms (8) that sweep towards the knife.



Details of Meccano Reaper

The driving spindle of the motor also drives through bevel pinions (9) a 1" sprocket wheel (10) coupled by a chain (11) to another 1" sprocket wheel (12) which in turn drives through bevel wheels (13) a coupling (14). This coupling acts as a crank and is connected by 1" strip lock-nutted (15) to the cutter (16). The cutter is formed by a rack strip guided to and fro by two 1" × ½" angle brackets between two 5½" strips (17) spaced apart by washers at each end. The outer end of these strips is fitted with a ½" pulley (18) on which the cutter knife travels. The remainder of the detail of the model will be made quite clear from our illustration. When completed the model works in a very realistic manner.

This model may be made with a No. 7 Outfit, but those who have a No. 4 or No. 5 Outfit will be able to build it with the addition of certain extra parts. The following is a full list of parts required.

Parts required for construction of Meccano Reaper (Model 716) :

7 of No. 2	2 of No. 12a	4 of No. 20	8 of No. 37a
6 „ „ 3	4 „ „ 12b	1 „ „ 23	6 „ „ 38
8 „ „ 5	1 „ „ 13	1 „ „ 24	1 „ „ 41
1 „ „ 6a	2 „ „ 14	2 „ „ 26	1 „ „ 48
2 „ „ 8a	2 „ „ 15	1 „ „ 27a	2 „ „ 48a
14 „ „ 10	1 „ „ 15a	4 „ „ 30	1 „ „ 48b
1 „ „ 11	2 „ „ 16b	1 „ „ 32	1 „ „ 52a
7 „ „ 12	1 „ „ 17	58 „ „ 37	1 „ „ 83

7 of No. 59
1 „ „ 63
16" „ „ 94
1 „ „ 110
7 „ „ 111b
1 „ „ 125
3 „ „ 126a

OUR MAIL BAG

H. Vial (Kidderminster).—Thanks for photo of yourself surrounded by your Hornby Train system and Meccano models. They look fine!

J. Candler (Tulse Hill, S.W.).—You are probably right when you say that most boys have no idea how a gas-meter works. We will try to find room for an article on this subject, sometime. There are lots of Meccano girls, John, who derive great pleasure from building Meccano models, but, of course, girls as a rule do not take as much interest in things mechanical as boys. We are always very glad to see Meccano boys when they come to Liverpool, so hurry up and come along!

Manual Tubis (Philadelphia).—Yes, the Philadelphia-Camden bridge will be the largest suspension bridge in the world, but not for long. New York proposes to build one a great deal larger; it will cross the Hudson River and the centre span will be 3,240 feet long.

A. Scott (Cunnamulla, Aus.).—Your suggestion for a Meccano calendar is a good one, and we will see if it cannot be adopted. We will try to find a correspondent for you in India.

G. Tippings (Golborne).—We are sorry you have had such poor luck so far in forming a Meccano Club. Better leave it over now until next autumn, and then try again. Your stamp queries are being replied to by separate post.

S. F. Hazelton (Chelmsford).—We will consider your suggestion for a general "Queries" column. We fear there would go up a strong protest from the majority of our readers if we were to discontinue our Stamp Column even for a few issues. We can only add new features by enlarging the "*M.M.*" Let us give you a piece of information quite privately, just between ourselves:—We shall shortly add a new feature dealing with a new hobby for boys. This will be a hobby almost as attractive as Meccano itself. Now you may have three guesses!

F. Spear (Lauriston).—We have no room for serial stories just at present. In fact, we find that most of our readers prefer interesting and informative engineering and other articles, such as we are now printing.

E. P. Peterson (Chicago, Ill.).—Indeed you are not too old to derive pleasure from Meccano. We know of a number of men who get a great deal of enjoyment from Meccano model-building. "Anywhere from 5 to 70 years is the Meccano age," you know.

J. Alston (Camberwell).—We get lots of riddles sent to us by readers and these will find their way into our "Puzzle" column, but your's is hardly suitable, we fear. "John and James were brothers. John said to James, 'Your father is not my father and your mother is not my mother.' What is John?" After much thought we can only come to the sorrowful conclusion that he is what David said in his heart all men were! Perhaps some of our readers can provide an answer which shows John in a better light.

J. C. Rishworth (Tiptur, India).—We read your last letter with great interest. If at any time you are able to send us photos of the country and the work you describe so well, we will endeavour to publish them.

Rex Andrews (Wichita, Kansas).—We are very sorry to learn that a terrible Kansas storm tore down your aerial. Unless we are badly mistaken, no storm is strong enough to blow away your enthusiasm for Meccano.

J. E. Govan (Birkdale).—You need have no uneasiness about our publishing further serial stories for some time. We have no room for them. By all means send along the article that you have written for us. We wish more boys would try their hands at writing suitable articles for our columns for we like to encourage those who have any literary ability.

S. A. Saunders (Smethwick).—

"There was an old man of Nantucket
Who kept all his "dibs" in a bucket,
His daughter named Nan
Ran away with a man,
And as for the bucket—Nantucket."

Terrible, Sydney!

Buera Hamman (Colorado Springs, U.S.A.).—We regret that you are ill and hope you will soon be restored to perfect health. It is very nice to learn that Meccano has helped you to spend the long wearisome hours more pleasurably.

L. Fletcher (Glasgow).—We are pleased to know that you take such a great interest in railways, and that you know so much about them. We are rather surprised to learn from you that the average life of a locomotive is only thirty years. We suggest that perhaps it would live longer if it didn't smoke so much!

Brandes

THE NAME TO KNOW IN RADIO

Result of 15 years' experience

Jack chafes at an evening with his school text-books but he is always willing to further his education in a more pleasurable way—by Wireless. He gets the facts distinctly and accurately with Brandes "Matched Tone" Headphones—and is a fearsome authority on sporting records to the obvious discomfiture of his schoolfellows.

PRICE 25/-

BRITISH MANUFACTURE

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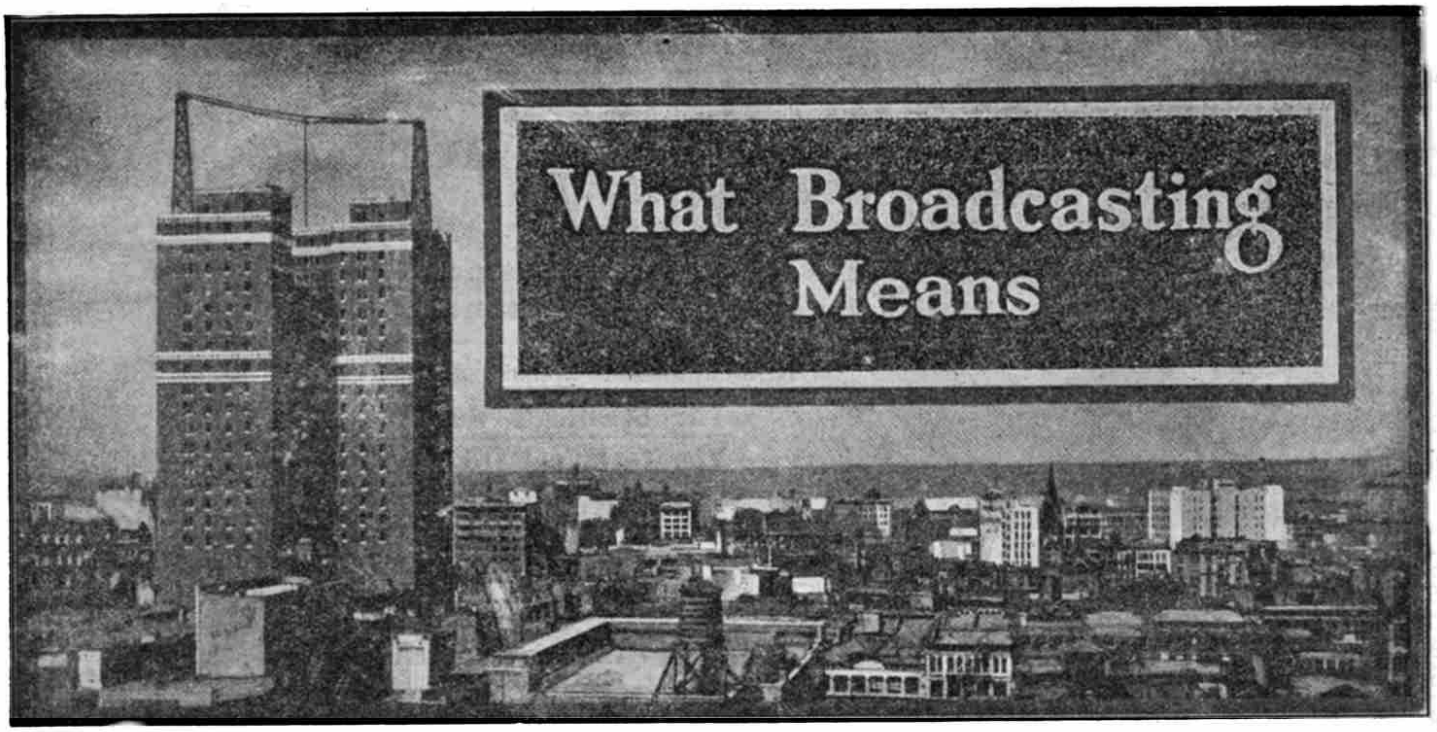
Matched Tone
TRADE MARK
Radio Headphones



II. COVERING BRITAIN WITH BROADCAST

THE wonderful possibilities of wireless telephony had been thoroughly demonstrated by the end of 1919, and had aroused widespread interest. Early in 1920 the Marconi Company carried out a number of important tests at Chelmsford, and these were remarkably successful. Madame Melba took part in one of them, and her singing was heard, not only in various parts of Europe, but as far away as Persia.

In July of the same year an even more striking success was achieved. The steamer Victorian, which conveyed a number of the delegates to the Imperial Press Congress in Canada, had a wireless set installed. During the whole voyage across the Atlantic, with the exception of a few hours, the vessel was in constant communication with either Chelmsford on one side or St. John's, Newfoundland, on the other. From time to time during the trip gramophone records were transmitted by the Victorian, and were heard by ships several hundred miles away. The excitement of the wireless operators of the various ships, who suddenly heard songs or instrumental solos when they were expecting nothing but Morse dots and dashes, is better imagined than described.

American Broadcasting Muddle

By this time a serious epidemic of "wireless fever" had broken out in the United States, and before the end of 1920 broadcasting was in full swing there. The country simply rushed headlong into a wireless boom, without any kind of Government control, with the result that transmitting stations sprang up by the score, all broadcasting on closely similar wavelengths. Very serious confusion followed, and when the demand arose for broadcasting in this country, the Postmaster-General refused to grant any concessions until a sound scheme, designed to prevent any repetition of the American muddle, had been agreed upon.

The Chelmsford transmissions in 1920 were followed by the famous Writtle concerts on Tuesday evenings, which began early in 1921 and continued up to the beginning of 1923. In May, 1922, the Marconi Company opened the London Station, 2LO, and gave a number of concerts. The success of these various transmissions had by this time convinced everybody that broadcasting had come to stay.

The British Broadcasting Company

After prolonged negotiations between the Postmaster-General and the principal electrical firms, a sound scheme of broadcasting was decided upon, and on November 14, 1922, the British Broadcasting Company came into existence, with Lord Gainford as chairman. The company undertook to provide eight broadcasting stations, to cover England, Scotland and Wales, and three of these stations, London, Manchester and Birmingham, were put into operation immediately. About a month later the Newcastle station was opened, and last year the remaining four stations commenced as follows:—Cardiff, February 13; Glasgow, March 6; Aberdeen, October 9; and Bournemouth, October 17.

Broadcasting Programmes

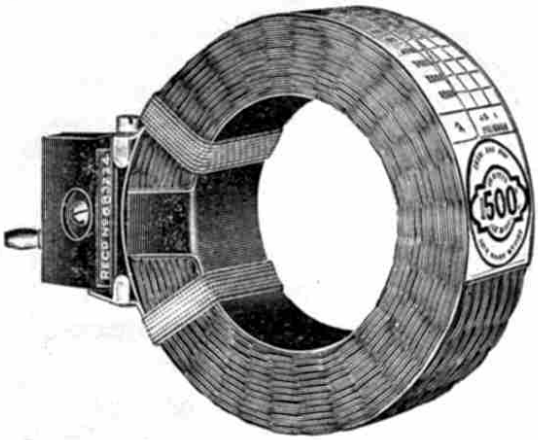
From the outset it was evident that, apart from engineering problems, the Broadcasting Company's greatest difficulty would be to cater for the widely differing tastes of its listeners. The task was tackled resolutely, however, and as the result of experiment and criticism the broadcasting programmes have improved steadily month by month. Music occupies the greater part of the programmes, and the musical policy is directed by Mr. Percy Pitt, of British National Opera Company fame. Every kind of music is included, from classical to jazz. Another important feature is that of "talks," which include the women's hour, stories for children, and short lectures on various topics of general interest. Then there are the news bulletins, in which important items are clearly stated in the fewest possible words. The weather forecasts, supplied by the Air Ministry, are another regular feature of every programme.

(Continued on page 127)

CALL LETTERS AND WAVE-LENGTHS

The following table gives the call letters and wave-lengths of all the British Broadcasting Stations, and the wave-lengths of the only relay stations open at the time of writing.

Station	Call Letters	W.L. in Metres
Aberdeen	2BD	495
Birmingham	5IT	475
Bournemouth	6BM	385
Cardiff	5WA	353
Glasgow	5SC	420
London	2LO	365
Manchester	2ZY	375
Newcastle	5NO	400
Sheffield	2FL	303
Plymouth	5PY	330



IGRANIC
PLUG TYPE HONEYCOMB COIL
(De Forest Pat. No. 141344).
Obtainable from all Dealers. Write for Lists Z.177.

It is not by accident

that

IGRANIC HONEYCOMB DUOLATERAL COILS

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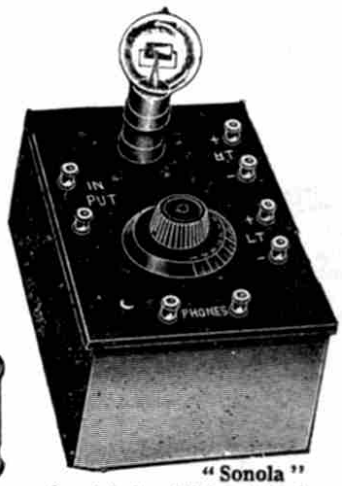

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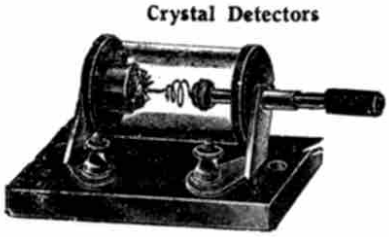

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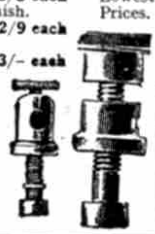

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What Broadcasting Means *(cont. from p.125)*

At each broadcasting station there is a station director who has the difficult task of planning out programmes and arranging for the necessary singers, players, etc. The difficulty of this work is enormously increased by the fact that the arrangements have to be made six weeks ahead, and are always liable to be upset by the occurrence of some special event.

The announcer, of whom we wrote in our previous article, has to act as a sort of stage manager, in addition to actually announcing the items and reading the news bulletins. He is responsible for carrying through the programme to a successful conclusion, and for dealing with the many little emergencies which arise from time to time. Then there are the engineers, of whom we hear little, but without whose skill and vigilance the station would quickly be in trouble. The transmitting set, with its glowing valves, has to be watched continually for slight defects, which may occur at any moment and must be rectified immediately. Even more attention is needed in manipulating the microphone amplifier, reducing too loud sounds, amplifying weak sounds, and generally controlling the volume of sound going to the power valves.

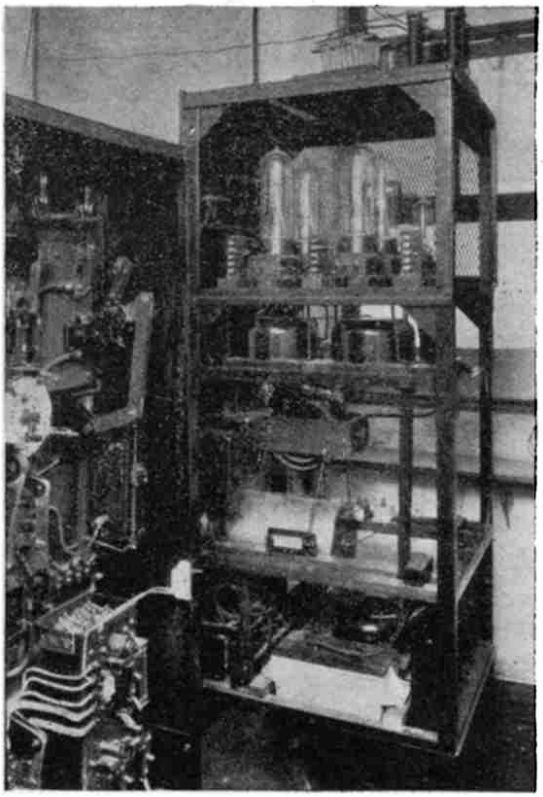
Simultaneous Broadcasting

In addition to the programmes arranged and transmitted by each broadcasting station, there is also an exchange of special items between the stations by means of simultaneous broadcasting. The London station does most of this, on account of its greater facilities for obtaining items of outstanding interest. Trunk telephone lines, specially tested for freedom from noise in transmission, connect the London station with each of the provincial stations.

If it is wished to transmit simultaneously to the whole country a London concert, the music is passed through the London station microphone and amplifier, and is then distributed to these trunk lines. Each line has a power amplifier of its own, to give a final strengthening of volume, and so the music reaches each station, to be broadcast in the ordinary way. On the other hand, a provincial station may have a particularly good item which it is desired that all stations should hear. In this case the item is strongly amplified at the provincial station, sent to the London station by trunk line, and distributed as we have just described.

Simultaneous broadcasting made possible the successful reception of American broadcast by users of crystal sets in many parts of Britain. It was received at the London station and simultaneously broadcast from there to all British stations.

It is of interest to know that land lines for simultaneous broadcasting from the London station to all other stations are available every day from 6 p.m. to 6 a.m. During these hours the lines are entirely under the control of the British Broadcasting Company, who are therefore able to eliminate interference. There are different lines for speech, music, and control.



Photograph by] [*Western Electric Co.*

Rear view of transmitting apparatus, showing the four 250 watt valves

Curious Fact in Long-Distance Broadcasting

A remarkably interesting state of things arises in connection with long-distance broadcasting, on account of the enormous difference between the speed of electric waves and that of sound waves. Wireless waves travel at the rate of about 186,000 miles per second, while the speed of sound waves is only about 1,100 feet per second. A wireless signal would cross the Atlantic in about one-sixtieth of a second, whereas in that time sound would travel less than twenty feet. Therefore, if a band performance were being broadcast to America, listeners in America would hear the music before people standing more than 20 ft. away from the band in the same room!

Photograph by] [*Western Electric Co.*

Front view of transmitting apparatus

The engineer is watching the ammeter (at the upper part of panel), and is thus following the modulation of the voice of the speaker.

Relay Stations

At the present time the eight broadcasting stations in operation in Great Britain are intended to cover the whole of England, Scotland, and Wales, and they do so for the fortunate possessors of good valves sets. For instance, the approximate effective range of each station for a two-valve set is about 100 miles, and there are only a few thinly-populated areas in Great Britain more than 100 miles from any broadcasting station. The case of the owner of a crystal set is very different, however, for the range for a crystal set is only about 25 miles, which means that there are many densely-populated areas in which crystal sets are practically useless.

Experts state that it is not possible to get over this difficulty by increasing the number of broadcasting stations, as this would cause confusion. A remedy has been found, however, in relay stations. These stations are much smaller and less powerful than the big "eight." They receive the broadcast programmes from the main stations by land lines, and re-transmit them by wireless. In this way many thickly-populated areas, which are far from a main broadcasting station, may be brought within range for crystal sets.

Relay stations are already in operation at Sheffield and Plymouth, and others will follow at Edinburgh, Liverpool, Rawdon, and Hull.

Army of Nightly Listeners

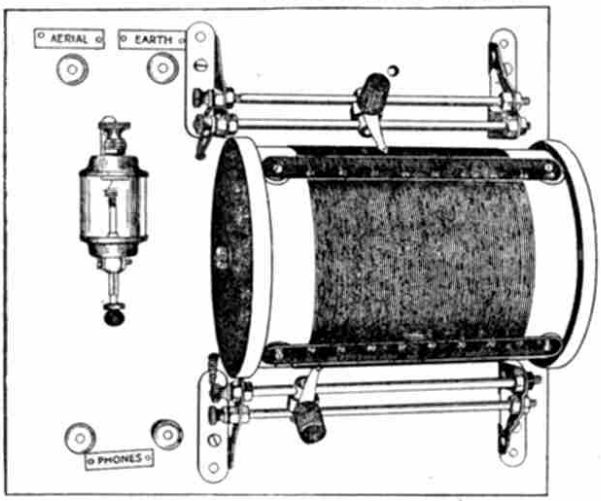
It is interesting to endeavour to estimate the number of people who listen to broadcast each night. Up to date more than 700,000 wireless licences have been issued. If we allow an average of three listeners to each licence, this makes a total of over 2,100,000 listeners in Great Britain.

The fact that the popularity of wireless is not decreasing is evident from recent figures issued by the Postmaster-General. These figures show that the number of broadcast receiving licences issued between October 1923, and February 1924, inclusive, in nine postal districts, was as follows:

London ...	200,000	Aberdeen ...	10,000
Cardiff ...	16,000	Bournemouth	9,000
Sheffield ...	8,000	Newcastle	30,000
Birmingham	30,000	Glasgow ...	44,000
Manchester	39,000		

Approximately 83,000 broadcast licences were in force in the whole of Scotland on February 29 last.

LISTEN WITH MECCANO RECEIVER No. 1



The Meccano No. 1 Receiver is a highly efficient and splendidly finished instrument. The crystal detector is exceptionally sensitive and is enclosed in a glass chamber. Two slides are provided, one on each side of the inductance, giving greater selectivity and clearness of reception. Wave length: zero to 1,000 metres.

Dimensions of Set: 9¾" × 8¼" × 5".

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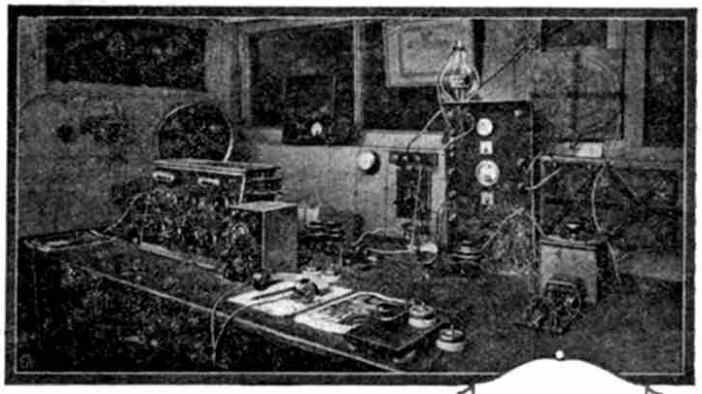

2KF. Mr. Partridge, Mitcham. The Mullard receiving valves are on the left and the Mullard transmitting valves on the right.

First Across.

YOU know the keenness and the rivalry which goes to win the coveted phrase "First across." Every wire is subjected to most careful scrutiny, but the choice of valve is almost a religious ceremony, so essential is the right selection of the valve.

*The **First** amateur "First across" the Atlantic, working both ways, was*

MR. PARTRIDGE, MERTON LANE, MITCHAM,

*and the **First** schoolboy*

Mr. C. W. Goyder, Mill Hill School

They both used

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BRIDGING THE ATLANTIC

Schoolboy Transmits to America

THE Radio Society of Great Britain recently organised a series of trans-Atlantic tests for amateur wireless enthusiasts, with a view to experimenting in transmission to and reception from America. About 60 British amateurs entered for these tests, including several well-known English amateur stations. One of these was the station of the great public school at Mill Hill, near London (2SZ). The operator of this station was Mr. C. W. Goyder, a pupil at the school who has been interested in radio for some time.

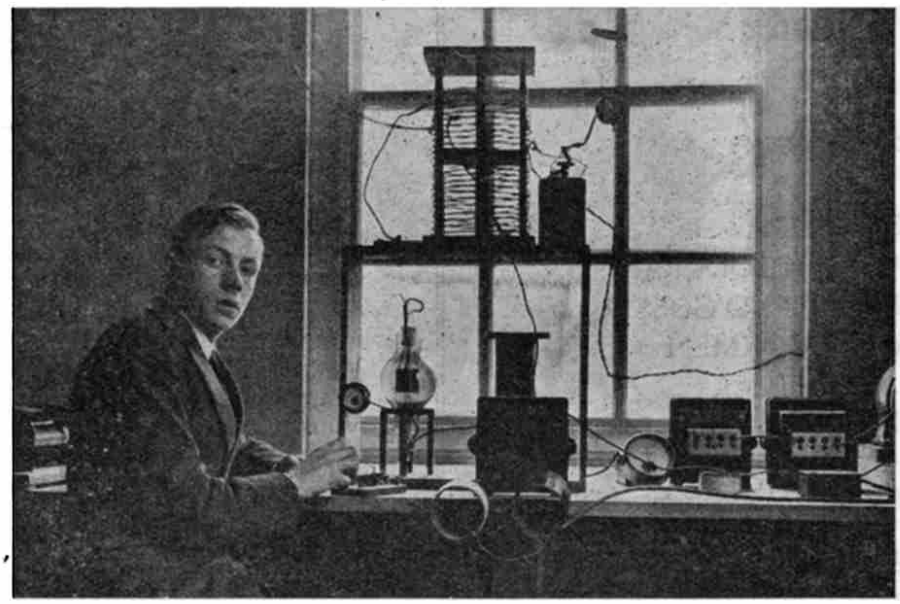
Choosing a Site

In order to take part in the tests it was necessary to use a higher-powered transmitting set than is allowed under the usual transmitting licence. The Mill Hill Station was fortunate in obtaining a 250-watt transmitting licence from the Postmaster-General and permission to use a wavelength of 100 metres, a wavelength that has been found to be the most suitable for long distance work.

The obstacles which confronted Mr. Goyder were considerable and would have deterred any less enthusiastic amateur. One great difficulty was the fact that the new science buildings, which were chosen as being the only suitable site for an aerial, were still in the process of erection. Walls and ceilings were unplastered, the floor was unlaid, and the window frames had to be stuffed with newspapers to keep out the draught. Even the staircase had not been built, and the room could only be reached by a ladder! It could scarcely be termed an ideal room in which to spend the twenty nights required for the tests. It had one possible advantage, however, that the operator was unlikely to be troubled by curious visitors during one of the critical tests!

Aerial Details

After several narrow escapes from disaster the set was at last installed in the half-built science room, and a cable laid for current to the chapel nearby. Readers of the "*M.M.*" will be interested to learn that our familiar advertisers, the Mullard Radio Valve Co., kindly loaned two Mullard Valves of the 0 250/C type for the tests, and it must be satisfactory to the manufacturers to know that their products enabled the operator to make wireless history. One of the Mullard valves is to be seen in the illustration, while above it is the cage-lead to the aerial and counterpoise. The 5-wire aerial, 55 ft. in length and 22 ft. above the roof, was fitted with 10 ft. spreaders. The lead-in, which was of the cage type, was fitted with rings of 3-ply wood, and was brought in through the roof. Eight wires were stretched between two cross wires below the aerial for the counterpoise, and were attached to the roof by hooks, with another lead-in, also of the cage type.



Mr. C. W. Goyder, the Wireless Amateur, and the apparatus with which he succeeded in transmitting to America

Two Aerials Used

A single wire aerial—the type most suitable for reception—was also erected, pointing in the direction of America. The "earth" consisted of a copper earthing mat ("borrowed" from the school O.T.C.), buried under the window to a depth of 3 ft.

The inductance used consisted of ¼" cable wound on the frame above the transformer, the clips fastened to it being adjustable for varying the wavelength. In the centre of our illustration is to be seen the transformer, which lights the transmitting valve. A reading of the amount of current passing is obtained from the ammeter shown to the left of the valve. The two panels on the right of the photograph are transformers for supplying current to the valve plate. The current used was rectified alternating current, at 2,500 volts potential.

First Night of the Test

While this set was being assembled the school term was still in progress. On December 18, however, Mill Hill "broke up" and Goyder was left in sole possession. The official tests were due to start on December 22, but on the night of the 21st Goyder decided to try his set. Working on a wave-length of 200 metres he was successful in picking-up several American stations, but no reply was received to messages sent out.

The first night of the test was unlucky, for at the very moment when officially due to transmit, the radiation of the set suddenly dropped to half normal. The reason for this mysterious occurrence was not discovered until two days later, when the trouble was traced to a piece of wet string hanging on the counterpoise and causing a leakage to earth! Troubles have an unpleasant habit of never coming singly, particularly in wireless, and on a subsequent night a valve was ruined through permitting an external wire to touch the valve, and spark through the glass. Also another leakage was caused by workmen leaving a piece of loose wire over the counterpoise!

First American Two-way Communication

At last the station was in working order, however, and on December 31 an American amateur living in New Jersey (2AGB) was plainly heard calling all stations. Goyder immediately called him up on the 100 metre wavelength and succeeded in getting his message across the Atlantic, for he received a reply from 2AGB shortly afterwards. Communication between the two stations was continued for some time, and Goyder took down three New Year messages for France. Arrangements were then made to carry on the next morning if possible, and before closing down, 2AGB sent "*You are the only European station heard here to-night.*"

At 6 a.m. on January 8 Goyder established communication with an American amateur (1XW) at Hartford, Conn., and worked with him for two hours. Conditions were particularly favourable that night, and signals were so loud and clear that when Goyder called his friend 2AGB, the latter was able to hear Goyder's signals at a distance of even 4 ft. from his phones and 75 to 100 ft. from the loud speaker! The next night a Canadian (1BQ) at Halifax, Nova Scotia, was picked up on 110 metre wavelength and signals were exchanged.

Reports of the reception of Goyder's signals soon began to come in from U.S.A.

(*Continued on page 131*)

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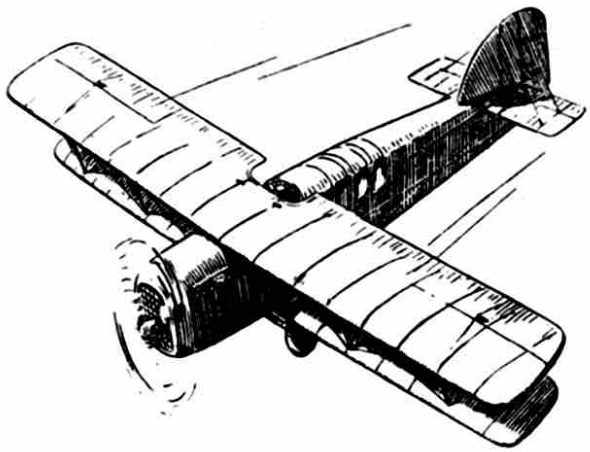

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