VOL. XIII. No. 8

AUGUST 1928

MECCANO MAGAZINE

"A HUGE WATERWHEEL GENERATOR"

(See page 626)

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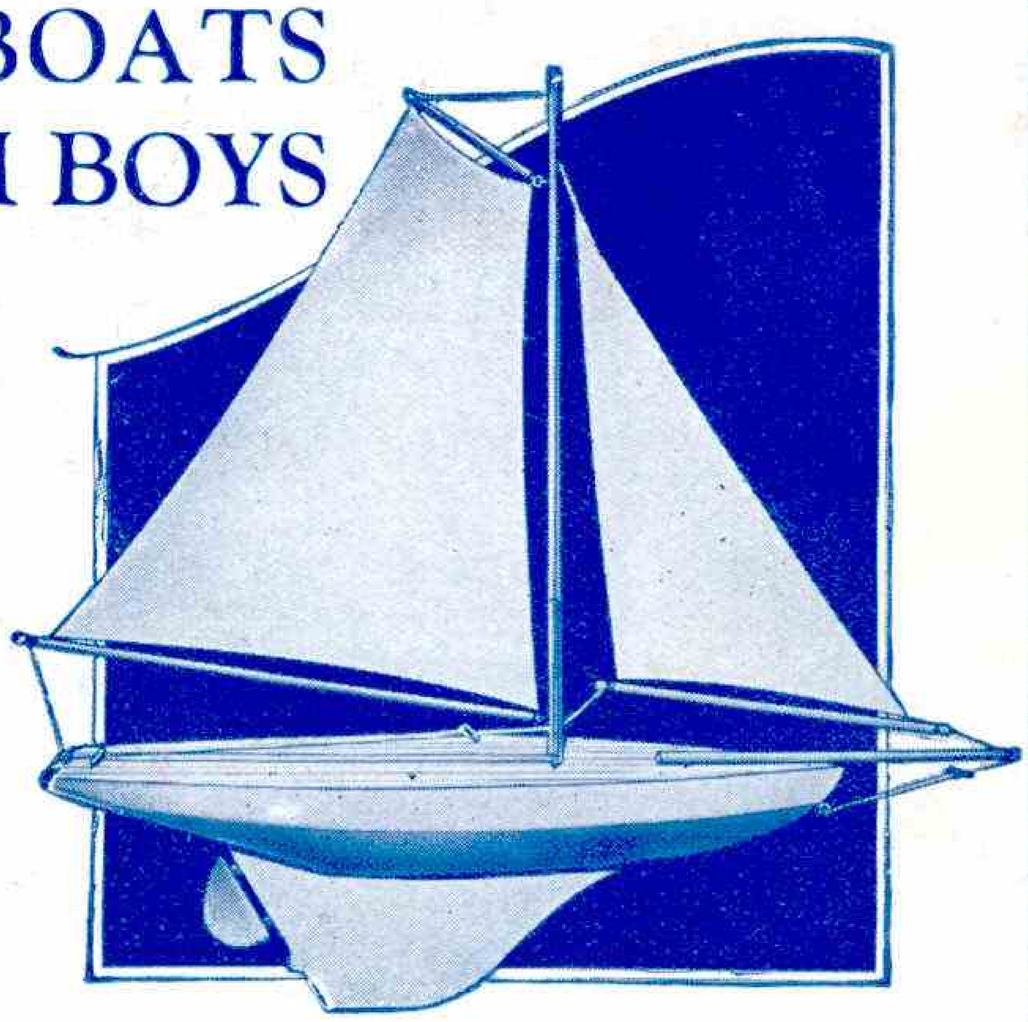
BRITISH BOATS for BRITISH BOYS



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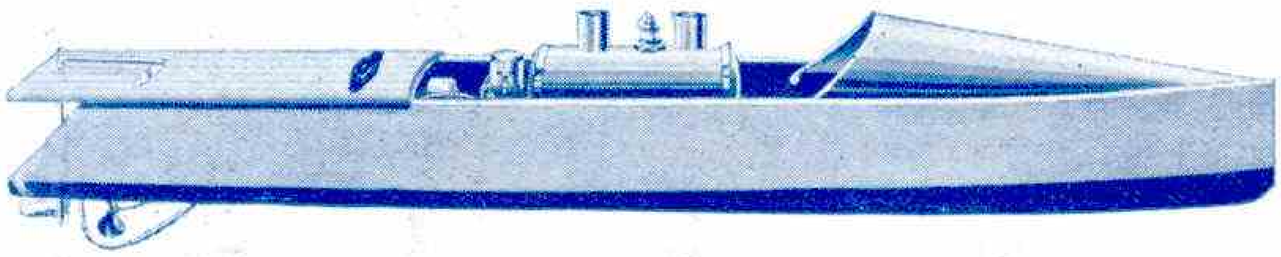

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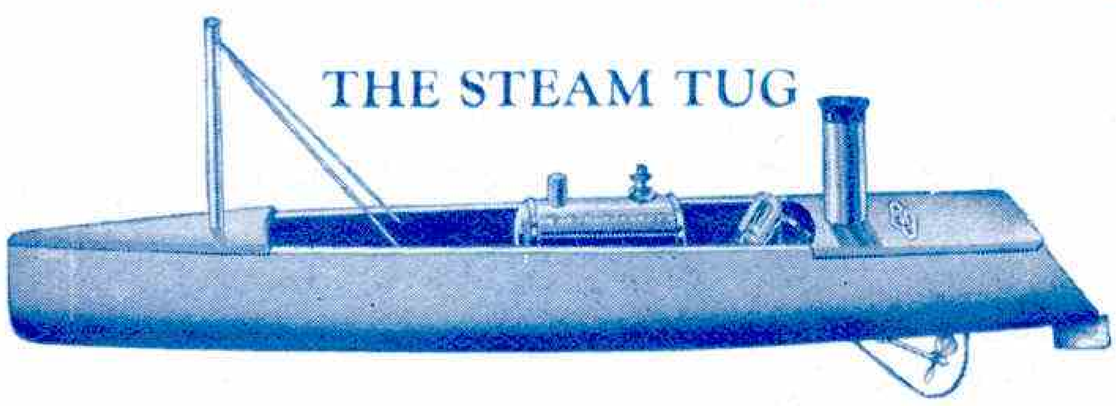

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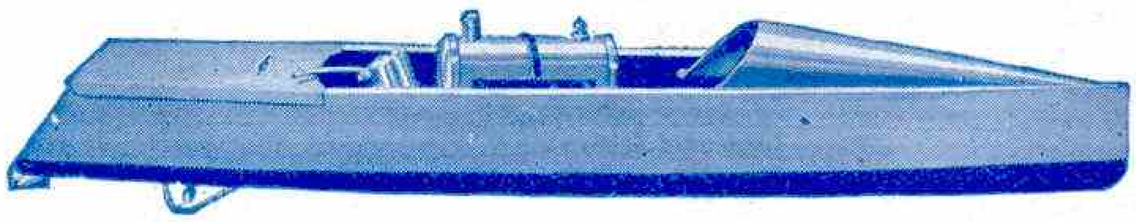

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With the Editor

Over Niagara Falls in a Ball!

The recent exploit of a French-Canadian named Laussier in safely negotiating the Niagara Falls in a rubber ball, comes as a reminder of the remarkable fascination these Falls seem to possess for seekers after notoriety. It seems extraordinary that so many people should have deliberately set out upon an undertaking that almost certainly involves a fearful death. Various people, for instance, have attempted the descent of the Falls in a barrel and, as might have been expected, most of them perished. One man, however, named Bobby Leach, succeeded in some marvellous manner in emerging alive, and he seems to have made a considerable amount of money subsequently by exhibiting himself and his barrel. It is a curious fact that Leach, after surviving the terrifying experience of falling 155 ft. in a thundering torrent of water, should die from injuries received as the result of slipping on a piece of orange peel!

The Canadian who made the descent last month certainly showed rather less lunacy in his arrangements. Instead of a barrel he provided himself with a rubber ball 12 ft. in diameter and with walls 3 ft. in thickness. As a further precaution 32 oxygen compartments were let into the wall of the space in which he sat. Even with this precaution Laussier was unconscious when he was rescued after making the descent and released from his temporary prison.

Almost everyone is familiar with the story of Blondin's crossing of the river below the Falls on a rope 2 in. in diameter. Some people seem to regard this feat as being as outrageously foolhardy as the exploits of the barrel enthusiasts, but there is no comparison between the two. Blondin was a tight-rope walker of extraordinary skill and unique experience. Not only was he perfectly at home on his rope but, in addition, it made no difference to him whether this was stretched 5 ft. or 500 ft. above the ground. Height simply had no effect, and therefore to him the crossing of the Niagara River presented no unusual difficulty or danger. That this was the case is shown by the fact that for three years he made the crossing once a fortnight without the slightest hitch.

Learn to Swim!

Mention of Niagara cannot fail to bring to mind the misguided attempt of Captain Webb to swim through the whirlpool. Webb was undoubtedly a swimmer of extraordinary strength and endurance; he had swum across the Channel and had often demonstrated his powers of remaining in rough water for long periods. But he utterly under-estimated the terrific violence of the currents in the whirlpool and he was swept away to his death.

None of us is ever likely to have to face such turbulent waters as those of the Niagara whirlpool, but at any time circumstances may arise when the ability to swim is of vital importance. In a small sailing boat, for instance, the slightest mismanagement in a sudden and unexpected squall may mean disaster to anyone unable to swim, whereas a moderately good swimmer, even though he may not be able to reach the shore, can usually keep himself afloat long enough for others to rescue him. Then again, the crisis may be of quite a different nature—we may be close at hand when somebody falls into the water, and then a glorious opportunity arises to plunge in and effect a rescue. On the other hand it is a bitter experience to have to stand by helplessly because one cannot swim.

In this connection I am proud to recall a very gallant rescue by a girl member of my staff. When she was only 14 years of age she plunged into the River Mersey, swam out some 25 yards and rescued an eight-year-old child who had fallen into the river and was being carried away by the strong current. For this rescue she received the medal of the Liverpool Shipwreck and Humane Society and also a special medal, "For Gallantry," from the Liverpool and District Teachers' Association. In addition to these two medals this girl has won nearly 30 others for swimming, and she is an enthusiastic member of our Magazine Department Swimming Club.

Swimming is a splendid exercise—perhaps the best in the world. As a sport also it has special and unequalled fascinations of its own. A race in the water, for instance, has far more attractiveness and certainly more excitement than a similar race on land. Swimming has the further advantage of being a form of exercise that may be practised at all times of the year, for swimming baths are so numerous to-day that it is not necessary to follow the example of the hardy enthusiasts who insist on their daily swim in the Serpentine, even though it is necessary to break through a sheet of ice to obtain it!

Buoy's Remarkable Voyage

To bathers on the sea-shore an additional excitement is often provided in the shape of mysterious objects that can be seen in the water. These are usually nothing more than pieces of driftwood, but occasionally strange finds are made. Imagine the astonishment, for instance, of certain Australians who fished a loose buoy out of the water and discovered that it was apparently of South American origin! Subsequent inquiries showed that it had broken away from its moorings in the River Plate estuary, 10,000 miles away!

The voyage of this buoy is full of interest. It almost certainly travelled east, for a current passing down the east coast of South America turns across the Atlantic Ocean off the River Plate, but the main portion of this current curls northward on reaching Africa. Apparently the buoy succeeded in finding its way into the smaller portion that rounds South Africa and then found itself in a similar anti-clockwise current in the Indian Ocean. This time it was caught in the northward curl and its attempt to travel round the world ended near Freemantle on the western coast of Australia.

"Unexplored Area" Competition Result

In February last I offered an autographed copy of my book "*Engineering for Boys*" to the reader who sent me the first correct statement of the proportion of the Earth's surface that had never been visited by man. This little competition aroused a considerable amount of interest and the entries revealed an astonishingly accurate knowledge of the progress of exploration. But with one exception, all overlooked what is by far the greatest unvisited area, which is at the bottom of the sea! The exception was J. Dixon, of Whitby, to whom the book has accordingly been sent with congratulations on his acuteness.

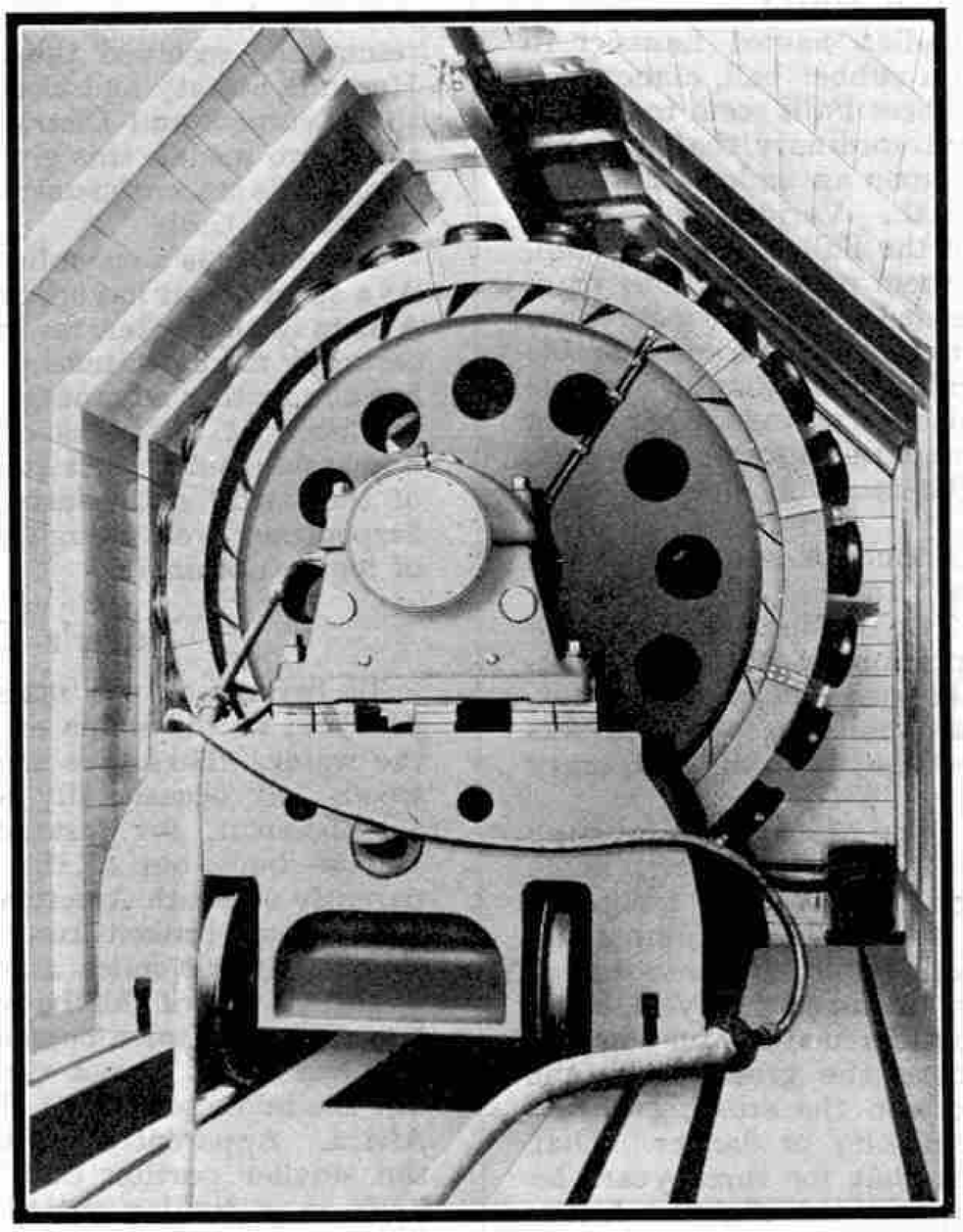
Sea covers no less than 142,000,000 square miles of the Earth's surface, this large total being 72 per cent. of the whole. The unexplored portions of the remainder include enormous areas in the Arctic and Antarctic regions, together with the Sahara and Gobi Deserts, the impenetrable forest lands of the Congo Free State and Brazil, and a large proportion of Central Australia. At a conservative estimate these and similar unexplored areas amount to 15,000,000 square miles which added to the 142,000,000 square miles covered by water, give a final total of 157,000,000 square miles, or 80 per cent. of the Earth's surface.

Mammoth Waterwheel Alternators

British Machines for Chilian Power Station

AN interesting British achievement in heavy electrical engineering is the construction by the Metropolitan-Vickers Electrical Company Limited, of three large vertical waterwheel alternators to form the initial equipment of a large new power station on the Maipo River in the High Andes in Chile. The plant will supplement the existing supply of power in bulk by means of an overhead system at 110,000 volts to undertakings in the Santiago and Valparaiso districts for lighting and industrial power services, and also for tramways and main line services. The site of the new plant is about 40 miles south-east of Santiago at a height of 4,250 ft. above sea level.

The power of the station will be derived from water falling at the rate of 1,500 tons per minute from a height of 670 ft.—nearly twice the height of St. Paul's Cathedral! The water will drive three water turbines of 18,600 h.p. and the three generators driven by the turbines will convert this energy into electricity at 12,000 volts. The generators are 21 ft. in overall diameter, 16 ft. in height and weigh 128 tons each. The rotating portion weighs 56 tons alone and 75 tons with its waterwheel runner attached. In normal operation this mass revolves with a surface speed of two miles per minute!



The alternator rotor in test house for test at twice the normal running speed. The walls of the test house are 9 ft. in thickness

The water turbines were constructed by Escher Wyss & Company of Zurich, and are of the Pelton wheel type. The decision to adopt turbines of this type in spite of their higher initial cost was influenced largely by the fact that the water contains a large amount of gritty sand and the impulse type of turbine has greater ability to withstand the action of the sand and gives greater facility of replacement of worn-out parts than is the case with turbines of the Francis type. The vertical type of machine was chosen on account of the comparatively small space required and also on account of the possibility of designing turbines for a relatively high speed of 250 r.p.m. by providing each unit with four inlets.

The pipe that distributes the water to the jets is of spiral shape and is fitted on its inner periphery with four inlets each equipped with a needle that passes through the spiral. This spiral serves at the same time as base for the whole turbo-generator set, which arrangement made it possible to build the power house with one floor only. The great advantage of this arrangement lies in the easy access to and control of all portions of the machines. The generator stator is connected to the turbine spiral by means of a cast iron solid yoke provided with large apertures giving access to the bottom guide bearing, governor driving gear, and the gear operating the deflectors. The bottom guide bearing is situated close to the runner wheel and is fitted with an oil pump built in the oil sump. This pump supplies the oil to both guide bearings.

Sight lubricators are provided and an alarm system is installed to give warning by means of a Klaxon horn in the event of the oil supply failing. Thermometers are placed in the thrust bearing and in the two guide bearings, indicating the temperature of each upon dials.

The turbine is separated from the bottom guide bearing by protecting shields of cast iron in the shape of a dome that deflects down the water thrown up by the runner wheel. This deflecting action is of the utmost importance in order to obtain high efficiency. The four needles are actuated by an oil pressure servo-motor arranged on the same level as the needles. The other servo-motor which operates the four deflectors is located on a raised platform which also carries the operating gear for the governor and for the main valve, the oil pump and air vessel.

The runner is fastened on to a tapered shaft extension by means of key and nut. For overhauling, the runner can be lowered down the wheel pit and hauled into the power house through a special pit provided in the floor. The runner has twenty buckets of cast steel, which are bolted on to the disc by means of conical bolts. For inspection purposes, and in order to facilitate the replacement of the wearing parts of the thrust bearing, the whole rotating part of the set can be lifted by means of a jack arranged in the wheel pit underneath the shaft end.

The part of the deflectors, nozzles and needles which are exposed to the action of the water and subject to erosion, are made of high quality steel, and are easily replaced. These parts are of so simple design that they can easily be made in the power company's own repair shop.

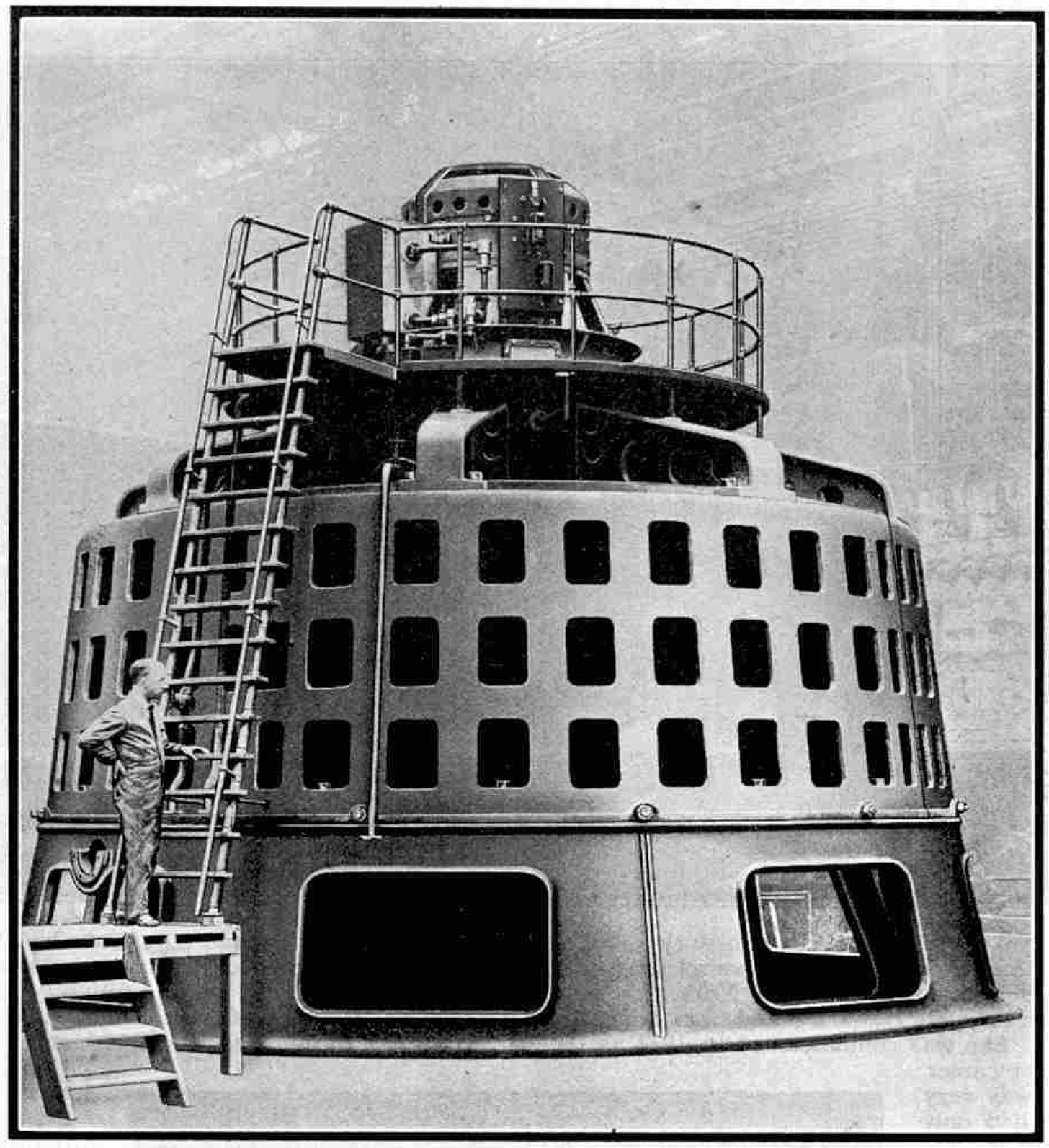
The immense generators are rated at 13,330 k V.A. at a normal pressure of 12,000 volts, three phase, 50 periods. The normal speed of the rotor is 250 r.p.m.

The stator of each machine was built up in four separate sections to facilitate transport, each section being shipped separately with its own part of the core assembled and the winding in position, except for the coils bridging the joints. The core consists of 21 tons of segmented stampings of high grade sheet steel, each sheet insulated on one side by a layer of paper. All the laminations throughout the machines had their edges ground to remove burs after punching. The core segments were secured to the yoke by dove-tailed projections on the stampings engaging with the corresponding grooves in the ribs of the yoke. The whole core was assembled under pressure and clamped between segmental heavy end plates by bolts that pass entirely outside the stampings.

The stator winding is of the two-layer diamond-coil type, all coils being identical and completely formed and insulated before being placed in the slots. Each conductor is built up of copper strips of rectangular section, which are separately insulated throughout with mica silk tape for reducing circulating currents. Each complete conductor is further insulated from adjacent turns in the same coil side by another layer of mica silk tape. The slot portion of the coil is finally insulated from the core by a heavy micafolium wrapping applied by means of a special machine that tightens the wrap by the rolling pressure of hot irons. The wrap thus applied is subjected at suitable stages to a pressure of more than one ton per square inch at a high temperature, and allowed to cool under this pressure. This process gives an insulation in which internal air spaces are entirely eliminated, and which has a mica content of more than 70 per cent. by weight. The coil ends are insulated with Empire cloth tape, each successive layer of which is treated with insulating enamel.

The rotor "spider" consists of two cast steel wheels each 11 ft. 5½ in. in diameter, 15 in. in thickness and weighing 12½ tons. The 24 poles are built up of heavy gauge stampings clamped under hydraulic pressure between cast steel end-plates of semi-circular section by a number of heavy bolts. Each pole weighs just over 15 cwt., including the coil.

The manufacture of such gigantic machines as these demands the use of materials of the highest possible class, the greatest care in construction, and the most searching tests. The tests that were made in regard to mechanical strength are of special interest. Not only were the surfaces of such stressed parts as shafts and rotor bodies thoroughly examined and sample pieces subjected to mechanical tests and microscopic examination, but also in many cases a central hole was bored in order to permit examination of the interior by means of a device that may be described as a combination of telescope, periscope, and microscope. This test involved the boring of a hole 21 ft. in length through each of the forged steel shafts.



A striking photograph of one of the alternators showing its immense size. It is 21 ft. 3 ins. in diameter, 25 ft. 5 ins. in height from the floor level, and weighs 128 tons

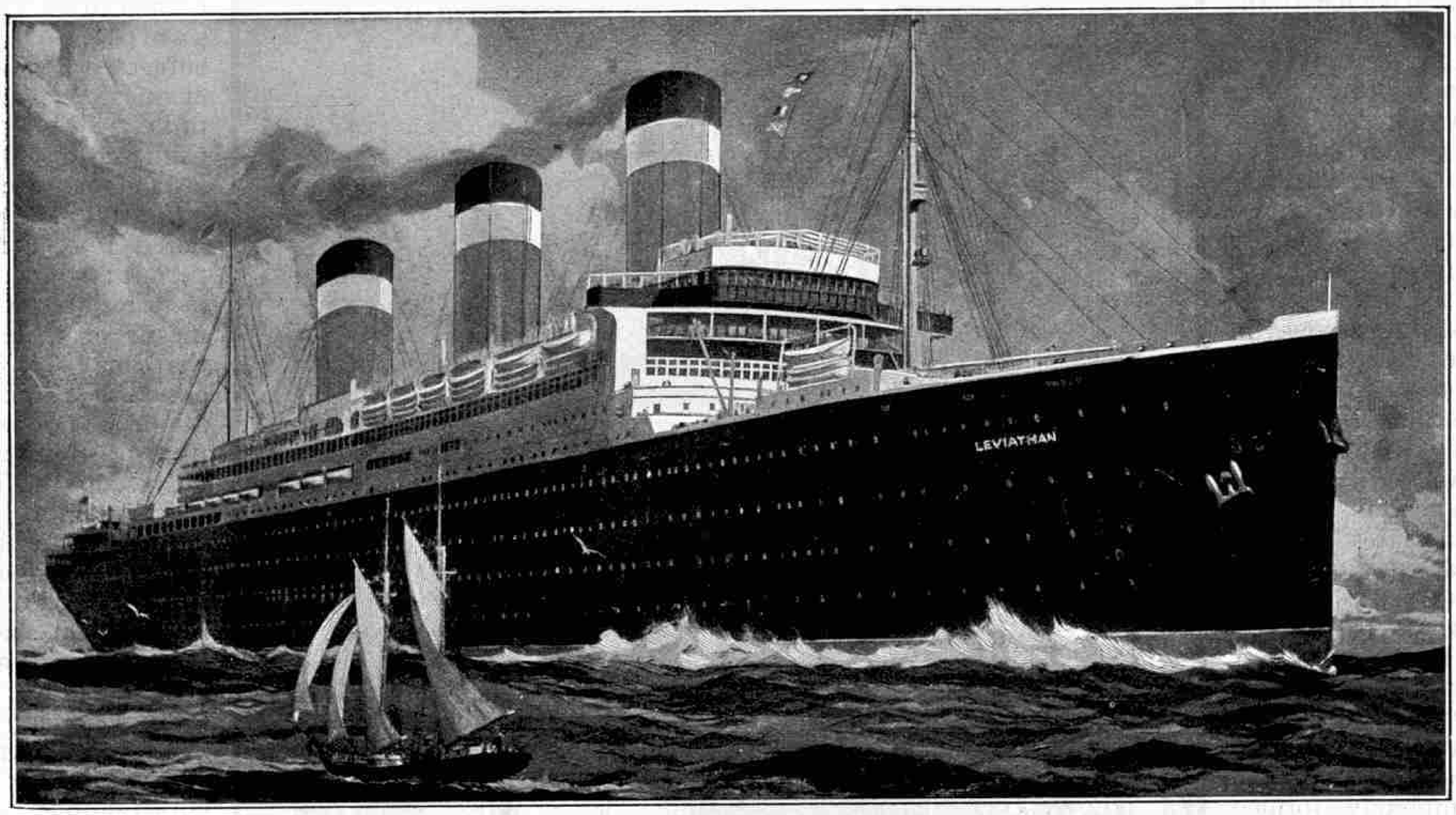
Finally, each complete rotor was given a special test to ensure that it was capable of withstanding the enormous stresses developed in such a large, heavy body at runaway speeds. This was done by subjecting the rotor to a run at twice normal speed. The test was carried out in an overspeed test house with reinforced walls 9 ft. in thickness, specially built by the Metropolitan-Vickers Company for carrying out such operations. The reason for the strength of the test house structure will be appreciated when it is explained that the force that would be liberated if one of these rotors were to burst would be equal to the impact of two express trains in head-on collision!

The heating test was carried out by operating the machine on open circuit and short circuit alternately for half-hour periods until steady temperatures were reached. The open circuit voltage and the short circuit current were selected so that the average total losses in the machine under the two conditions were equal to the actual losses on full load.

Immediately following the heating test, the insulation resistance was measured and pressure tests were applied to the stator and rotor windings. The stator winding was tested between phases and to ground at 27,000 volts for one minute, and the rotor winding and exciter circuit at 2,000 volts for one minute, the tests being made with alternating current at 50 cycles.

"The Flagship of the U.S. Lines Fleet"

The Romance of the S.S. "*Leviathan*": America's Largest Liner

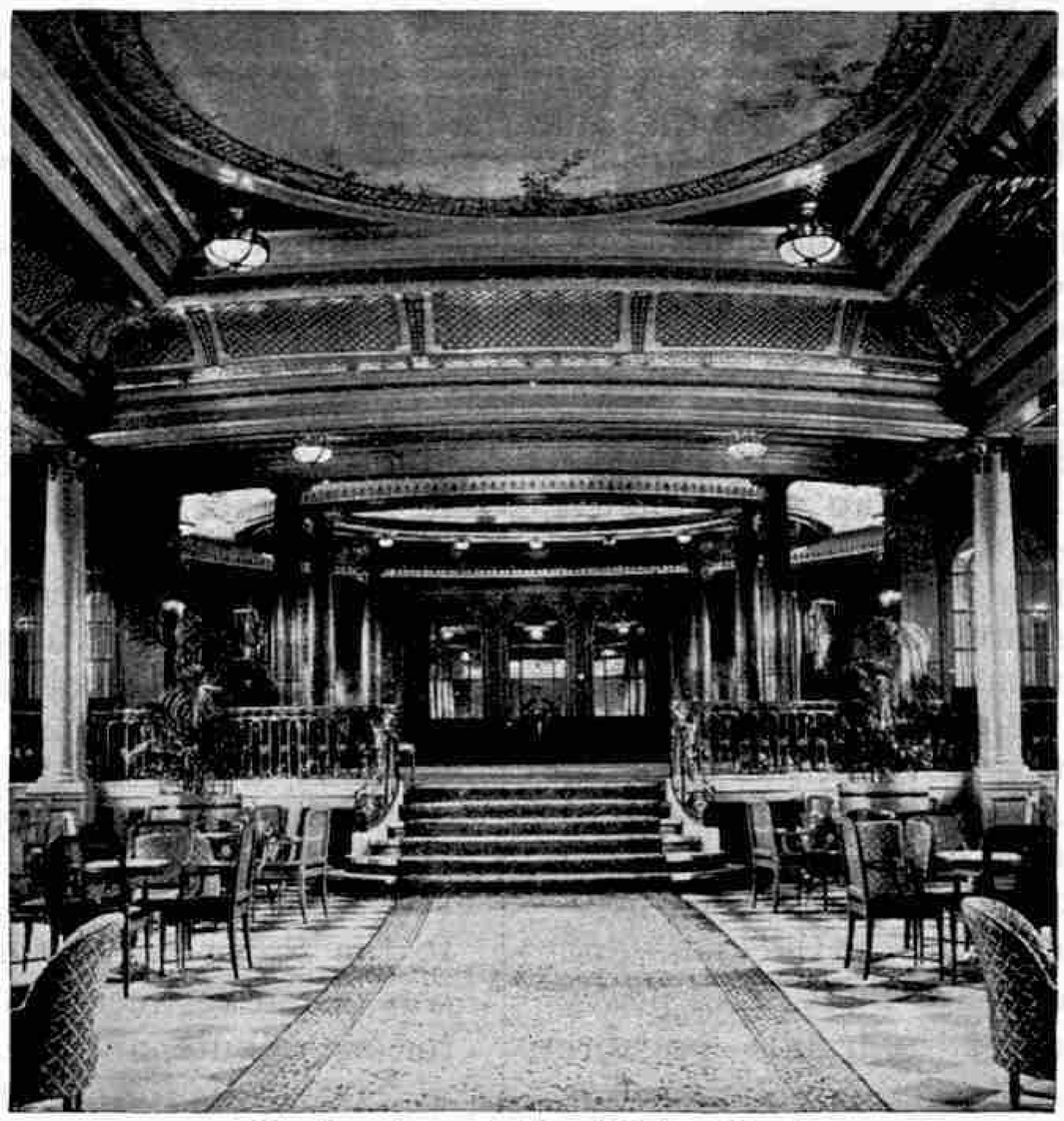


FEW ocean liners have had as varied a history as the "*Leviathan*," the United States monster vessel that sails regularly between Southampton and New York.

The "*Leviathan*" was built in Hamburg and was originally named the "*Vaterland*." She was commissioned in 1914 as the world's largest liner. Her career under the German flag was very short, however, for she had only made three voyages across the Atlantic when she was cornered in New York in August 1914. There she remained until the United States came into the war in 1917 and she was then seized by the United States Government. The Germans did not smash the machinery of the "*Vaterland*" as they did that of many other of their vessels on the declaration of war, but when the United States Navy Department came to examine the turbines of the liner they found them to be in a very bad condition and considerable work had to be carried out before they could be made fit for service.

It was decided to use the vessel as a troop ship and she was therefore stripped of all her splendid passenger accommodation in order to adapt her to service under war conditions. She was then re-christened the "*Leviathan*."

During her term as a transport the "*Leviathan*" made ten trips across the Atlantic in the course of which she carried a total number of 119,511 United States troops. On one voyage she had 13,558 persons on board—the largest number ever carried across any ocean by any ship on any trip. Included in this number were no fewer than 11,470 soldiers, a figure that constituted a world record for troop transport during one single voyage.



Up the steps to the Winter Garden

On the conclusion of her war service it was decided that the "*Leviathan*" should be re-conditioned and put into the American Atlantic passenger service. In order to do this it was necessary to have plans of the vessel. These plans were, of course, in the hands of the Germans, who declined to sell them for less than £200,000. The American authorities rightly considered this sum to be excessive and therefore instructed their own engineers to survey the ship. This survey was duly carried out and within six months a complete set of plans was prepared at a total cost of only £50,000.

The "*Leviathan*" has an overall length of 950 ft., a width of 100 ft., and a gross tonnage of 59,956 tons. She has nine decks and her height from keel to bridge is 124 ft. In regard to gross tonnage she is the largest liner in the world, but in size she is exceeded by the White Star liner "*Majestic*," which, while of the same width, has an overall length of 956 ft.

In spite of her immense bulk the "*Leviathan*" can be steered as easily as a yacht. This was

demonstrated very clearly while she was on her way to Newport News to be dry-docked for re-conditioning for passenger service. On this trip she was compelled to make a right-hand turn. At that time she was drawing 36 ft. of water as against her loaded draught of about 38 ft., and the depth of water between her keel and the bottom was only 6 in. In spite of this she swung about in perfect response to the helm. On this occasion the "*West Virginia*," the largest battleship of the United States Navy lay in dock a couple of hundred yards away from the "*Leviathan*" and from the decks of the latter she looked only about the size of a river steamer.

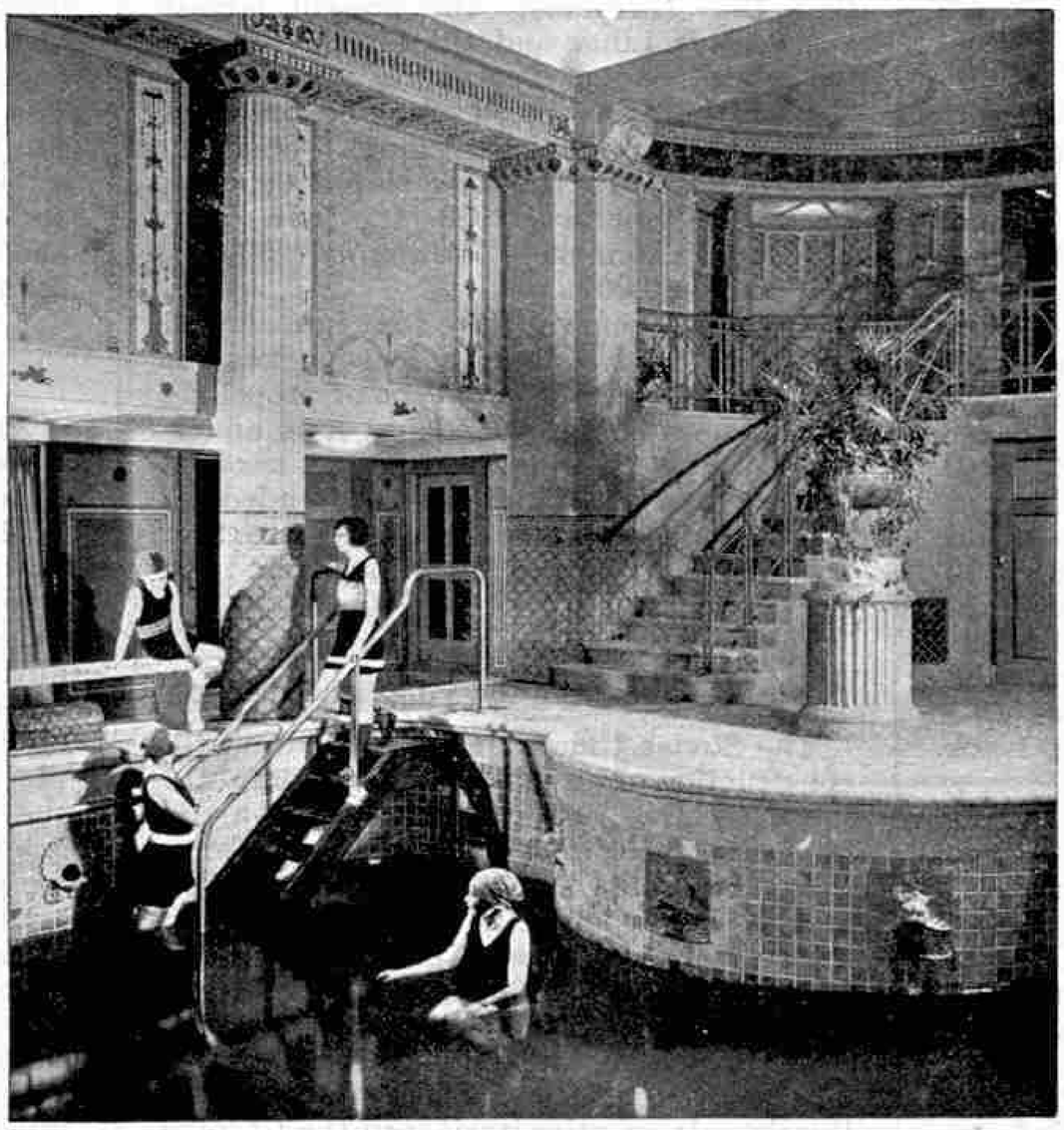
As might be expected, the anchors of the "*Leviathan*" are very massive affairs. The port and starboard bow anchors are each approximately 26,000 lb. in weight while the centre bow anchor weighs 33,000 lb.

In re-conditioning the liner for passenger service it would have been possible to make use of such of the German fittings that remained, supplementing them where necessary. After careful consideration, however, it was decided that such a course would not result in the ship presenting a uniformly harmonious appearance and therefore it was decided to make entirely new fittings. New steam radiators composed of coils of the finest copper tested to 600 lb. were installed in the state rooms, and the ventilating and cooking apparatus and the wiring and plumbing were all renewed. The original wiring of the ship did not satisfy the United States authorities and the wires installed by the Germans for the electric lighting system are now used only to connect up electric bells, the lighting system having been re-wired throughout. Altogether, nearly 250 miles of new wiring was installed and this, hidden away out of sight, forms a complex network through all the corridors and walls.

The Lounge, with the Winter Garden beyond

To describe in detail this gigantic floating palace, with its numerous state rooms ranging from the two-berth cabin to luxurious suites with spacious verandas looking out on the sea through thick plate glass windows, would require many pages of the "*M.M.*" The "*Leviathan*" can accommodate 976 first-class passengers, 548 second-class and 2,117 third-class, in addition to officers and crew numbering 1,150, making a total of 4,791 persons. The main dining saloon provides accommodation for 660 guests at small tables.

The German scheme of decoration for the assembly halls was considered by the Americans too elaborate and it was replaced by a modern colour scheme embodying grey, green and buff. The first-class smoking room on "A" deck forward was originally decorated with the coats-of-arms of the German Empire and German States but these were removed and the United States coats-of-arms, including those of the thirteen original states, were substituted for them. Forward on the main deck is a library and a social hall which is used also as a theatre, being provided with modern stage equipment. An uninterrupted view of the stage may be obtained from any part of the hall as there are no pillars, the roof being supported by struts on the outside. The vessel has also a swimming bath arrangement. Gymnasiums fitted with elaborate and costly apparatus are provided for both first-class and second-class passengers.



The beautiful Swimming Pool

The ship was constructed originally to burn coal but at the time of her re-conditioning she was converted to burn oil fuel, with a result of a saving of 10 per cent. in fuel consumption and a reduction in the engine room staff from 500 to 275 men. The storage capacity includes accommodation for 9,500 tons of fuel oil and 5,000 tons of fresh water. Six evaporators are installed each of which can transform 144 tons of sea water into fresh water every 24 hours, that is at the rate of six tons per hour.

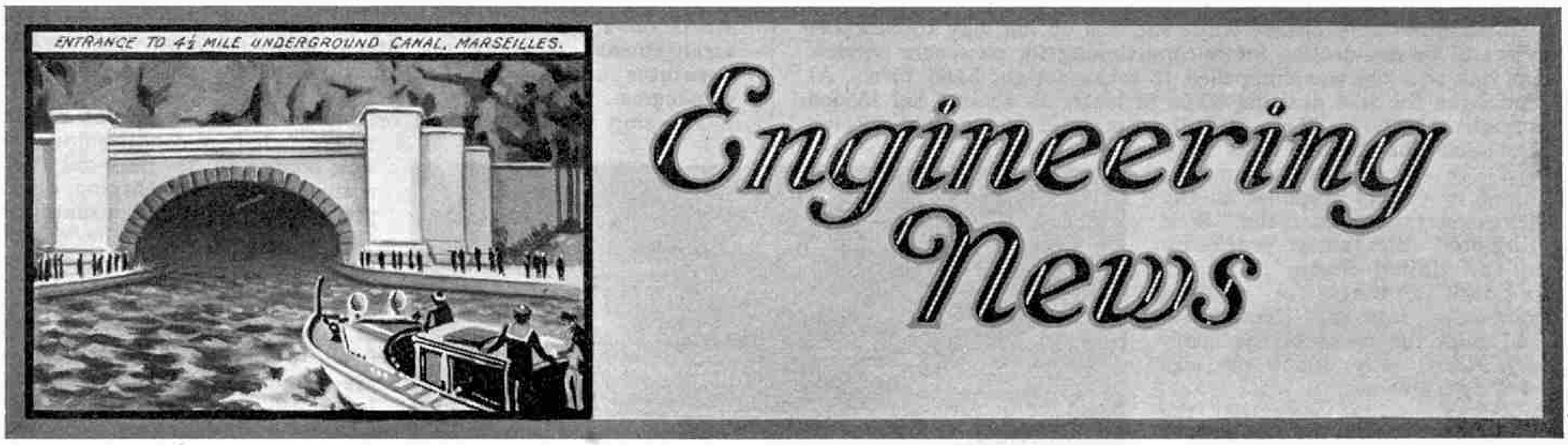
Adequate precautions have been taken against any possible failure of the electric lighting system and a storage battery capable of running all the lights for three hours is installed. In addition, there are two Diesel engines either of which is capable of running the lighting plant until repairs can be made. Every day at sunset one of these engines is run for an hour in order to make certain that it is in good working order and ready for any emergency.

Very elaborate precautions have been taken against fire. If fire should break out in any part of the hold the smoke would reach the fire station on the bridge through pipes and the particular pipe from which the smoke was seen would identify the locality of the outbreak. Steam then would be turned into that part of the hold and the fire would quickly be smothered. In other spaces an automatic fire alarm warns the bridge immediately if fire breaks out. In addition, 57 fire stations where manual alarms can be sounded, are situated in various parts of the vessel and these stations are attended to by an equal number of firemen working in three-hour shifts. The whole ship, even to the remotest part, is inspected every half-hour night and day for any evidence of fire.

Protective devices innumerable have been installed in the endeavour to make the "*Leviathan*" as safe as is humanly possible and it is estimated that she is now 50 per cent. safer than when she was built. The self-closing doors have been re-distributed and they now divide the ship into a series of water-tight compartments. All these doors may be shut by a single operation on the bridge and an electric indicator shows instantly when any particular door fails to work. Alternatively, the doors may be closed individually by hand.

The wireless equipment of the "*Leviathan*" is exceptionally powerful and is supplemented by elaborate direction-finding apparatus.

Until recently it was commonly supposed that the economic limit in size in liners had been reached and that no more ships would be built as large as the "*Leviathan*," the "*Majestic*" or the "*Berengaria*." This supposition appears to have been wrong, however, for a White Star liner is being built that will exceed these vessels both in size and tonnage.



Wireless Direction Finding Beacons

Experiments with rotating radio beacons have been conducted by the Air Ministry and a committee appointed by the Radio Research Board. These beacons are very similar in principle to those already authorised by the Air Ministry for use in guiding aircraft, and they employ a valve transmitter that operates through a vertical closed loop geared to rotate once each minute. While the loop is rotating it emits wireless signals at various points. The signals are picked up by any vessels in the vicinity and according to the strength of the signals received it is easily possible to locate the position of the transmitting beacon and from that to ascertain the vessel's own whereabouts.

The experiments already carried out have given remarkably accurate results both by day and by night up to a distance of 50 miles over open sea from the beacon. When land masses are in the path of the wireless beams, however, it is necessary to take the average of a number of consecutive readings.

* * * *

British Grand Prix Triumph

On 17th June, Captain Woolf Barnato, the world-famous amateur racing motorist, driving alternately with Mr. C. Ruben, won the International Motoring Grand Prix for Great Britain in a four-and-a-half litre Bentley.

This 24-hour road race was held over the eleven-mile Sarthe circuit near Le Mans, 150 miles west of Paris, and the Bentley was competing with the fastest and most powerful racing cars of three nations—Italy, France and the United States of America. Captain Barnato and Mr. Ruben covered a distance of 2,669.272 kilometres (1,668.295 miles) in the 24 hours, and thus eclipsed the previous record, held by Lorraine, by more than 73 miles. Their average speed was 69.5 m.p.h. and on some parts of the track 107 m.p.h. was attained.

From the very commencement of the race it was a fight for supremacy between the Bentley team and the American Stutz, but soon after the start a burst oilpipe forced one Bentley, driven by Mr. Clement and Dr. Bengafield, to retire. After an exciting race through the night and the early morning mists, Britain gradually crept into the lead, and at the end of the race Captain Barnato's Bentley led by over 60 miles.

A very remarkable incident occurred at three o'clock in the morning when the Stutz led the Bentley by about three seconds. The cars drew up almost simultaneously at the replenishment pits where in accordance with the racing conditions each driver was required to attend to his own car himself. In the British pit instructions were rapidly given by the superintendent and speedily carried out by Barnato, whereas in the American pit confusion reigned, orders being shouted by several people at once. Bloch, the driver of the American car became so flustered that he continued to pour petrol into his tank without noticing that it was full until several gallons had overflowed on to the ground.

* * * *

The New White Star Liner

Work has been commenced on the construction of the great new White Star Liner, to which reference was made in these notes last month, and the laying of the keel is nearly completed. The vessel is being constructed at the Belfast yard of Harland & Wolff where the "*Olympic*" was built. It is estimated that the cost of the new vessel will be approximately £5,000,000.

The liner, the name of which has not yet been decided, will be considerably larger than the "*Majestic*," the present largest White Star Liner and the largest liner in the world. Some idea of the comparative size of the two vessels may be obtained from the following figures:—Length, "*Majestic*" 915 ft., new ship 1,000 ft.; Beam, "*Majestic*" 100 ft., new ship 115 ft.; Tonnage, "*Majestic*" 56,650, new ship, 60,000.

The new liner will have four funnels and eight decks. No definite decision has yet been made regarding the type of propelling machinery to be installed but it is understood that a cruising speed of 28 knots is to be aimed at. The ship is intended for trans-Atlantic service on the White Star line route between Southampton and New York.

* * * *

Soviet Canal to Join the Volga and the Don

The Soviet Union are contemplating the construction of a large canal to link the River Volga with the River Don, to facilitate the direct passage of steamers from the Volga to the Black Sea. This scheme is the outcome of the growth of the traffic making use of the rivers. Even in 1913 some 25,000,000 tons of goods were transported on the River Volga, which drains an extremely large area and flows through the richest districts in Russia. It empties itself into the Caspian Sea and is thus in direct communication with many important ports, while produce from far inland can be shipped down any of the Volga's numerous tributaries and thus distributed.

The construction of a canal joining the Don to the Volga near Stalingrad has been the subject of discussion for very many years. Originally only a fairly small canal, to be navigable by smaller types of craft, was suggested, but the scheme at present under consideration is much more ambitious, a canal 65 miles in length being projected. The estimated cost of the project is approximately 150,000,000 roubles, about £15,000,000.

* * * *

Elevator Traffic in New York

Just how numerous are the "ups and downs" of elevators in busy office buildings in large cities may surprise even those of us who travel in them daily. A company operating a number of structures of this kind in New York has recently published the following facts and figures on this subject, for which we are indebted to the "*Compressed Air Magazine*."

During 305 working days in 1927, the elevators in fifteen prominent office buildings in the neighbourhood of the Grand Central Station transported 33,592,348 persons in both directions. The total number of trips made by the 107 cars in question was 4,577,583, and the aggregate distance covered was 378,000 miles—enough to encircle the globe fifteen times. The statement is concluded with the simple though significant comment that "there has not been a serious elevator accident in those buildings in ten years, and during the last two years cars have been stalled only four times."

* * * *

Broadcasting Photographs

Although the transmission of photographs by wireless is by no means a new process a demonstration given a short time ago in London was of considerable interest owing to the fact that the instrument employed when attached to an ordinary valve set enables photographs transmitted from a broadcasting station to be received. The photographs to be transmitted are imprinted on copper foil and placed in the transmitting apparatus while the paper on which the completed photographs are to appear is specially treated with iodine and starch. The copper foil and the paper are mounted on rotating cylinders which are synchronised automatically by wireless. The time taken to transmit one photograph is usually about three-and-a-half minutes.

Captain Fulton who demonstrated the invention stated that photographs had been transmitted by this system for distances up to 650 miles. Various continental broadcasting stations have already expressed their interest in the apparatus, and the comparative cheapness of it will make a great appeal to wireless enthusiasts of all nations.

FROM A CANADIAN READER

A photograph by T. R. Lindsay, of Lenzie, of the s.s. "*St. Lawrence*," the largest and newest of the Canadian Steamship Line's lake steamers. The "*St. Lawrence*" was built at Quebec and commenced service in June last year. Her accommodation is devoted entirely to passenger service

New Town to Manufacture Paper

In connection with the opening up of a great new paper-making plant a sum of over £7,500,000 is being spent by the Spruce Falls Power and Paper Company at Kapuskasing and Smoky Falls on the Mattagami River in Northern Ontario, in the construction of a model industrial town complete with park, sportsground, a large hotel and an up-to-date hospital. Railway and telephone services are to be provided, and an electric supply will be available from a hydro electric plant utilising Smoky Falls for generating purposes.

In connection with the power house a barrage 17,000 ft. in length has been constructed across the river. A head of water of 114 ft. will be available for the power plant which ultimately will have a capacity of 75,000 h.p. Immediately the first unit of the plant comes into operation the paper mill at Kapuskasing will commence work. When running at its maximum capacity this mill will be capable of producing 550 tons of paper per day or 170,000 tons per year. A contract for a yearly supply of 110,000 tons has been made with the "*New York Times*" and the residue of 60,000 will be sold in the open market.

In order to facilitate inter-town communication and transport the Spruce Falls Power Company have connected Kapuskasing and Smoky Falls with a standard gauge railway track 50 miles in length. This will allow the National Trans-continental Railway to penetrate as far as Smoky Falls where developments are proceeding with great rapidity.

* * * *

Refrigerators for Postage Stamps !

A Post Office in St. Petersburg, Florida, has had a special cold-storage room, 8 ft. in width, 13 ft. in length and 7½ ft. in height, built on the premises. In this room any perishables, vegetables, fruit, or flowers, etc., that may be passing through the post, can be stored until they are ready to be sent to their destination. The refrigerator is also put to another very novel use. As St. Petersburg is in a fairly warm locality, the post office officials keep their postage stamps inside the refrigerator to prevent them sticking together !

* * * *

On 10th July a new motor-boat speed record of 80 m.p.h. was set up on Lake Windermere by Miss Carstairs on her "*Estelle II.*"

New Canadian National Steamships' Vessels

Work is proceeding rapidly with the five new vessels being constructed by Cammell Laird & Company at Birkenhead for the Canadian National Steamships Ltd. The first of these ships was launched last month and it is expected that the others will follow at regular intervals until the last of the series leaves the stocks in the middle of December next.

The first three ships completed are to be placed on a service to the eastern group of the British West Indies, the remaining ships will serve the western group. It will be necessary to carry out the official trials of the ships fairly rapidly, as present plans call for the inauguration of the eastern service with the first sailing out of Halifax early in December of this year. The western service is due to commence early in the spring of 1929.

Each of the new steamers will be over 400 ft. in length, and have a gross tonnage of about 7,800. The designed speed is 14 knots. The ships on the western service will have a large ventilated space for the carriage of bananas, and each of the five vessels will have from 13,000 to 15,500 cu. ft. of refrigerator space. Accommodation will be supplied for 235 passengers on the steamers of the eastern service, and for 100 passengers on the western trip.

* * * *

British Engineering Feat

The new road and railway bridge spanning the River Atbara 250 miles east of Khartoum, which was commenced last November, has been completed five months ahead of contract time. The distance across the river at this point is 1,050 ft.

Messrs. Dorman, Long & Company, the British contractors who have had the work in hand, had not anticipated finishing the job before next December.

New Extension to Bristol Dock

When the Royal Edward Dock at Bristol was completed and officially opened in 1908 it was already becoming apparent that extensions to its accommodation would be necessitated before long and within ten years the increased traffic of the port and the growth in the size of ships compelled serious attention to the matter. An extensive addition to the dock's accommodation has now been completed and officially opened by the Prince of Wales.

The extension consists of an east wing to the existing dock, 1,700 ft. in length and affording an additional area of approximately 680,000 sq. ft. Provision has been made for three new deep-water berths and two transit sheds. A transit-silo granary and a grain-conveyor gallery have been built on the east wharf. For the time being the west wharf is to remain as an open quay.

Reinforced concrete and a series of frames built on reinforced concrete piles were used in the construction of the wharves. The frames were covered by concrete on the top and concrete walls were built at the front and the back of the frames. This method of constructing a wharf is an interesting innovation.

* * * *

First British Ship to Burn Pulverised Coal

A voyage of 7,000 miles from Philadelphia to Rotterdam and back was accomplished recently by the 9,500-ton ship "*Mercer*" owned by the United States Shipping Board, throughout the whole of which voyage the vessel was fired with pulverised coal.

The success of this trial has led the Dominion Shipping Company to make a similar experiment with the "*Lingan*," an 800-ton ship which has been fitted with pulverised fuel burning equipment consisting of pulverisers, distributors, and burners. The "*Lingan*," which thus has the honour of being the first British ship to burn pulverised coal is engaged in the coal-carrying trade between Sydney and Montreal.

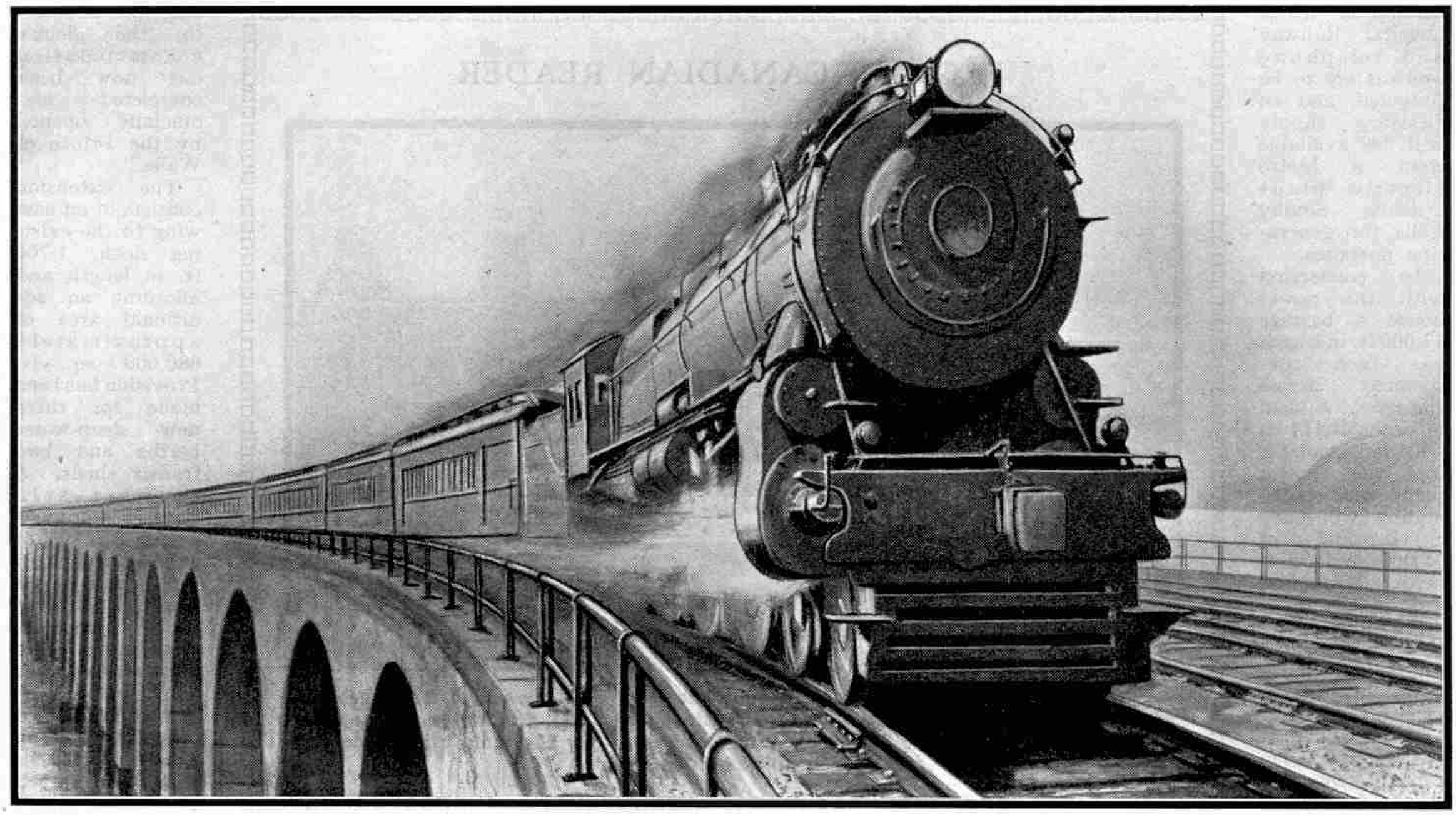
* * * *

New Mersey Landing Stage

The Wallasey Council have now decided not to discontinue the Egremont—Liverpool ferry service, as previously contemplated. The Egremont landing stage is to be reconstructed at a cost of nearly £29,000, and it is estimated that the work will take at least nine months to complete.

In the Cab of the "*Congressional Limited*"

By Ben McKelway



The "*Congressional Limited*," en route Washington to New York

MY watch said 4 o'clock, but my watch cost 5/– and is a consistent liar! C. E. Bush, engineer of the "*Congressional Limited*," pulled his out and shook his head.

"Ten seconds yet," he said.

But he was ready exactly 10 seconds later when J. E. Donohue, the guard and master of all things on the "hind end," pulled down twice on the bell rope that runs through the cars and the little whistle in the cab responded with a pair of toots.

"Clear!" yelled Bush.

"Clear!" echoed his fireman, H. L. Phelps, pulling open the fire-box door and throwing in a shovelful of coal.

Bush eased back on his throttle.

No. 3749, the big, black passenger locomotive that pulls the Congressional, stopped panting and snorted like a drowsy horse that's been tickled in the flank with a spur. Bush pulled back his throttle another notch or so, and No. 3749 spouted steam like a geyser and nervously spun her driving wheels around on the slippery rails.

Bush shoved his throttle in and cut off steam, then drew it gradually out again. No. 3749 seemed to catch the idea. The wheels bit into the track. Her snorts gave way to slow, earnest puffs, and she moved smoothly out of Washington Terminal, dragging her long line of high-hat coaches behind her. Some unseen hand guided her through the maze of switches and set her on the right track after she had tried first one, then another, weaving in and out of the yards like a big snake.

Bush turned his reverse wheel around two or three revolutions and set it. He modifies the travel of the piston valves that way, not unlike the driver of some puny automobile setting his spark. Leaning out of his cab, he caught the semaphore that told him he was entering the next short block.

"Clear!" he yelled.

"Clear!" echoed Phelps, throwing open the fire-box again and adding more coal to the fiery pit within.

No. 3749 is an aristocratic lady of the rails, but she's a hog for coal. She can't seem to get enough. Phelps feeds seven or eight tons into her red mouth between Washington and New York, and she runs the distance in five hours flat. That's fast eating.

The "Congressional Limited," one of the world's famous trains, has been operated by the Pennsylvania Railroad since 7th December, 1885. It makes the run between New York and Washington in four hours and forty minutes, and has probably carried more famous personages than any other American train.

By special arrangement the author of this article recently rode the locomotive of the "Congressional Limited" on a northbound trip, and has recorded his impressions and experiences in the following article which is published by permission of the Pennsylvania Railroad.

There's a slight upgrade out of the yards above the sheds of the Washington Terminal, but now that No. 3749 had got her load in motion, she quit stalling and fruitless spinning of her wheels and went to work in earnest. Bush watched her like a jealous father, feeling her out as she got under way, turning a valve here, pushing a lever there, caressing her lovingly until she got the hang of things and went to work. Phelps wiped his brow on his sleeve, opened the fire-box and fed her coal. Between his lunges at the coal pile and the fire-box he never spilled a lump. I resolved to try his system with the furnace. Bracing his feet firmly on the jolting, lurching platform of steel, he digs his shovel into the coal and brings it around easily without changing his stance, throwing the load far and accurately into the fiery bowels of No. 3749.

No. 3749 hisses with pleasure. She sends clouds of white, damp steam back into the cab. As her wheels clank over the joints in the rails, she lurches dizzily, finally topping the grade out of the yards going a good clip, and making an awful racket. She moves swiftly down grade toward a sharp curve. The observer in the cab, holding on for dear life to a narrow window sill, fairly radiates pleasure as he recognises the purpose of Bush in reaching for his air brake and applying the pressure that slows down the train.

Phelps stops shovelling a minute to come over and explain.

"Testing his brakes," he screams, for one must converse in screams if one would be heard above the rattle and the bang and the hiss and the roar of No. 3749.

"It's a rule," loudly explains Phelps. "Every train leaving the terminal must test its air before the run gets under way. We know our brakes are O.K., because we backed the train down into the station. But it's a rule."

Bush evidently was satisfied with the test. So was No. 3749.

"Clear!" yelled Bush.

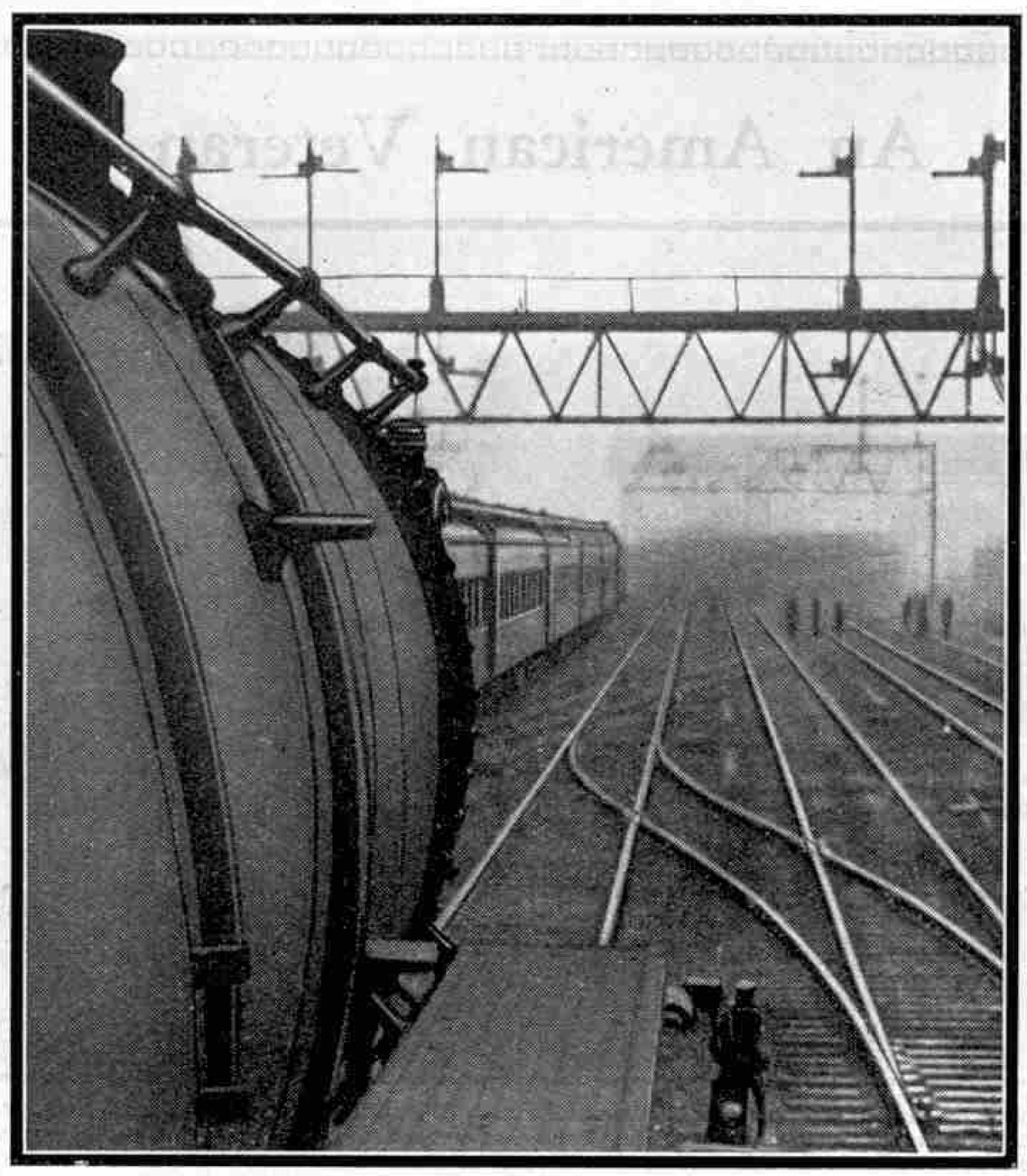
"Clear!" echoes Phelps, adding to the cost of operating the Pennsylvania railroad with another shovelful of coal.

Rattle, bang, bang-bang, bang, sang No. 3749, her nose now pointed down the main line, released from Bush's restraining air brake, and ready to go.

She went!

Up in the cab one gets the sensation of unadulterated speed and power with all the noisy accompaniments of the manufacture of high speed. No. 3749 lunges forward, her drivers making a terrific clatter, steam hissing as Bush pulls out his injector and sends more water into the boilers for Phelps' fire to boil. The big locomotive shivers throughout her frame of steel as she gathers speed. The track up front rushes toward her, cross-ties and roadbed merging in a gray, liquid mass that surges forward in a torrent.

Back in the long line of swaying parlour cars the passengers settle themselves comfortably in easy chairs and stare out on the panoramic landscape. Protected from dust, steam, smoke, flying coal and the swishing rush of air, they might as well be at home in their front parlours.



View from the cab of No 3749 en route

Up in the cab it's another story. There's action here. The force of the wind cuts your face if you lean far out to look at the flashing rails ahead. Bush sits at his throttle, motionless except for the lurch of his body as the engine he rides lurches, eyes fastened somewhere ahead to catch the next signal. Phelps keeps an eye on the big steam gauge over his head. The hand of the gauge has a way of wanting to slip back under the "200" mark. But Phelps must keep it hovering just around 200. It takes coal and elbow grease to do this, and it must not be overdone.

At 205 the safety valve pops and No. 3749 looses good steam. Below 200 the pressure goes down, and Phelps will get a dirty look from Bush. He is a good fireman, though, and he keeps the hand of the gauge hovering about the mark like the indicator on the dial of a wiggly baby's scales. He shovels and rests, resting by standing over the narrow step that leads down from the cab to the swirling rush of eternity beneath him, watching ahead, with his mate, the engine driver, for the signal that spells their fate for the next few miles.

Bush sets his throttle and his reverse wheel and No. 3749 does the rest. He must watch the signals, the water gauge, the time he's making, and the grade crossings. He has been running this route for about 35 years, and he knows the road by heart. He reaches up now and then and jerks down on his whistle rope for two long and two short blasts—signaling the approach to a grade crossing or way-station, and seconds later the observer sees a blurred smear on the landscape as his train roars over a road, automobiles lined up to let it pass, or thunders past some tiny station.

Seventy miles an hour is the speed limit. No. 3749 hits it up around fifty-five, sixty, and sixty-five. She pounds the rails under her like a blacksmith's hammer hitting an anvil, and she sways and jerks and lunges until the observer in the cab, holding tight, wonders what makes her stick to the rails. She rushes toward a curve like a halfback skirting his end, and she takes the curve as sweetly as an old lady rounding a bend in the stairs. Looking back from the cab window, one catches a glimpse of her silent followers, the afternoon sun painting the rows of windows as red as autumn maple leaves.

Bush motions the observer in the cab to come over to his side. Up to this minute, the observer has been debating the possible advantages of getting off at Baltimore and coming back on the W., B. & A. He has been clinging to the fireman's seat like a rat on a raft, and he undertakes the perilous voyage across the swaying floor of the cab with no small amount of trepidation. But he accomplishes it with a surge of honest pride as he remembers the caution displayed in the safe and sane vestibule for weaklings who ride in coaches.

Passengers Should Not Stand on the Platform While the Train is in Motion.
SAFETY FIRST.

Bush, his eyes never leaving the track ahead of him, explains, above the roar of No. 3749, the rudiments of the block system—the semaphores, with their warning arms; arms which point to the sky when the way is clear and the track is fast; arms which hang doubtfully at a 45-degree angle when there is something up ahead somewhere, and arms that hang uncompromisingly at 90 degrees and order a stop.

The blocks are arranged, Bush shouts, so that a train entering one of them at the speed it is supposed to travel will have plenty of time to stop before it reaches the next one. The "clear" signal indicated in the daytime by a semaphore or by a vertical string of lights, means that all is clear for the extent of that block and the next one, and tells the engineer as he shoots past that he has several miles of clear running ahead. The "approach" signal, indicated by lights or a semaphore arm at 45 degrees, means that the train may have to stop on entering the next block, and is a sign to slow down. The stop signal means stop—then proceed slowly until the cause of the stop becomes apparent to the engineer.

As No. 3749 clangs her way to Baltimore she has a clear track. Bush, to show that he's alive and to tell the fireman that he has seen the next signal, shouts them out to his fireman. The fireman shouts them back to show that he understands. When the train rounds a curve that brings the signal first into the fireman's vision, he calls it, and the engineer repeats it.

During the 40 mile run to Baltimore, Bush has put to shame the motion-picture engineer who glances nervously at his watch every few feet. He has never looked at his watch a single time, for he knows instinctively how fast his charging steed is covering ground. But as we enter the outskirts of Baltimore he pulls out his watch and gives it a tentative glance. We are on time to the minute. For the first time, Phelps, the fireman, has a chance to rest, and he climbs up on his seat, which has been usurped thus far by the observer, and pants. His train glides down a heavy and long grade and plunges into the "hole" of the Baltimore tunnel.

An orange light, indicating caution, flashes out of the darkness.

"Approach," yells Bush.

"Approach," Phelps agrees heartily.

Bush gives her a touch of air and the long train slows down. Around the bend there's a warning red light.

"Stop," says Bush, and he comes to a stop just as the nose of No. 3749 pokes out of the tunnel.

The cause of the delay is at once apparent. A vulgar, crawling freight train is ambling across our right of way. The fireman and the engineer of the impudent freight jeer at us, taking evident relish in having stopped the Limited. Bush and Phelps return their greetings with suitable dignity. They both feel rather hurt that this crack train should be held up by that upstart of a freight, but the delay is momentary and as the caboose of the freight clanks over the crossing and clears the line, the signal twinkles green, and beckons us on.

Bush shoots enough steam into No. 3749 to ease her down into the terminal, and he and Phelps jump to the ground with their oil cans to make the best of a 5-minute halt and see if everything is as it should be with the big locomotive's running gear.

Just as they climb back into the cab, Donohue, from the "hind end," impatiently sends them on again. The daylight has given way to dusk, and the dusk soon turns to dark. The semaphore signals with their eloquent arms have been replaced by lights that shimmer in the distance. We watch for the "clear" signal, a red light, which marks the spot for seeking eyes, and directly above it a green light.

The signals come and go with steady regularity, Bush, crouching on his seat, singing them out as he spots them. Phelps singing back, bending all the while to his endless task of keeping No. 3749 full of coal and steaming.

Phelps screams an interesting bit of information into the observer's ear. He is saying that the train will take water soon. No. 3749 takes her water on the run, as all fast passenger trains do. And to enable them to do this, troughs are constructed for maybe a quarter of a mile between the rails. When the train passes over the troughs, the fireman pushes over a lever which lowers a scoop and the water rushes up into the tank on the tender.

Bush applies the air and we slow down a bit.

"Couldn't take water at 70 miles an hour," he explains.

Phelps has his hand on the lever. Bush yells "Hey!" and Phelps pushes it over. The train rushes along, water hissing. "Hey!" yells Bush again. Phelps brings back the lever with a jerk and the operation is over. He acts quickly, blind and deaf to everything but Bush's emphatic "Hey!"

Passing the trough and getting her fill of water, something that No. 3749 does four or five times on her way to New York, we eat miles and coal, swish through Wilmington and strike out for Philadelphia.

The block ahead shows orange.

"Approach!" yells Bush.

"Approach!" Phelps agrees, barely pausing as he passes coal.

"There's another fellow ahead of us," Bush explains. "He'll either get out of our way pretty soon or we'll go around him."

Slow running for a few blocks, then a signal which tells Bush to slow down to 35 miles an hour for a "cross-over" to another track, and pretty soon we leave the track occupied by the other train and speed up on one of our own.

"Clear!" shouts Bush, and No. 3749 follows a clear track into West Philadelphia, where she pauses for a moment to allow Bush and Phelps to anoint her limbs with oil.

Again the whistle in the cab toots the signal to start, and Phelps, with his shovel, and Bush, with his throttle and injector, push No. 3749 laboriously up the steady grade from West Philadelphia to North Philadelphia and out on the main line again, where the running's clear and the lights flash green.

We are now on a much-travelled division. Trains flash past us in the opposite direction, their approach heralded far down the tracks by the burning eye of the locomotive—then the sudden roar as the locomotives greet each other in passing; a flash of lighted windows, white cloth and gleaming silverware; an abrupt shutting off of the roar and, looking back from our cab window, we see the twin tail lights of the passing stranger dancing away far down the track.

Here the blocks are rather close together, in spots, but the Congressional has a clear road and she plows along through the dark, shooting gay sparks from her smokestack and changing the colour of the plume of steam she wears from white to crimson as Phelps throws open the door to his roaring fire and feeds her more coal.

Here Bush, the engineer, sitting silent at his throttle, keeps his never-ending vigil for the lights that beckon him on. There seem to be many lights to pick from, for at times there are six parallel tracks, each of them with signals, some a warning red, others a golden yellow, others like ours, a cheerful green. The observer's untrained eyes confuse him, and he is forever picking up signals intended for somebody else, and looking for confirmation to Bush. But not Bush. His eyes are for his signals alone. He is not bothering his head about what the other fellow must do. The wheels of his big engine sing him that song that George O'Connor and Matt Horn like to sing—"Jes' Mindin' His Business, an' Goin' Along."

Finally the observer catches his breath, what there is left of it, for this time there is no mistaking the orange signal that means slow down.

"Approach!" Bush yells.

"Approach!" answers Phelps, stopping his shovelling and looking ahead.

Bush cuts off his steam, feels his air, and No. 3749 glides coasting down the rails.

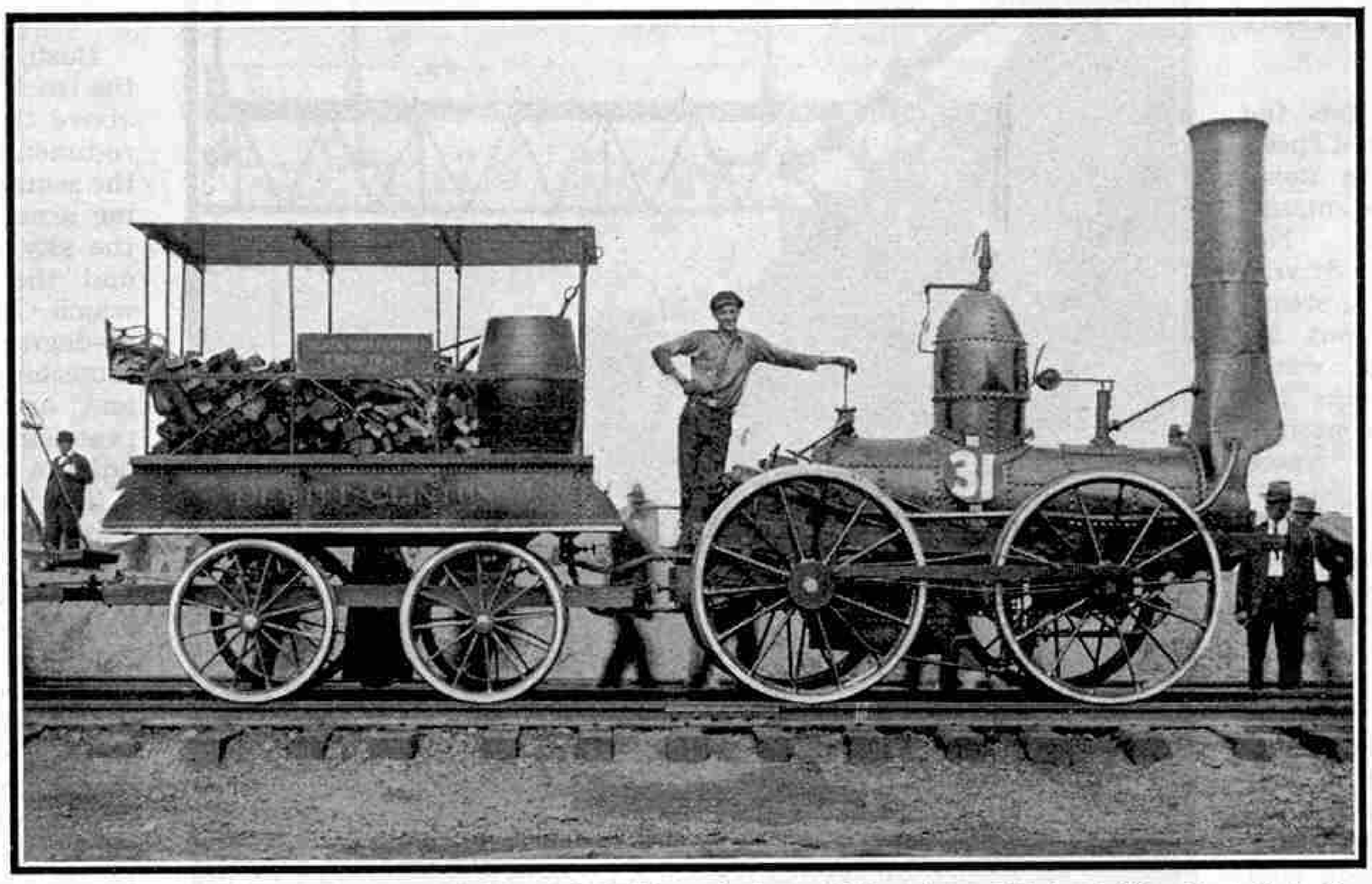
We run through the block and far ahead we pick up lights moving back and forth and jerking up and down. One of them is waved excitedly across our path and No. 3749 comes gently to a halt at the foot of a signal that glares down at us with an angry red eye. Bush toots his whistle and notifies the conductor with two short, sharp blasts, that he has struck a closed block. Then he moves forward at a snail's pace, toward the moving lights ahead. The lights turn to lanterns and flares, burning in the middle of the track. A man with a lantern runs toward No. 3749 and Bush leans out to ask him "What's the trouble?"

"Number 8 hit an automobile. Nobody killed."

Bush explains that the grade crossing is no other than the famed De Russey's lane, where so many people were on the night of the Hall-Mills murder. Somebody crossing the tracks in an automobile had stalled, and jumped from the car as No. 8, running ahead of us, smashed it to smithereens. The red tail lights of No. 8 are just ahead of us, the rear end of the train harboring a crowd with lanterns, the railroad officials checking up on names and other data useful later on. Behind us we hear the two short blasts of another train that has moved cautiously up in our rear.

No. 8 finally moves ahead. Bush whistles to recall his brakeman, who has gone to the rear with a lantern, and when he climbs aboard, he signals off with a toot-toot on the bell rope. Then we set out again, and in a few minutes we are chasing the dimming tail lights

An American Veteran



"De Witt Clinton," a famous American locomotive of the early days. This engine, which hauled New York Central's first train, is now on permanent exhibition at the Grand Central Station, New York. Our photograph was taken by Mr. Horace Pontin, an enthusiastic U.S. reader, when the engine was under steam at last year's Centenary Exhibition, at Baltimore, in which the G.W.R. "King George V" took part.

of No. 8 into the black darkness lying ahead of us.

For a few blocks the Limited is kept moving slowly until No. 8 moves out of danger, then we get the "clear" signal, and Bush yells it out with real enthusiasm and gives her more steam as we prepare to make up for lost time.

Fourteen minutes late, Bush, affable, friendly, willing to explain everything a few minutes ago, has settled down now to serious business. Phelp shovels coal without a pause. The Limited is behind time and must make it up.

No. 3749 runs like a fresh horse. Her whistle shouts a deep, throbbing warning to anybody who might be in the way and tells him to clear the track. She rocks from side to side like a ship in a gale and she makes the rails sing as she pounds them for footing to move ahead still faster. Black dark rushes past the cab window, broken now and then by flashes of light that go for wayside stations or brilliant streaks of yellow that are factory windows. Bush has her wide open and she's hitting it up. Hold your hand out of the cab window, the rushing wind grabs it and tries to snatch it away. Bush hunched on his seat like a jockey coming down the home stretch, peers always ahead. On his eyes alone depend the safety of this thundering mass of steel and the passengers carelessly and leisurely sprawling in their cushioned seats reading magazines in the coaches behind. We are running almost in pitch dark. Bush has his headlight dimmed most of the time to keep from blinding the eyes of the engineers on the trains that pass us going the other way. Bush jerks down on his whistle now and then, tooting a warning for a grade crossing. But there's no slowing down; the public wants speed, and the Limited is late. The chances of the motor driver who finds himself on a grade crossing in our path are less than one in a thousand. Bush depends on the other fellow to keep himself out of the way, just as he depends on the other fellow to give us a right of way down that shimmering path in front.

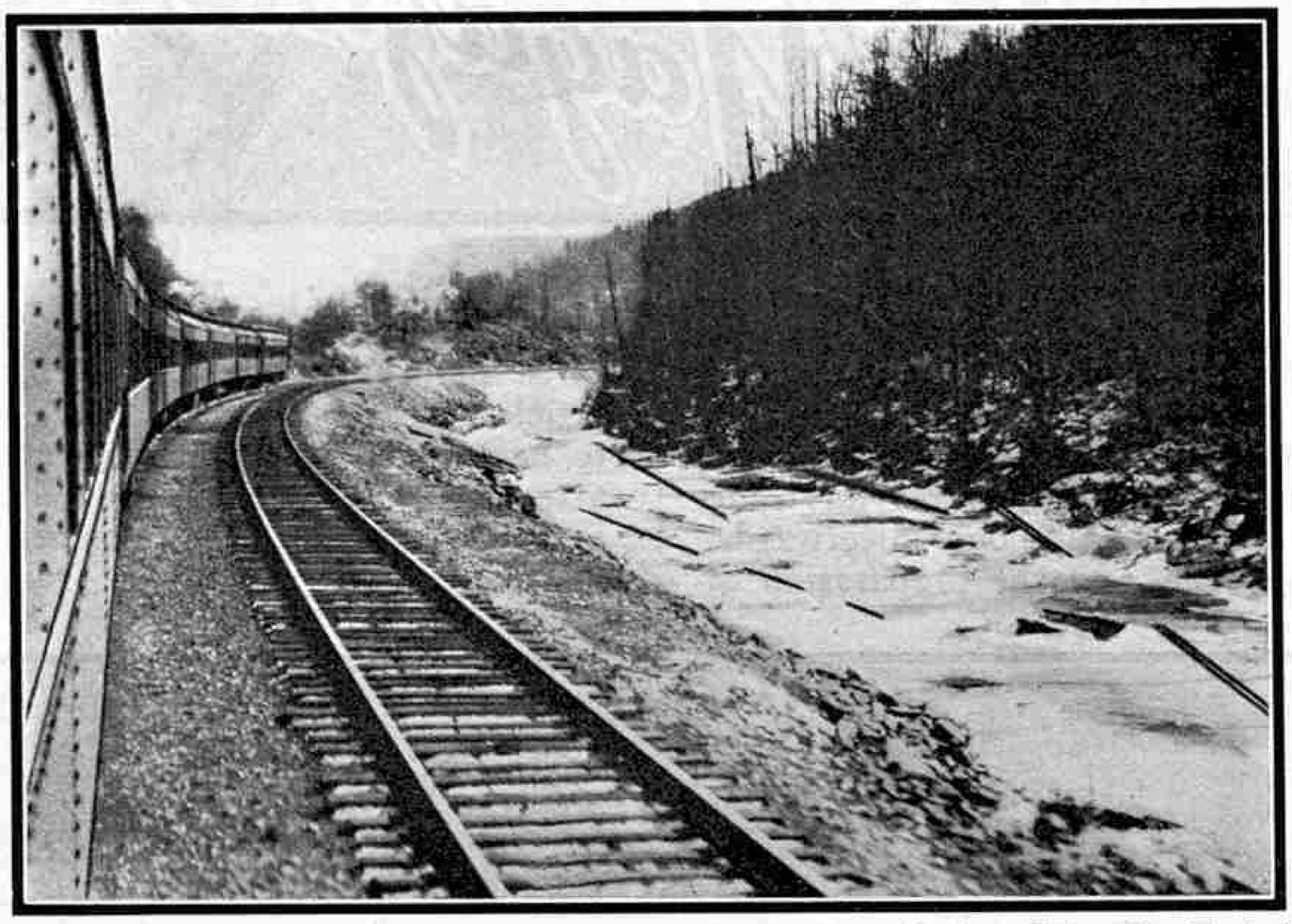
Somebody in a lonely switch tower along the humming rails pulls a lever that shunts the Limited from the fast passenger track we've been travelling to a freight track. The difference is almost as marked as the change from a concrete to a dirt road. Number 3749 increases her rattle and her bangs and her quick lurches in proportion. She also slows down some. The speed limit on a freight track is only 55 miles an hour.

Phelps, perspiration streaming from his ruddy face, comes over and screamingly explains the change. Even the Limited gets shunted off the fast passenger track sometimes and has to take a freight track. This time it is probably due to No. 8's difficulties with the careless automobile. Phelps has had so much explaining to do that he is beginning to get hoarse.

A string of yellow beads ahead signals Manhattan Transfer. No. 3749 slows down and stops, panting, at the far end of the platform, while Donohue, conductor, runs up alongside, watch in hand, checking up with his engineer over the cause of their running late. They both agree that it was No. 8's fault.

But there's little time for explanations. The Limited is allowed two minutes at Manhattan Transfer, and in this time No. 3749 bids good-bye and hustles off for a rest and a cleaning in a roundhouse a short distance away, while a sleek electric locomotive takes her place as pilot of the Congressional for the remaining nine miles into New York.

The new pilot is a colourless thing, but highly efficient as most colourless things are. It is quiet and clean. It moves over the rails with a smooth purr instead of the clanking, grinding, hissing roar that marks the progress of No. 3749.



Photograph] [*Railway Photographs, Liverpool*

Looking back! A photograph taken from the baggage car of the American "North Shore Ltd." At the time the photograph was taken the train was passing the scene of the recent disastrous floods at Beckett, Mass. Some of the rails of the destroyed track can still be seen in the river

Instead of Bush, iron moustache and grey hair, hand on his throttle and peering far out of his cab window through goggles that protect his eyes from the clouds of smoke, his figure half obscured at times by swirling steam, a young man sits in a chair, manipulating a lever and conversing easily in a drawing-room voice. Instead of Phelps, balancing himself on a swaying platform of slippery steel, tirelessly throwing shovel after shovel of coal into a white-hot fire, another young man sits in a chair and announces the signals as they bob up out of the dark. Behind them comes the swaying line of lighted coaches, just as speedily and just as faithfully as they followed old 3749. But the thrill of riding on an engine has gone, with No. 3749, to the roundhouse. We know that the electric power is there, but it is so silent, so easy, as to be altogether unimpressive.

The Congressional slips silently into the tube under the river, and a minute later discharges her passengers at the end of her run.

Famous Inventions (*continued from page* 651)

the vessel submerged.

During the Great War the need arose for submarines capable of accompanying the British Fleet on ocean cruises and this resulted in the production of the "K" class. These were large submarines of 2,650 tons displacement. They had steam turbines in place of the ordinary oil engines, and a Diesel engine was installed as auxiliary surface power. The first "K" class submarines were constructed with a flush deck, having a superstructure amidships that accommodated two above-water 18 in. torpedo tubes. Two anti-aircraft guns were mounted on the hull, one in front of and one behind the superstructure. Later this arrangement was altered, the torpedo tubes being removed and a navigating bridge screen built up on the conning tower, while the guns were transferred to the superstructure and the bows built up into a bulging form technically known as a "high clipper stem."

A feature of the "K" class was the two hinged funnels. When the vessel was preparing to submerge the steam power was used until exhausted and the electric motor was then brought into operation. The funnels were lowered into wells, which were then closed by watertight lids. The submarines were 338 ft. in length, 26½ ft. in width and 16 ft. in depth, with a maximum displacement of 2,650 tons. Storage was provided for from 200 to 300 tons of oil fuel. The crew of a "K" class submarine numbered 55.

The "*K 26*" submarine, laid down in July 1918 by Vickers Ltd., is of slightly larger size, being 251½ ft. in length, 28 ft. in breadth, and 16¾ ft. in depth. She is equipped with turbines giving a total of 10,000 h.p. and is capable of a surface speed of 23½ knots. When travelling submerged she is electrically driven and can maintain a speed of nine knots. Her armament consists of three 4 in. guns and eight torpedo tubes.

In 1915 Lord Fisher proposed the construction of a submarine having a big gun mounted on the superstructure. Three vessels equipped in this manner were built, and are known as the "M" class. They have a short 12 in. gun mounted inside a thin shield on the deck superstructure. These "M" submarines are 305 ft. in length, 24½ ft. in breadth, and 15 ft. 9 in. in depth. They are of 1,950 tons displacement, and when cruising on the surface are propelled by two sets of Diesel engines totalling 2,400 h.p. and giving a maximum speed of 15½ knots. When submerged they are electrically-driven and can attain a speed of 9½ knots. A crew of 60 is carried on each vessel.

In this and the previous article we have described the early efforts to produce a submersible boat and the lines upon which development has proceeded up to the large and powerful submarine cruisers of to-day. Next month we shall describe the mechanism and interior fittings of a typical modern submarine.

THE great difficulty in writing a description of the work of the Editor of the "*M.M.*" and his staff is to know where to begin. It would be comparatively simple if each issue of the Magazine were complete in itself, without connection with anything that has gone before or that will come afterwards. This is not the case, however, and the preparation of each individual issue is a task that begins months before the date of publication. For example, in order to understand how a Christmas issue is produced, it would be necessary to go back to the beginning of the previous summer, or even earlier.

A beginning has to be made somewhere, however, and so we will imagine that the Editor has before him what he calls a "dummy." This consists of an exact duplicate of the magazine, but with blank pages, and the task is to fill these pages with suitable articles and illustrations. First of all there are what might be called the "fixtures" to be considered. On the first page appear the Editor's notes, above which is the magazine heading with the number and date of the issue, and above that again a line drawing attention to the main feature of the succeeding issue. Then there are the continuations of serial articles to be inserted, the length of which is carefully worked out and the necessary number of pages in the dummy allotted to each. A rough note is made on the blank pages of the dummy accordingly.

These serial articles—such as "The Conquest of the Air"; "The Story of the Motor Car," etc.—frequently have the same heading block for two or three months in succession, but occasionally, as the articles progress, the heading block has to be changed to be in keeping with the current instalment, and due attention must be given to this. For other serial articles, such as those dealing with "Famous Aero Engines" and "Famous Trains," the heading may be changed entirely each month. Other fixtures are "Railway News"; "Air News"; "Engineering News"; "Books to Read"; "From Our Readers"; "Suggestions Section"; "In Reply"; "Competition Page"; "Stamp Notes"; "Fireside Fun"; and the pages devoted to New Meccano Models and Model-building Contests and their results.

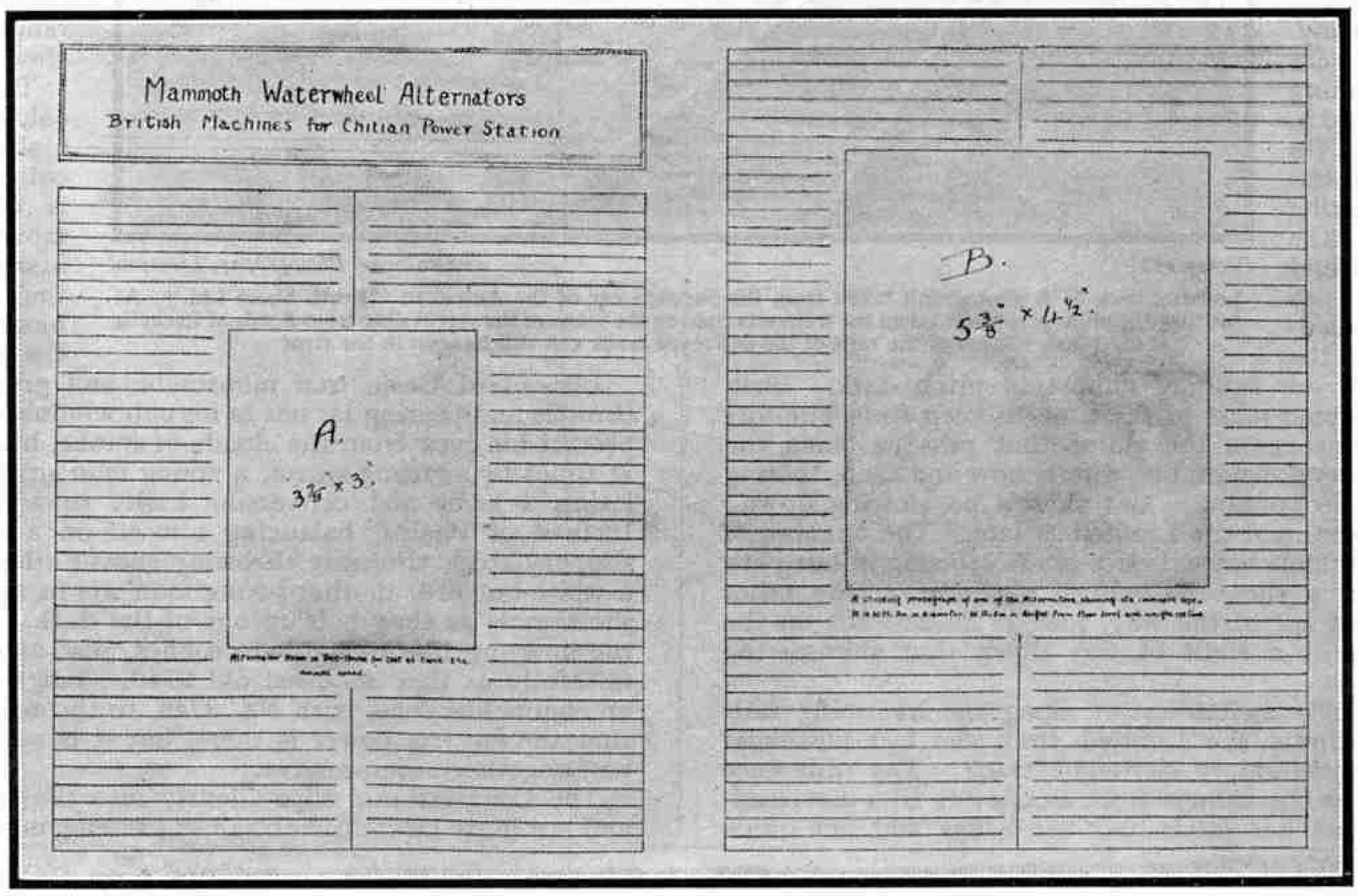


Fig. 1. This is the rough layout, as sent to the printer, for the two pages 626-7 of this issue. The position and size of the blocks are shown and the lines around these spaces indicate to the printer where the type is to be set

When the necessary space has been allotted to each of these sections there is a number of pages left for other articles, and from the available material a selection is made to fill the space. In addition to this, the advertisement pages have to be filled. Most of the larger advertisements may be regarded as fixtures as the advertisers are so satisfied with the results they obtain from the "*M.M.*" that their notices are inserted month after month. Then there are the readers' sales and wants, and also the small advertisements that alter every month, their appearance often being determined by the season of the year according to whether the goods advertised are of summer or of winter interest.

All this sounds quite simple as we have outlined it, but the carrying-out of the scheme involves an almost incredible amount of detailed work. As we

have already pointed out, it is absolutely necessary to plan ahead to a considerable extent and several months' issues are laid out well in advance of publication date. For instance, at the time this article is being written (early July) not only the August issue but also the September, October and November issues have been planned and exist in dummy form in the Editor's desk. The November dummy is a mere ghost of a "*M.M.*"; the October one is more life-like, and that for September is practically in its final form. As soon as the August issue has gone to press the details of the September dummy will be finally settled and the October and November issues advanced a step further, while at the same time the December dummy will be taken in hand.

The articles come from a variety of sources. Many of them are prepared by the Editorial staff, the members of which are experts on the different topics dealt with. They also have the valuable faculty of being able to communicate their knowledge to readers in simple and interesting language, and without the inclusion of technicalities where these can be omitted without any loss of accuracy. Other articles are selected from the large numbers sent by outside contributors. Every article that is submitted to the Editor is given critical consideration, and only those are accepted that contain something of really outstanding interest.

In addition there are the articles that are written specially and exclusively for the "*M.M.*" by recognised experts in their own particular line. As examples of these we may mention the series on "*Famous Trains*" by Mr. Cecil J. Allen, who is probably the most popular of all writers on railways; and the articles on running an aquarium by Mr. W. Coles-Finch, the well-known waterworks engineer and nature student. Other experts who contribute special articles from time to time are: Mr. R. D. Gauld, M. Eng., A.M. Inst. C.E., who writes fascinatingly on railway engineering; Mr. J. H. Shepstone, F.R.G.S., who tells of scenes and adventures in all parts of the world; and "Airman," a famous pilot, with whom we make imaginary flights in an aeroplane and learn exactly how the pilot handles his machine.

THE MECCANO MAGAZINE

pieces of wood tied to a rope in such a manner that, if a caiman could be persuaded to swallow the "bait," the more he pulled the more the pieces would widen out and stick into his jaws. The other end of the rope was securely hitched to a stake driven into the ground and the bait was slung close to the water's edge. In due course a caiman came along, investigated the contrivance carefully and eventually swallowed it.

Having caught the caiman, the next thing was to get him out of the water without damaging his armour. At first the party refused to have anything to do with this part of the process, but by a combination of judicious bullying and persuasion—including the chasing of one man for a quarter of a mile over a sandbank—Waterton succeeded in getting them to make the attempt. The first effort only brought the caiman to the surface of the water, but on a second and more vigorous attempt he was hauled steadily to the bank. Waterton's account of the subsequent proceedings is interesting:—

"I took the mast of the canoe in my hand (the sail being tied round the mast) and sank down upon one knee about four yards from the water's edge, determined to thrust it down his throat in case he gave me an opportunity. This was an interesting moment. I kept my position firmly, with my eye fixed steadfastly on him. By this time the caiman was within two yards of me. I saw he was in a state of fear and perturbation; I instantly dropped the mast, sprang up, and jumped on his back, turning half round as I vaulted, so that I gained my seat with my face in a right position. I immediately seized his fore-legs, and by main force twisted them on his back; thus they served me for a bride.

"He now seemed to have recovered from his surprise, and probably fancying himself in hostile company, he began to plunge furiously, and lashed the sands with his long and powerful tail.

"I was out of reach of the strokes of it, by being near his head. He continued to plunge and strike, and make my seat very uncomfortable. It must have been a fine sight for an unoccupied spectator.

"The people roared out in triumph, and were so vociferous that it was some time before they heard me tell them to pull me and my beast of burden further inland. I was apprehensive the rope might break, and then there would have been every chance of going down to the regions under water with the caiman. The people now dragged us above forty yards on the sand. It was the first and last time I was ever on a caiman's back. Should it be asked how I managed to keep my seat, I would answer, I hunted some years with Lord Darlington's foxhounds."

The caiman made desperate efforts to regain his liberty but after a while he became exhausted and was firmly secured.

Waterton was such a keen naturalist that he spent over £10,000 in building a high wall to convert his Yorkshire estate into a sanctuary for birds.

Incubator with baby alligators just emerging from the eggs. Above—their ultimate fate!

Conquest of the Air—(continued from page

less liable to oscillation. The diameter of the parachute was 34 ft. and it weighed about 400 lb.

The trial took place on 24th July, 1897. Green and a soldier named Spencer occupied the car of the balloon, beneath which was suspended the open parachute, having beneath it a small car in which Cocking was seated. The parachute greatly retarded the ascent of the balloon but eventually a height of about 5,000 ft. was attained, the balloon then being almost over Greenwich. Cocking signalled that he was about to free the parachute from the balloon and then manipulated the catch to effect this. For a few seconds the parachute descended rapidly and without oscillation, and then, suddenly, it was seen to collapse, crumple up, and fall at a greatly increased speed. At a height of about 20 ft. from the ground the car broke away from the parachute and crashed to earth, Cocking being literally dashed to pieces.

The sudden disengagement of the parachute caused the balloon to shoot upward at a great speed and it was with the utmost difficulty that Green and Spencer succeeded in checking its progress. Subsequently they effected a safe landing in the vicinity of Maidstone and then heard for the first time of Cocking's terrible death.

The Story of Oil—(continued from page

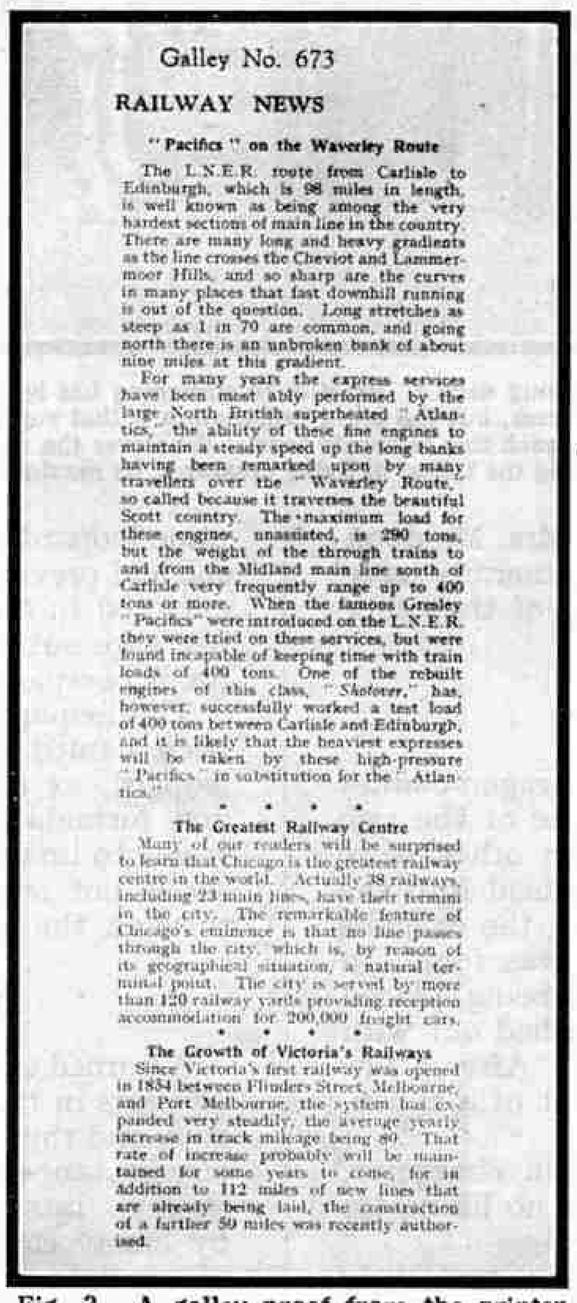
companies struck oil at a depth of 1,820 ft., and so prolific was the output that Mexico's reputation as a territory rich in oil was established beyond dispute. The thrilling story of how this great well caught fire and provided one of the most terrible conflagrations ever witnessed upon an oilfield will be related in a subsequent article. In January 1910, an equally vast supply was tapped in another Mexican well, at a depth of 1,911 ft.

These great "strikes" were the signal for a rush of prospectors to the new oilfield. Companies were hastily financed to exploit large tracts of land and when the boom was at its height more than 120 organisations were operating oil wells in Mexico. Of these, about one half ultimately closed down. It is of interest to note that more oil is nowadays brought up in Mexico during 24 hours than 20 years ago was obtained in the course of one week.

This is a sufficient indication of the enormous progress made in drilling machinery.

(To be continued)

Fig. 2. Showing a page proof as received from the printer with certain blanks to be filled. The blank in the right hand column was not then filled, but later was filled with more copy, as will be seen on reference to page 143 in our February issue. The lower portion of the page has been filled with the continuations of other articles



Galley No. 673

RAILWAY NEWS

"Pacifics" on the Waverley Route

The L.N.E.R. route from Carlisle to Edinburgh, which is 98 miles in length, is well known as being among the very hardest sections of main line in the country. There are many long and heavy gradients as the line crosses the Cheviot and Lammermoor Hills, and so sharp are the curves in many places that fast downhill running is out of the question. Long stretches as steep as 1 in 70 are common, and going north there is an unbroken bank of about nine miles at this gradient.

For many years the express services have been most ably performed by the large North British superheated "Atlantics," the ability of these fine engines to maintain a steady speed up the long banks having been remarked upon by many travellers over the "Waverley Route," so called because it traverses the beautiful Scott country. The maximum load for these engines, unassisted, is 290 tons, but the weight of the through trains to and from the Midland main line south of Carlisle very frequently range up to 400 tons or more. When the famous Gresley "Pacifics" were introduced on the L.N.E.R. they were tried on these services, but were found incapable of keeping time with train loads of 400 tons. One of the rebuilt engines of this class, "*Shotover*," has, however, successfully worked a test load of 400 tons between Carlisle and Edinburgh, and it is likely that the heaviest expresses will be taken by these high-pressure "Pacifics" in substitution for the "Atlantics."

* * * *

The Greatest Railway Centre

Many of our readers will be surprised to learn that Chicago is the greatest railway centre in the world. Actually 38 railways, including 23 main lines, have their termini in the city. The remarkable feature of Chicago's eminence is that no line passes through the city, which is, by reason of its geographical situation, a natural terminal point. The city is served by more than 120 railway yards providing reception accommodation for 200,000 freight cars.

* * * *

The Growth of Victoria's Railways

Since Victoria's first railway was opened in 1854 between Flinders Street, Melbourne, and Port Melbourne, the system has expanded very steadily, the average yearly increase in track mileage being 89. That rate of increase probably will be maintained for some years to come, for in addition to 112 miles of new lines that are already being laid, the construction of a further 50 miles was recently authorised.

Fig. 3. A galley proof from the printer showing some matter that could not be accommodated on the Railway News pages last month. Two of the paragraphs appear on page 646 of this issue

Practically every article that appears in the "*M.M.*" is illustrated and the selection and preparation of these illustrations requires a considerable amount of skill and care. In the majority of cases the illustrations are prepared from photographs, but drawings are used in certain instances. In any case a "block" for the printer's use has to be made from the original. The making of these blocks is an extremely interesting process and in a subsequent article we shall deal with it in detail, and also with the preparation of the fine coloured covers that are one of the most striking features of the magazine.

When the Editor has before him the manuscript of an article and the necessary photographs or drawings, he prepares what is called a "layout." If, for example, the article is to fill three pages, he takes three blank sheets of paper the size of the magazine page. He thinks out suitable headlines for the article, and indicates at the top of the first page the position for these and the size and style of type to be used. As an alternative he may decide to have a heading made up partly from photographs and partly from type, and in this case the artist department makes a sketch and a block is made from this material. The block will be the full width of the page and of a depth that is in proportion.

Having arranged the title, the Editor has to decide on the position of the illustrations and the scale upon which they are to be reproduced. He then draws on the blank pages in the required position a rough outline of the illustrations with an indication of their size in inches; and finally, indicates by rough pencil lines that the manuscript is to be set by the printer to fill the space around the illustration (see Fig. 1). The "caption" for each illustration has then to be drafted out, its position is indicated and the size and style of type to be used. Generally the captions in the "*M.M.*" are set in "Ludlow Bold" face of type, in 6 or 8 "point" size. (The "point" system of measuring type will be explained in a later instalment of this series).

Having drafted out the page and arranged the (*Continued on page* 694)

Notes from the Zoos

Sunshine for Chimpanzees
The Zoo's Centenary
A Modern Dragon
Recent Additions to the Zoo

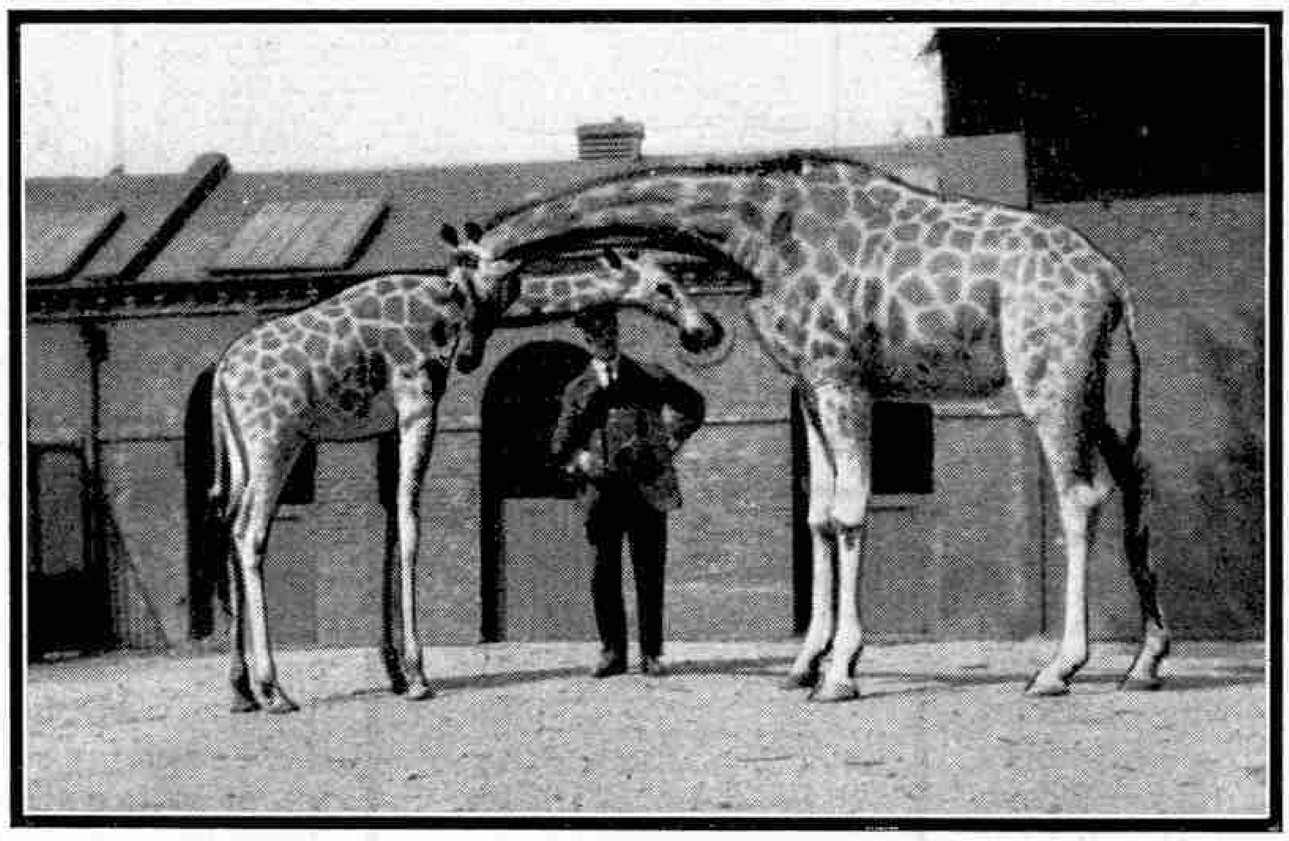
Concentrated Sunshine for Chimpanzees

Two members of the Edinburgh Radio Circle were recently restored to health by the application of one of the most important discoveries of modern science.

Their names are Nora and Boko, and together with a friend of theirs, by name Mrs. Muldoon, they had lost all the liveliness and high spirits that formerly characterized them. Events occurring around them aroused no interest, and Nora in particular became so obviously ill that it was thought that she would not live long.

The fact is that they belong to an alien race and the climate of Edinburgh does not suit them. They are chimpanzees, and in the days before their capture and transport to Scotland they were accustomed to great warmth and abundant sunshine. It is impossible to increase directly the amount of sunshine received in any one place, and merely warming up the room in which they lived did not prove sufficient to make life congenial for the three exiles. But scientists are now able to make preparations that contain concentrated sunshine in the form of what is known as Vitamin D, a somewhat mysterious substance that is found in cod-liver oil and elsewhere. The special preparation used in treating Nora and her companions is much more effective than cod-liver oil, however, four drops being equal to a spoonful of that notoriously unpleasant liquid.

The three chimpanzees were given daily doses of sunshine from the bottle, with astonishing results. Poor Nora had practically lost the use of her legs, but is now one of the most active animals in the Zoo. Boko, too, has become vigorous and healthy. He is so boisterous, in fact, that it is unsafe to take him out for a walk, so that he and his keeper have been deprived by Vitamin D of a pleasure that they enjoyed daily before he became too ill! Mrs. Muldoon also has recovered her old liveliness, and the results generally have proved so successful that it is to be tried on many of the other inhabitants of the Edinburgh Zoo.



How did the giraffe get its long neck? Practice in stretching has been suggested, as the animals feed on the leaves of high trees, but the usual explanation is that short-necked giraffes have been weeded out by inability to reach this favourite food. Whatever the cause, its long neck gives the giraffe the distinction of being the tallest of living creatures, its maximum height being about 18 ft.

Dragon Eats Out of a Spoon

The Komodo lizard that is usually described as a dragon cannot be a very fearsome reptile after all, for although one of the two specimens in the London Zoo is bad-tempered, the other is so tame that all last summer she could be taken on a lead into the Gardens for a walk. Kindness is the secret. When the dragons arrived in London, "Sumbawa," as she is called, was found to be suffering from canker of the jaw. Instead of being placed on show she was sent to hospital and her mouth washed out with lotion daily, a treatment that she seemed to relish. After a few weeks of this she became sufficiently tame to eat out of a spoon, a strangely undragon-like proceeding!

Of late "Sumbawa" has become more retiring in character. She is still amiable enough with her keeper, but has no liking for meeting other people and refuses to leave her cage.

At the present time there are several other comparatively tame reptiles in the Zoo. These include two small pythons, one of which is 8 ft. in length, and an eight-year-old crocodile. The latter is very small and it is easy to detect his two eyelids when he blinks. The outer of these eyelids is of the ordinary kind, while the inner one is used when the animal is swimming under water.

London Zoo's Hundredth Birthday

The London Zoo this year has celebrated its hundredth birthday. The Society that owns the famous gardens is actually older, as it originated in 1822, when a few members of the Linnean Society, an organisation interested in botanical studies, formed themselves into a Zoological Club. Two years later this club became the Zoological Society of London.

The first President of the Society was Sir Stamford Raffles, a famous Colonial governor who had spent many years in Singapore and the East Indies, a quarter of the globe that is a paradise for naturalists. Under his guidance a start was made on 27th April, 1828, when a Russian bear, an eagle, a vulture, kangaroos, leopards and deer were exhibited "for the amusement and interest of the public" in gardens constructed on 20 acres of land in Regent's Park.

In the 100 years that have since elapsed the Gardens have made wonderful progress. The area covered by them has increased to 34 acres and the animals in the collection now number more than 5,000. In addition a magnificent aquarium has been constructed and stocked at a cost of £26,000. A staff of more than 100 men is necessary to care for the animals and to keep the gardens in order, and the annual number of visitors is well over two million.

New-Comers to London Zoo

Among recent additions to the London Zoo are a young chimpanzee and a tame leopard cub. The chimpanzee is only 12 months old, and as she had previously been a domestic pet she did not appreciate being enclosed in a cage. Her temper is normally good, however, and her rage subsided quickly when she was given a young monkey for a companion.

The leopard cub is even younger than the chimpanzee and has been named Cleopatra. It is not quite safe to make a pet of a leopard, as the claws and teeth of this animal are really sharp and formidable. Cleopatra is no exception in this respect and seems to imagine that clothing is made to be torn to pieces. But she is not really vicious, and can be taken on a lead for a walk through the gardens.

Animal Released from Prison

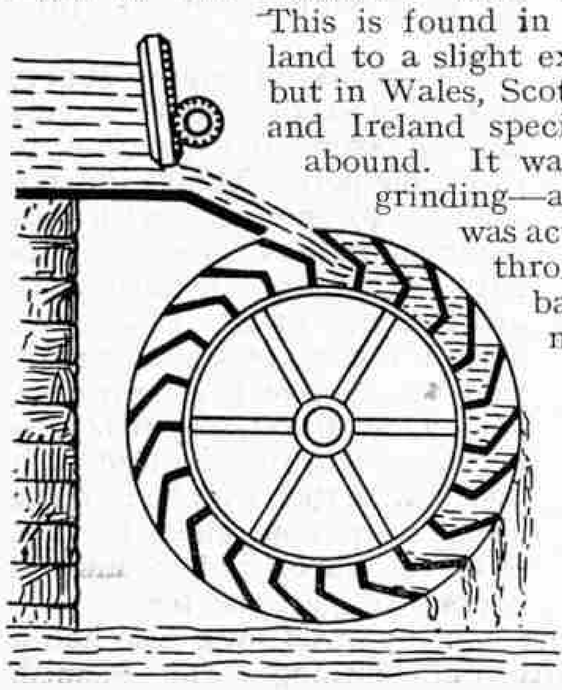
A horned toad now in the New York Zoo lived during the previous 20 years in the cell of a prisoner serving a life sentence in a Texas gaol, and thus added another to the list of strange pets kept in such circumstances. Many instances have been known of birds, spiders, rats and mice that have been tamed into friendliness by lonely captives, but this seems to be the first case on record of a prisoner making a pet of such a slow reptile. The special variety to which this specimen belongs is particularly ugly even for a toad. The creature will no doubt be much more comfortable in the Zoo than in a prison cell.

II.—TWO THOUSAND YEARS OF WATER POWER

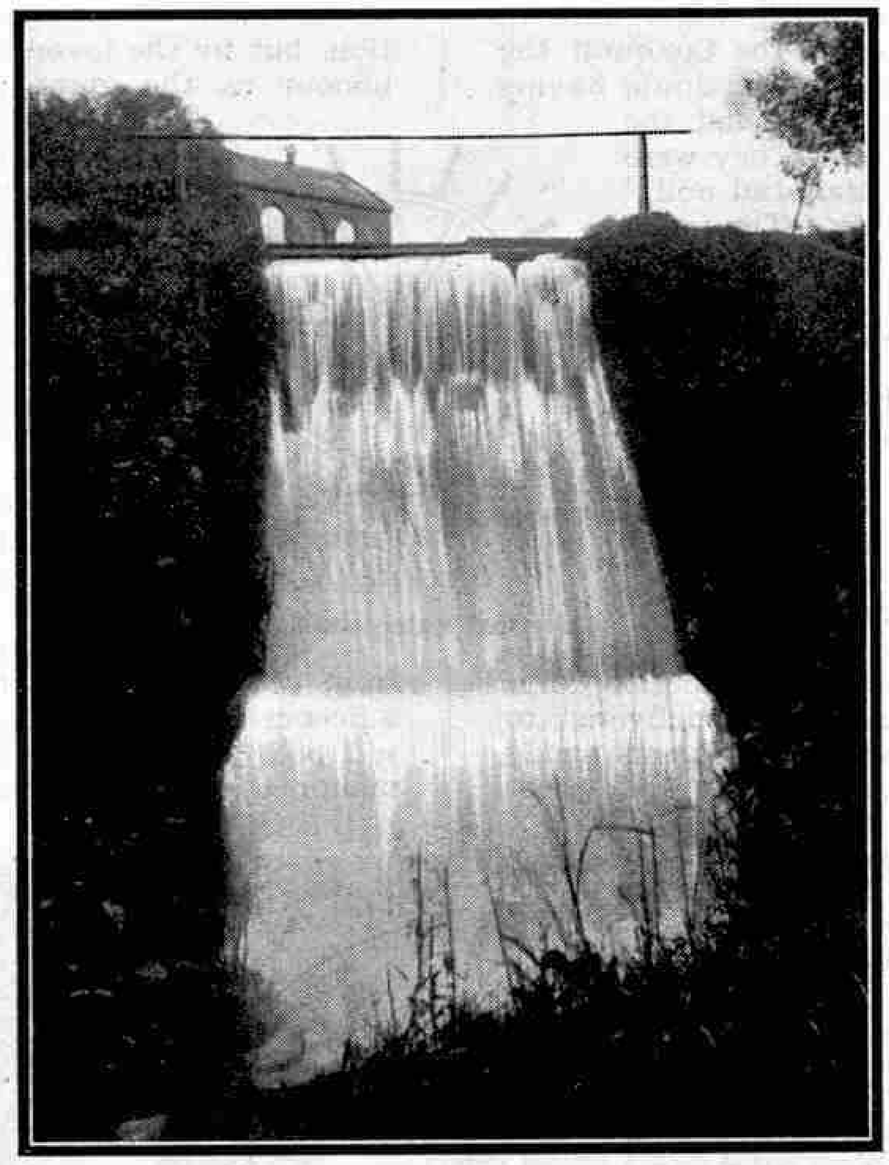
THE story of the wheat plant, from the first discovery in prehistoric Asia of its food value to developments in Canada, the granary of the modern world, was traced briefly last month, and we must now pass on to deal with the operations that turn the grain into the flour used in making bread. It has already been pointed out that in prehistoric times corn was simply crushed. Two stones were used for this purpose—a flat stone with a small hollow to contain the grain, and a crushing stone, not much larger than a man's fist, with which to pound the corn.

Another primitive contrivance was the pestle and mortar, adopted by the Israelites. It is certain that the pestle and grain mortar can be traced back as far as 1490 B.C., and the appliance was used by the Romans down to 173 B.C., the work being done by women. Among Eastern peoples of ancient times the hand stone mill must have been held of considerable value, for in the Bible we read of a warning against its theft: "No man shall take the nether or the upper millstone to pledge; for he taketh a man's life to pledge." (Deuteronomy, Chap. XXIV., v. 6.)

The Earth had passed through 4,000 of the 6,000 years of its recorded chronology before any other corn mill than the handstone was known. Throughout this period the stones underwent various changes. The common type of pounding stone and a more or less shapeless mortar, which by incessant use was beaten into a hollow cup, were followed by other crude types for pounding acorns, nuts and grain. The next step was the development of the "saddle" corn stone. This is found in England to a slight extent, but in Wales, Scotland, and Ireland specimens abound. It was the first contrivance by which grinding—as distinguished from pounding—was actually effected. It has been used throughout the world, enduring in barbaric ages and surviving in the midst of Grecian and Roman civilization, and it is still in use in many places.


Overshot water-wheel

The saddle-stone derives its name from the resemblance of its concave upper surface to the seat of a saddle. In this hollow the grain was rubbed or ground by a small stone muller, worked backward and forward, but not rolled. Pictures of the Egyptians thus employed are found in the decoration of the tombs of Kings.


The safety valve of the mill pond. Surplus water flowing over the weir

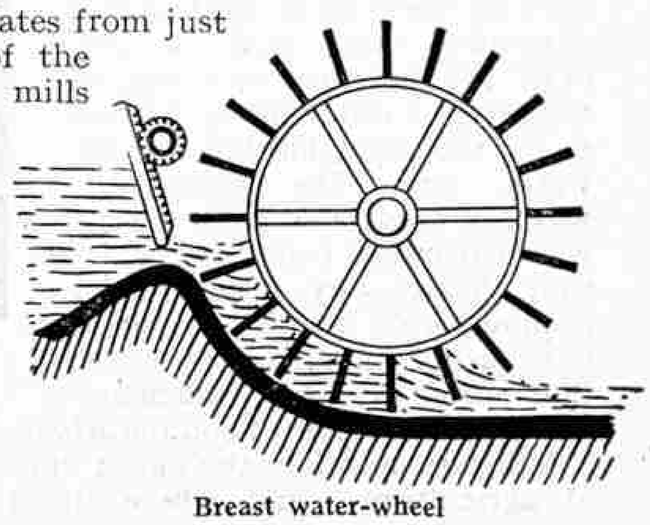
The various forms of archaic handstones culminated in the Roman quern. This was not known until 2,000 years ago, and it was the earliest complete grinding machine, the upper stone revolving upon the lower. From this were developed revolving mills known as "slave" and "cattle" mills of all kinds. The earliest allusion to revolving mills of this type occurs about 200 B.C., in the writings of Cato. In Rome, criminals were made to turn them, and according to Apuleius (about 170 A.D.) these unfortunate people were shockingly treated. He wrote:—

"Ye Gods, what a set of men I saw! Their skins were seamed all over with marks of the lash; their scarred backs were shaded rather than covered with tattered frocks; some wore only aprons; all were so poorly clothed that their skin was visible through the rents in their rags! Their foreheads were branded with letters; their heads were half shaved; they had irons on their legs; they were hideously sallow, their eyes were bleared, sore, and raw, from the smoke of the ovens; they were covered with flour as athletes with dust."

Another writer tells us "they wore yokes or collars of wood of such a size that the hand could not reach the mouth, lest any hungry wretch should eat the grain it was his business to grind."

Mills operated by slaves and criminals are mentioned as early as 200 B.C. by Plautus, and the principal remains of them are those unearthed at Pompeii. Roman writers of about 100 B.C. allude to the ass mill, so that we may safely assume that slave mills were followed by the cattle mills of mediæval times. There exists a reference to one erected at Dunstable Abbey in 1295.

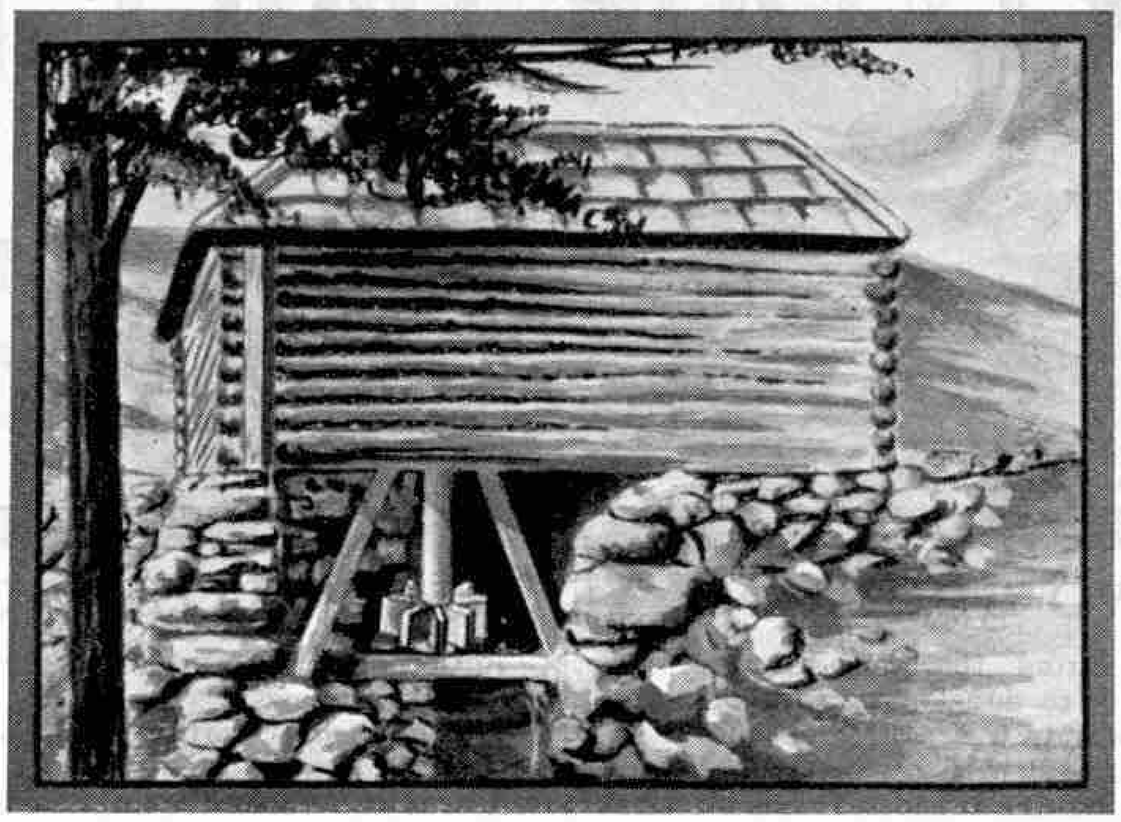
The use of natural power dates from just before the commencement of the Christian era, when water mills were first established in Greece, and the study of their development abounds with interest. First came the primitive mill with horizontal wheel, known as the Norse mill. It was small and of crude construction and developed little power, but it was sufficient for the small demands made upon it. The shaft-wheel was placed in


Breast water-wheel

the bed of the stream in such a position that, as the water rushed along, it turned the vanes or paddle blades, which in turn revolved the small mill-stone attached to the top of the shaft. These mills were protected by a rough shelter of stone or timber, erected upon a timber platform set astride the stream. The Norse mill was probably introduced into Great Britain by the Teutonic tribes who overran these islands in the fifth century.

In due course the Roman type of mill, with a vertical wheel, reached Great Britain. It was extensively adopted throughout the kingdom by the Saxons, and gradually it displaced the Norse mill.

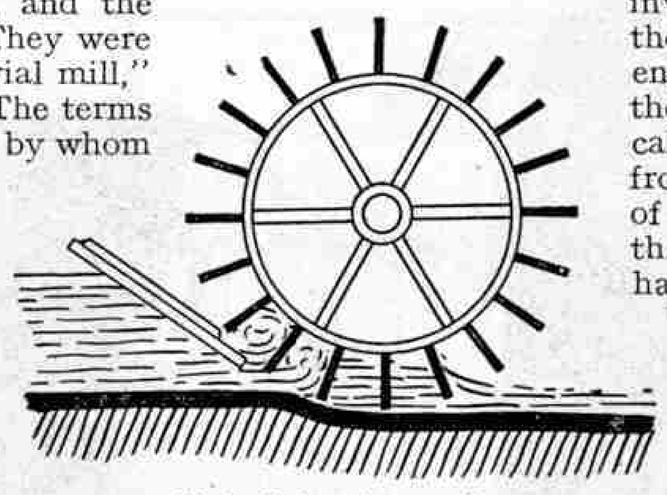
The earliest mention of an Anglo-Saxon mill occurs in the foundation charter of Medeshamted Abbey, dated 664. This charter is regarded by some authorities as doubtful in character, but in the year 762 there is a reliable reference to charters in reference to mills, granted by Ethelbert of Kent, and subsequently a prodigious number of mediæval charters mention corn mills that stood near rivers and bridges and must, therefore, have been water mills.



A Norse Mill, the earliest type of power mill. The paddle wheel turned by the stream drove the grindstones in the mill above

The Domesday Book (1080-1086) records 7,500 water mills in England, thus revealing the fact that prior to the Conquest the country abounded with mills, the smaller streams no doubt having the trifling structures of Greek or Norse type, and the river courses the more complete Roman mills. They were known as "King's mill," "Town mill," "Manorial mill," "Monastic mill," etc., according to ownership. The terms on which they were rented and the names of those by whom they were built are given in full.

These mills included examples of three kinds of water-wheels that are named from the manner in which the water actuates them. The most familiar is the "overshot wheel," which is driven by water shot over from the top, the buckets of the wheel receiving the water as nearly as possible on the top and retaining it until they approach the lowest point of descent. The water acts principally by gravity, though some effect is due to the velocity with which it strikes the wheel-buckets. Another form is the "breast-wheel." The water driving this is delivered to float boards a little below the axle of the wheel, and it acts partly by impulse and partly by weight. There is also the "undershot-wheel," in which the water is delivered to the float boards at their lowest point, and acts entirely by its momentum.



Undershot water-wheel

If we take the theoretical power of a water-wheel to be 1, then the relative efficiency of the three forms is approximately as follows :—Overshot-wheel .6, breast-wheel .5, undershot-wheel .3. Thus we see that the familiar overshot type has a decided advantage. There are, however, many matters to be taken into consideration in deciding the form of wheel to be used in any particular case, such as the limit set by the variation of the level of water in the "head race," the available fall for the water, etc. The undershot-wheel is rarely met with except where peculiar conditions exist that make any other form impracticable, and where there is such an abundance of water that economy and efficiency are considerations of comparatively little importance.

Closer view of paddles and shaft of a Norse Mill

Mills are certainly the oldest among the surviving "antiquities of agriculture," and where the buildings have been renewed again and again in the course of centuries the site of the mill and the mill cut to-day is often exactly the same as that occupied by each in Saxon times. This can be verified by anyone who will note the position of an old mill he knows and compare it with the record of the Domesday Book, in which every mill existing in England in 1068 was registered and assessed. These were nearly all Saxon mills built before the Conquest, most frequently by some far-sighted abbot or prior of a monastery, who first cut the mill stream and converted "force" into "energy."

The mills immediately attached to the abbeys and monasteries were probably the largest and best in the country. There the corn was ground for the great and growing garrison of "clerks," whether priests or lay brethren, who swarmed within the abbey walls. Busily occupied either in daily work or in daily prayer, the earlier monastic brethren earned their bread thoroughly, and the abbots and priors saw that they got it. There are plenty of abbey mills grinding corn to this day, though not for holy "clerks."

In this country the reputation of the monks was badly shattered by the calamities of the Reformation, but by the lovers of country-life they will always be held in honour as the great pioneers of agriculture. They were the inventors of most good things in the orchard, the garden and the farm, in addition to being engineers, architects and builders in what in those days was practically a wilderness. The calibre of their work as landowners may be judged from their splendid barns, many typical examples of which still remain. It is interesting to recall that even the famous Thomas à Becket tossed hay and bound sheaves in the field.

Water mills provided the only means of grinding corn throughout the middle ages and their ownership was one of the great grievances of the period. By the time of Richard II the mill monopoly owned by the lords of the manors was becoming intolerable. No one could build a new mill without a licence from the Crown, and it was about six times as difficult to get a licence to build a mill to grind flour as it was to get a licence to sell beer and spirits. The peasants, in their revolt against the manor system, included among their demands one that they should be permitted to use hand-mills to grind their own corn. At that time no tenant was allowed to take his corn to be ground anywhere except at his lord's mill, and the lord of the manor, if he were needy, unscrupulous or extortionate, was able to grind the faces of the poor while he ground their corn.

The riches of many abbeys and monasteries were largely derived from participation in this monopoly. Things did not always go merrily with the monkish millers, however. In 1314 A.D., for instance, the great Abbey of St. Albans was kept in a state of seige for more than ten days by the townsmen, who were driven to frenzy by not being allowed to grind their own corn in their own hand-mills. They were compelled to take it to the abbey millers and, of course, to pay the fee.

It is of interest to recall that our ancient water mills also had a direct and vital association with our clothing. The Flemish inhabitants of what is now Belgium were early buyers of the wool

The bridge across the River Medway at Rochester, with the old tide mill on the right. The water required to work the mill was stored at high tide in large ponds, where it was retained as the level in the river fell until the head of water was sufficient for successful working. Two windmills are to be seen in the background

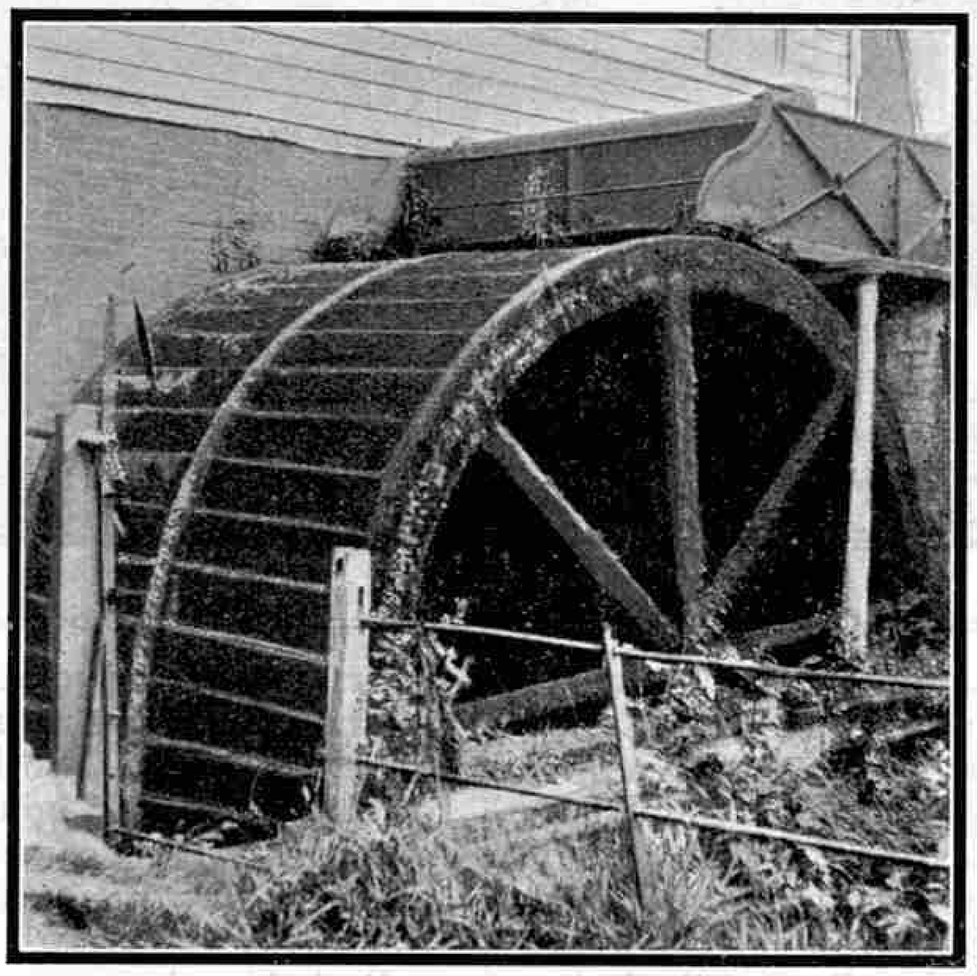
for which England was famous, and they wove it into splendid cloth. About the year 1338, Edward III invited some of them to establish their weaving industry in this country and the invitation was accepted. Here they cleansed and whitened the wool in the rushing water of the clear streams, aided by "Fullers earth," a kind of clay that they found in abundance. They also harnessed the powers of the streams to drive their mills, many of which to-day bear the name of "Fulling mills," from the clay used for cleansing.

These old engineering works have been generally abandoned. Apart from the competition of steam power, difficulties arose from the small amount of power developed from the falling water and from the unreliability of the flow of the streams owing to the vagaries of the seasons. Some idea of their profusion in former days is indicated by the fact that as late as 1913 nearly 60 mills were driven by water power in the Medway Valley alone. The majority of these mills are in a state of picturesque decay, but many of them have been converted to a new use. The streams that formerly served to grind our daily bread are now the means of providing the paper for bank notes and postage stamps, and for superior hand-made paper of all kinds.

The old water mills played a great part in the progress of our civilisation in other ways. As an example we may note their use in the iron industry. As most "*M.M.*" readers know, this industry was carried on in former times in the richly wooded country known as the Weald in Sussex and Kent, as wood charcoal was used in the smelting process long before the use of coal and coke was developed. One centre of the industry was Horsmonden, where the stream was embanked and converted into a large pond. The water thus enclosed actuated a wheel that in turn conveyed power to the forges where huge hammers beat the iron into shape. Nothing, of course, now remains except the extensive pond and the mill-race down which the surplus water still runs.

Besides using the fall of water in streams for driving mills, the power of the tides was similarly utilised before the introduction of steam power made such methods unprofitable. Few of these tide mills now remain, and two great weaknesses are responsible for this. One is that the rise and fall of the tides is small, while in addition an enormous amount of water is required, and storage conditions are therefore difficult. To develop one horse-power a rise and fall of 10 ft. is necessary, with a run of four tons of water per minute.

The tide mill was invented about the tenth century, one existing at Dover when Doomsday-book was compiled. The majority of later mills appear to have been on the Sussex or Essex coasts, where the tides have a range up to 20 ft. or more.



A once busy water-wheel now moss-grown and decayed

A very interesting mill was built at Woodbridge in Suffolk. This relic of olden days is nine miles inland and may still be seen working when the tidal conditions are suitable. It has an old oak timber-built wheel 20 ft. in diameter and of great breadth. As this great wheel goes round and round it drives four pairs of heavy stones to make flour, pig and poultry meal, sharps and pollard, the flour being still used for bread-making. The age of this mill is uncertain, but it is recorded that about 740 years ago a mill standing in the same spot was leased to the prior and canons of St. Mary's Church, for a yearly rental of a pound of cummin, the value of this medicinal herb in those days being twopence per pound. Corn is still brought in barges to feed this mill. The mill-pond is five acres in extent, and the whole surroundings attract many visitors, and particularly artists.

Other tide mills still in working order are to be found at Eling, three miles from Southampton, and on the shores of Milford Haven, in Wales.

On the banks of the River Medway at Rochester and Strood were the sites of interesting tide mills, none of which is now working. The mill at Rochester was built below the castle and it seems that the tidal waters impounded by the castle moat provided the means of actuating it. This was probably erected to provide flour for the monks of the Priory of St. Andrew. The river afforded a bountiful supply of fish, including salmon, and thus the Medway, both directly and indirectly, provided two of the most important articles of food. With the dissolution of the monasteries the monks were dispossessed of the Priory, and there now remains little of the original buildings.

The mill at Strood was built upon the sloping bank of the river, the part that projected over the river being carried upon piles of wood. Underneath was the waterwheel, and the other large wheels, all made of iron, which drove the machinery above. At high tide this was all covered with water but at low tide it was open to view, and many a pedestrian passing over old Rochester Bridge has stopped to watch the roaring driving wheel, as it was forced round by the water let loose upon it from the penned-up pond above.

It appears that this mill was from 200 to 300 years old, was pulled down when the first unsightly railway bridge was thrown across the river, and ceased to be used as a mill in 1858. It consisted of two waterwheels, between which hung the heavy sluice gate. This was hinged on the top, swing-like, a huge flap opening inward and admitting the rising waters, and closing automatically when the tide fell, thus imprisoning the water. It drove altogether five pairs of stones. One of the wheels drove two pairs of wheat stones and one pair of barley stones; the other wheel drove two pairs (*Continued on page* 669)

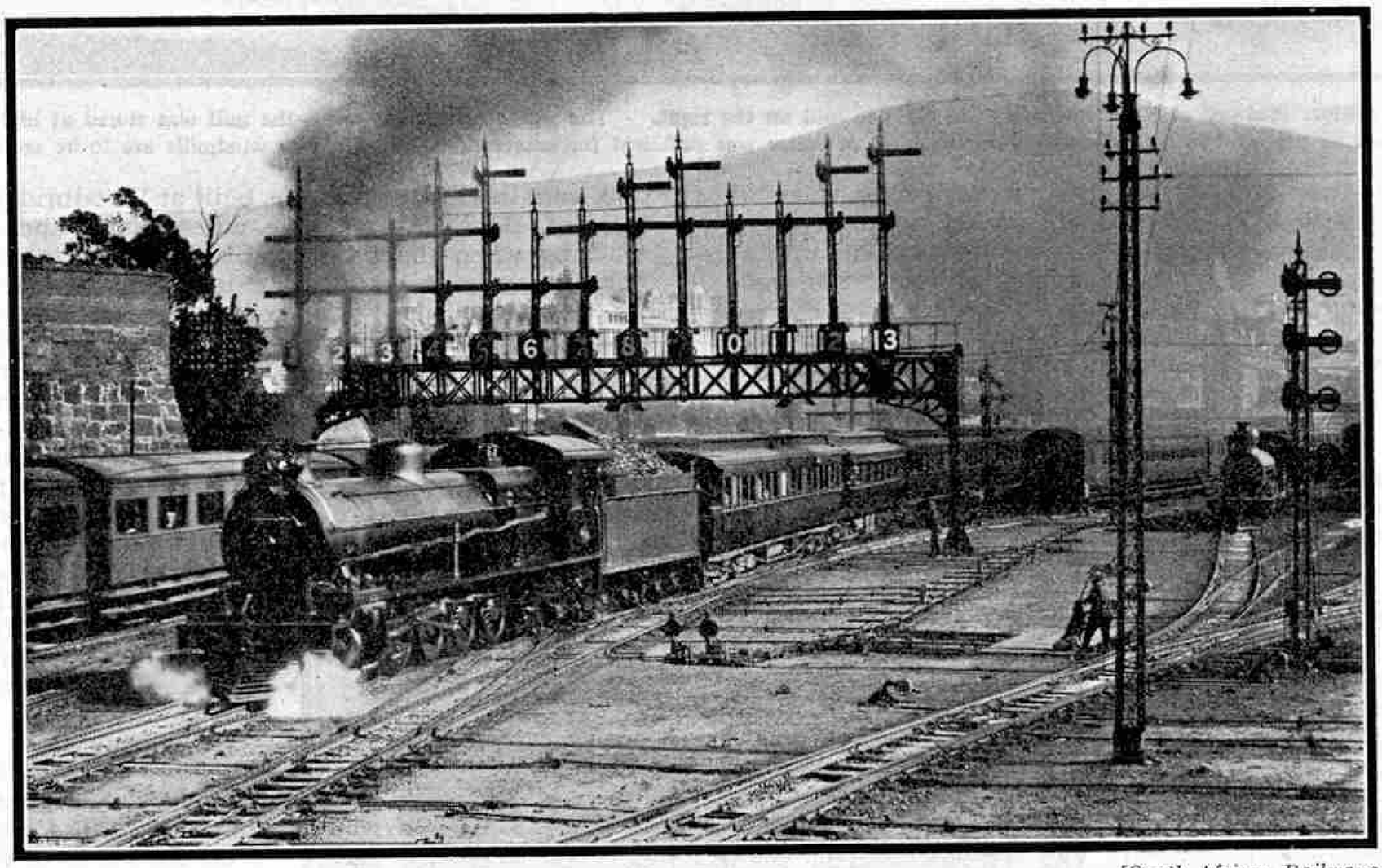
FAMOUS TRAINS: XX.

The "*Union Express*," South African Railways

By Cecil J. Allen, M.Inst.T., etc.

ONCE again those travelling bags of yours will be in request this month, for we are to make an even longer journey than that which took us across the Atlantic to Canada, and yet further over the American Continent to Vancouver. Another of the British Dominions now claims our attention.

Over the 16-day sea voyage from Southampton we have no time to dwell, but the ship that has brought us from England is lying at anchor in Table Bay, under the shadow of the singular and characteristic shape of Table Mountain—the landmark of the Southern Seas, as it has been called. Very likely on the morning of this day it is wearing its "table-cloth"—a mass of flat cloud or mist wrapping itself round the flat top of the mountain. But we shall have little time for the beauties of the Cape, which might well occupy us for days; for as soon as we set foot in Africa we are going to board the train that is to take us up-country for the best part of a thousand miles from the city of Capetown. From the morning of to-day till the evening of to-morrow we shall be comfortably ensconced in the "*Union Express*" of the South African Railways, on our way northward to Johannesburg, or "Jo'burg," as it is often affectionately called by the South African.



Courtesy] [South African Railways

"*Union Express*" leaving Capetown with 4-8-2 locomotive. (Note the electric headlight, with dynamo)

This being Monday morning, the day of the arrival of the mail steamer from England, the South African Railway authorities have kindly sent the "*Union Express*" down to the docks to fetch us. Only on Mondays and Fridays does this famous train run. On Friday mornings it starts direct from the main terminus of the S.A.R. in Capetown at 10.45 a.m., but on Mondays from the Docks at 10.15, leaving the Monument Station, on the suburban lines, half-an-hour later, at 10.45. It is a strictly limited train, carrying first-class passengers only, and unless we had been farsighted enough to secure our places beforehand there might have been some doubt as to whether we should have got on board at all. But it is well worth our patronage, as the next train up-country does not leave until four o'clock in the afternoon, and takes all but 10 hours longer on the trip of 956 miles than our "crack" express.

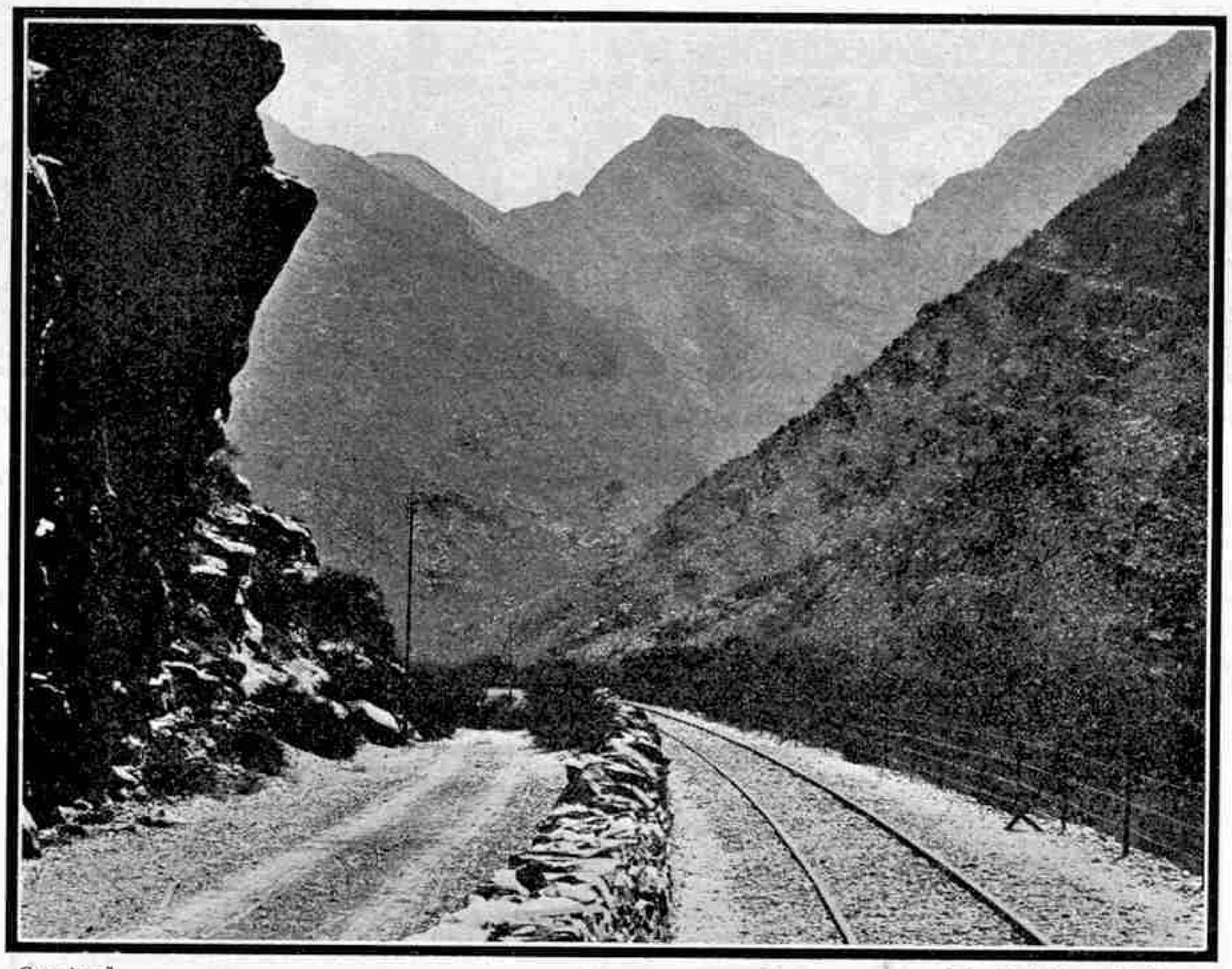
In spite of my use of the word "crack," however, we need not look forward to anything in the way of high speed. For reasons that you will appreciate presently, the overall time of 29¾ hours entails an average rate, stops included, of 32 miles per hour. On the return journey this time is cut to just under 28½ hours. Both figures are an enormous advance on the time of 44¾ hours that operated before the Union of South Africa came into being in 1910, since when unceasing progress has been made by the South African Railways.

Probably, before we take our places in the train, the track over which we are to run will attract our attention. It is possible that you saw the South African train when it was on exhibition at Wembley in 1923 and 1924; you may, indeed, have had lunch or dinner in its excellent restaurant car. But if not, your astonishment will be excusable when you find that you are to travel in vehicles that are slightly lower on the wheels, perhaps, but in length and width just as big as those to which you are accustomed at home—over a gauge but three-quarters of the British standard

Dimensions of "Mountain" Type (4-8-2) Main Line Passenger Locomotives, South African Rlys.

	Class 15A	Baldwin Type
Cylinders, diameter	22 in.	23 in.
" stroke	28 in.	28 in.
Driving Wheels, diameter	4 ft. 9 in.	4 ft. 9 in.
Heating Surface: Tubes	1,834 sq. ft.	2,579 sq. ft.
" " Firebox	192 "	201 "
" " Superheater ...	549 "	702 "
" " Total	2,575 "	3,482 "
Firegrate Area	40.0 "	48.3 "
Working Pressure (per sq. in.) ...	170 lb.	200 lb.
Adhesion Weight	62 tons	71 tons
Weight of Engine (in working order)	88 tons	101½ "
Tender Water Capacity	4,250 gals.	7,200 gals.
" Coal "	10 tons	12 tons
Weight of Engine and Tender (full)	142¾ tons	166¾ "
Tractive Effort (at 85% Wkg. Press.)	33,400 lb.	44,180 lb.

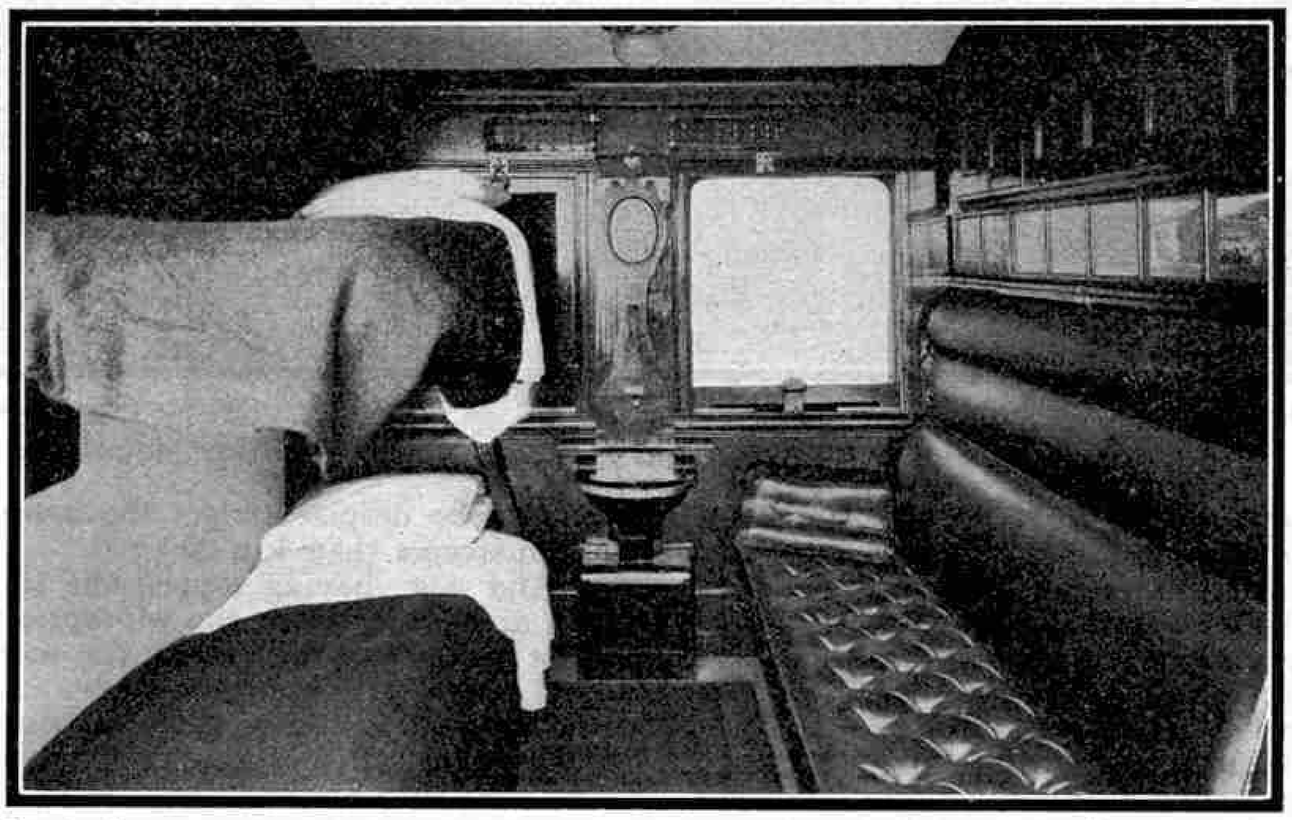
figure of 4 ft. 8½ in. The first beginnings of railways in both the Cape and Natal, in 1859, were on the 4 ft. 8½ in. gauge, but when the mining areas in the interior of South Africa began to be developed and railway communication with the sea became imperative it was realised that to connect the interior with the coast on the wider gauge would be an unjustifiable expense. A narrower gauge would allow much more latitude in the engineering, enabling the engineers to employ a sharper curvature and to carry their lines round the contours of the mountainous intermediate country, thus saving much cost in the matter of cutting and embanking, bridging and tunnelling.



Courtesy] [South African Railways

Entering the Hex River Pass

Consequently it was decided to use a gauge of 3 ft. 6 in., which has served South Africa well, and is now in practically universal use south of the Equator. Should the dream of Cecil Rhodes ever materialise in the shape of through railway communication from the Cape to Cairo, it will not be possible for the "*Union Express*" to make the through journey, as the railways of Egypt are laid to the standard gauge of 4 ft. 8½ in. But as yet more than 1,000 miles of largely unexplored country lie between Bukama, in the Belgian Congo, most northerly point of the railway systems in South Africa, and Sennar, on the Upper Nile, which represents the most southerly tentacle of the railways of the Soudan, before the through railway route becomes an accomplished fact.



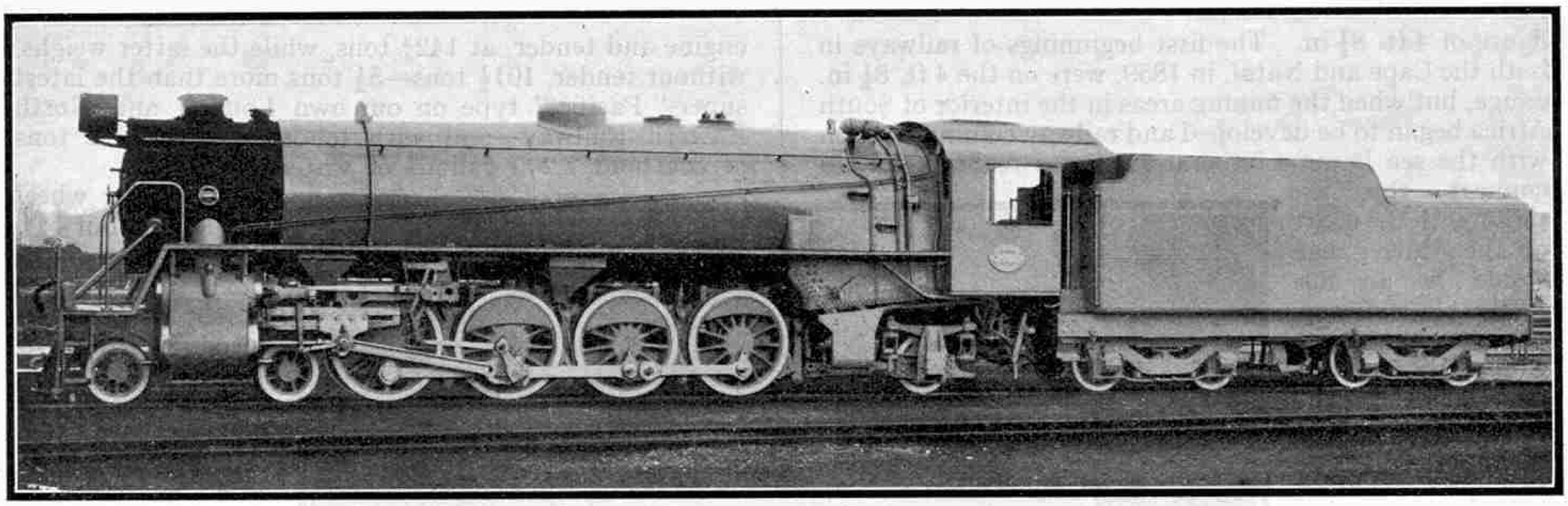
Courtesy] [South African Railways

First-Class compartment of "*Union Express.*" The two beds have been made up on the left hand side of the compartment

Despite this limitation in gauge width, the South African Railways now mount on their tracks locomotives of greater size and weight than the biggest in Great Britain. In all probability we shall find at the head of our train a powerful "Mountain" (4–8–2) type locomotive, with eight-wheeled tender, either of the "15 A" class, which is seen in the picture of the "*Union Express*" leaving Capetown, or of the later Baldwin-built type. The former turns the scale, engine and tender, at 142¾ tons, while the latter weighs, without tender, 101½ tons—5½ tons more than the latest super-"Pacific" type on our own London and North Eastern Railway—and with tender, carrying 12 tons of coal and 7,200 gallons of water, 166¾ tons.

A coupled wheel diameter of but 4 ft. 9 in. clearly indicates that tractive effort rather than speed is desired. The fastest runs in South Africa that I have been able to trace do not exceed an average speed of 40 m.p.h. between stops, and 30-35 m.p.h. is the more common figure. If we touch so much as 50 m.p.h. at any point we shall be doing well. Why, then, the need for this tremendous tractive power? We shall not be far on the way out of Capetown before the reason will be apparent. Striking external features of the engines are the "cow-catcher" and the powerful electric headlights, which generate their own current. Both are reminders that in a country like South Africa railways are not fenced, and provision must be made for seeing possible obstructions and dealing with animal "trespassers" on the line.

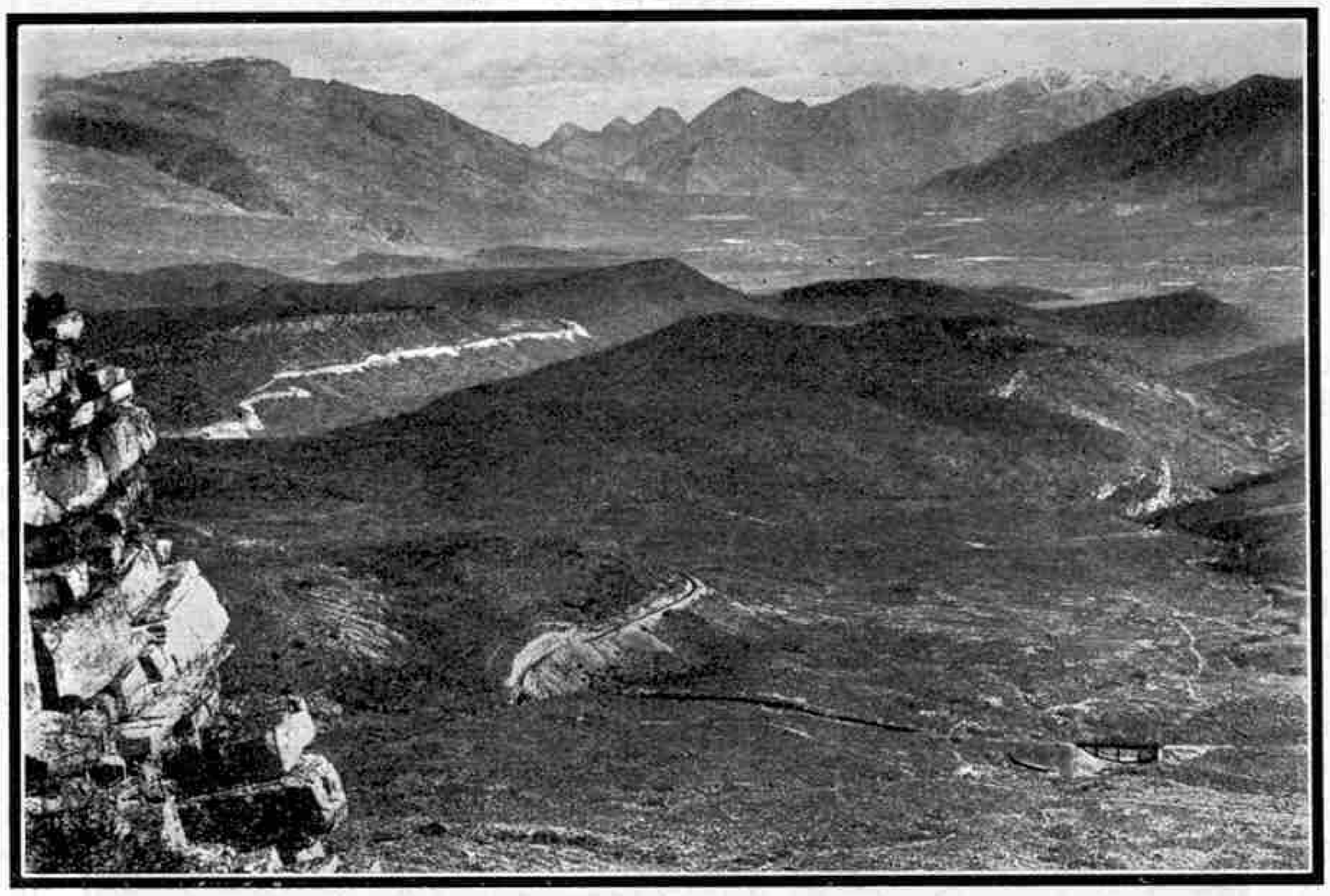
Our train is made up of first-class coaches, a restaurant car, and a van or two for baggage and mails. The coaches are each 63 ft. in length and are divided into five ordinary compartments and three half or *coupé* compartments apiece. Every compartment has its own wash-basin, with hot and cold water laid on, which we shall find of no small use on some of the dustier parts of the journey. The width of the coaches is 8 ft. 9 in., which is within a few inches of our British width dimension, but these first-class compartments are not arranged to hold more than two a side, so that we have plenty of elbow-room. The dining-car, it is interesting to find, is a "twin" coach articulated on the Gresley principle. One of the two coach-bodies is the large open dining-saloon, and the other contains



4-8-2 ("Mountain") type Baldwin-built Passenger Locomotive. South African Railways

the kitchen and pantry, and sleeping compartments for the restaurant car staff who, like ourselves, are going to sleep on board. And, by the way, if we want to be economical, we can go to the chief steward on the restaurant car, before we start, and obtain from him a book of tickets covering all the meals on the journey, by which procedure we shall save two shillings a day!

There is a very busy suburban train service round Capetown, of which we shall see plenty of evidence shortly after starting. The busiest routes are those from the Monument Station to Seapoint, and from the main station to Wynberg, the Cape Flats line, and over the main line to Bellville, all of which have train services throughout the day at 15-minute intervals or less. The number of suburban passengers carried in the year amounts to well over twenty millions, and a start has been made with the work of electrification. At the Monument Station we shall see that the Seapoint suburban trains are already being worked electrically, and work is now proceeding rapidly on the 22-mile stretch through Wynberg to Simonstown.



Courtesy] [*South African Railways*

The sinuous course of the S.A.R. main line among the Hex River Mountains

Promptly at 10.45 a.m. we are away from Monument, on our journey northward. Soon we are passing Salt River, a busy suburban junction with a power-operated signal-cabin, where the Wynberg and Simonstown line leaves us; and at Maitland, a short distance farther on, we part company with the Cape Flats line. Talking of signals, we shall not have failed to notice that in South Africa the semaphore arms rise into the "upper quadrant" when pulled off, instead of falling; ere long this is to be the standard in Great Britain also. Bellville is another important junction where a couple of lengthy branches diverge, one to Saldanha, on the west coast, and Bitterfontein, 289 miles out of Capetown; and the other going eastward over the Sir Lowry Pass to Caledon and Bredasdorp, 156 miles out. The mountains of the Cape Province are in view ahead of us, and already we have begun to rise; in the 15 miles from Maitland to Kraalfontein we ascend all but 300 ft. This, however, is only a beginning.

The first stop is at Wellington, 45 miles out of Capetown, which we must clear at 12.3 p.m., 78 minutes after starting, the booked start-to-stop speed being about 36 m.p.h. Next comes a stop at Wolseley, 40 miles on, at 1.22 p.m.; at Porterville Road the line, which has been heading northward through the hills, bends completely round to a south-easterly direction for some distance. Through Worcester, an important junction, we pass without stopping, now at a level of 795 ft., 109 miles from Capetown, and with the mountains closing in ahead. At Hex River, 15 miles farther on, and 1,275 ft. above the sea, climbing begins in real earnest. In the course of the next 21 miles, through the Hex River Mountains, we are to ascend to an altitude of 3,147 ft. at Matroosberg. For mile after mile the engine toils unceasingly upward; the "ruling" or steepest gradient is 1 in 40, and the curves sharpen to a minimum radius of 330 ft. Advantage is taken of every kloof and ridge to obtain the development of the line necessary to overcome these great differences in altitude. Travelling "up-country" takes on a new meaning in South Africa. It is "up" in every sense of the word, as the whole of the interior consists of one vast plateau, varying in height from a minimum of 1,820 ft., at roughly 300 miles from Capetown, to no less than 5,735 ft. at the termination of our journey. On to this plateau we are now ascending. The speed is naturally reduced by the ascent. Between De Doorns and Touws River, the next two stops, 84 min. are allowed for a distance of 31 miles, or an average of 22 m.p.h.; but this is not to be despised when the *average* up-grade for 21 miles has been steeper than 1 in 60!

And now, having topped the summit of the Hex River Pass, we find ourselves in the widespreading Karoo. We shall not at first be enthusiastic about the scenery. There is little stirring, and not much appears to grow. A lonely farm is seen here and there, and an occasional plantation, but very, very little water. There is no stint of sun, hour after hour and day after day, and the dry thin air will soon begin to invigorate us, even though the sun-swept, drab and lonely scenery at first may fail to interest. Sundown is now approaching; the stunted bush is growing dusky; bush-fires blink in the background; the Karoo will soon be asleep. We begin to think of sleep, too; and for the first time, perhaps, we realise that we have not so much as seen a sleeping car on the train. Presently the mystery will be solved.

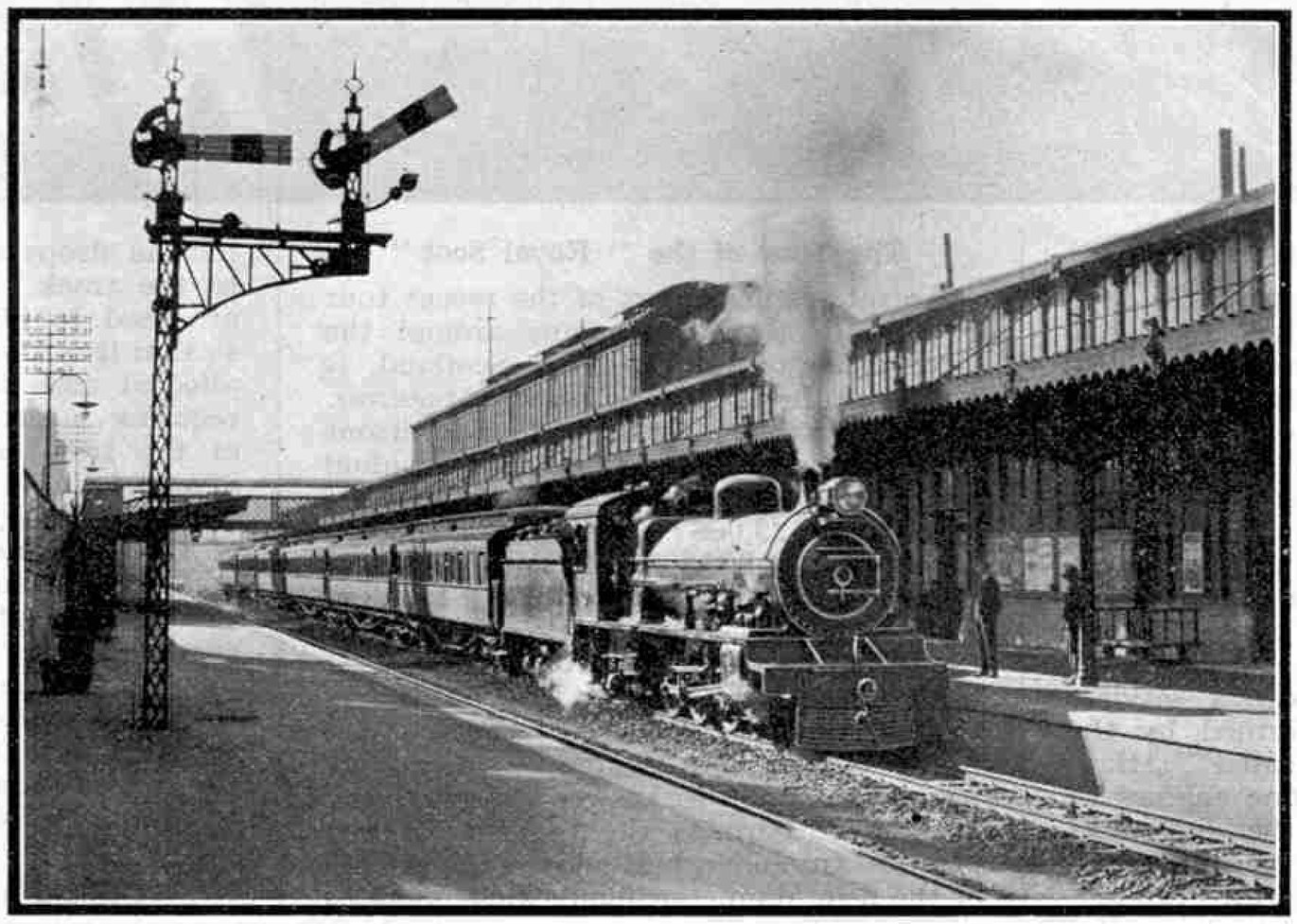
We have had two longish evening runs—an hour-and-three-quarters over the 53 miles from Touws River to Laingsburg, and a still longer one for four hours over the 126 miles from there to Beaufort West. The latter is the longest break on the whole journey without any publicly-booked stop, although quite possibly we shall have had service stops, as the whole of our route, except in the neighbourhood of the large cities, is single line. During the course of this last run we have dined, and on leaving Beaufort

West at 9.53 in the evening we are ready for bed.

Along comes one of the train attendants and proceeds to transform the very compartment in which we are riding. It is a compartment by day and a bedroom by night. Comfortable beds are made up on the two seats, on each side of the compartment, and then there are let down, above them, the two side partitions of the compartment, making two upper berths. Our compartment now contains four beds, one for each occupant, unless we have been fortunate enough to obtain one of the *coupé* compartments, in which case there are only two beds.

What the "bedroom" looks like is made clearly apparent in one of the accompanying photographs. It is of the more interest to us in that in the autumn of this year three of the British railway groups are to introduce sleeping cars of this type for third-class passengers on the long night journey. Beds will not be made up in the British cars, however; they will simply give facilities for four passengers to lie at full length in each compartment.

In long-distance trains that convey second-class passengers the same type of car is used, but three berths, one above another, are squeezed in on each side of every compartment, instead of the two in the first-class. The South African Railways charge little enough for making you comfortable, too—three shillings is the modest exaction for the use of the bedding, whether you use it for a single night or, on the longer journeys, for two.



Courtesy] [*South African Railways*

The "*Union Express*" at Johannesburg, with 4-6-2 locomotive. (Note the upper-quadrant signal)

So, for the present, goodnight! Things will be happening during the dark hours of which, doubtless, we shall be blissfully unconscious. We shall stop at Hutchinson, and then, at 2.40 a.m., in the very "small hours," we shall reach the important junction of De Aar. From De Aar there goes north-westward to Upington a branch line which, after crossing the Orange River by means of the longest bridge on the South African Railways—102 steel spans with a total length of 2,974 ft., more than once totally submerged by great floods, but without damage—joins the system of what until the Great War was German South-West Africa. This has now been taken over by the South African Railways, and the "branch" from De Aar to Upington, Windhoek, Swakopmund and Walvis on the west coast, has a modest length of 1,134 miles! So uninhabited is much of the country traversed that there is only one passenger train from De Aar to Walvis, and that only runs twice a week! Even over the important main line by which the "*Union Express*" is now travelling, for a large proportion of the distance there are not more than three daily passenger trains.

De Aar, 501 miles from Capetown, is one of the most important locomotive depots on the route, and it is quite likely that our locomotive will be changed here. The tractive power required for working over the Karoo is not so great as that needed in the climbing of the Hex River Pass, and our large "Mountain"-type engine may now have substituted for it a Baldwin-built "Pacific," with larger driving wheels. Not that the Karoo is entirely flat, by any means. From the lowest point at Fraserburg Road, 1,820 ft. above the sea, we climbed 2,355 ft. to Hutchinson, in 129 miles, but from De Aar onward we shall remain at a fairly even level of between 3,500 ft. and 4,100 ft. for the next 250 miles. Fraserburg "Road," by the way, is 92 miles from Fraserburg!

Dawn has broken when we stop at Orange River. The dining car stewards have plied us with early morning tea, and we have washed and dressed and are feeling distinctly ready for breakfast when the "*Union Express*" draws into the famous mining town of Kimberley, 647 miles from Capetown. The time is 6.47 in the morning, and we have been 20 hours on the way. Probably there is no other piece of land of comparable size in the world from which has been wrung such wealth as from 200 acres at Kimberley. Four mines in this small area have produced, in 50 years, diamonds worth 255 millions sterling! The peerless "*Star of South Africa*"—a single stone valued at £25,000—was picked up on the banks of the neighbouring Vaal River, and caused the frenzied rush of diamond-diggers up from the coast, long before the South African main lines were in existence, which laid the foundation of the fortunes of Kimberley. In the neighbourhood of the city we shall see many of the old open diamond mines, as well as the pit-head gear of the newer underground mines.

We get away from Kimberley at 7.2 a.m., and the going now becomes more brisk. The 45 miles from Kimberley to Warrenton are run in 74 minutes, at an average of 36½ m.p.h. Three miles beyond Warrenton, at Fourteen Streams, there diverges an even more important "branch" than any hitherto seen. It goes across the border into Rhodesia, and then north through Vryburg and Mafeking away up to Buluwayo. From there one can go by rail eastward through Salisbury down to Beira, on the east coast of Africa; or northward to the wonderful Victoria Falls, onward through Livingstone to Broken Hill, across into the Belgian Congo to Elisabethville and Bukama—farthest north of all the railways of South Africa and 1,739 miles from Capetown. But our course lies north-east, to Johannesburg. We travel onward, stopping at Bloemhof, Harrisburg, Klerksdorp, Potchefstroom, and Randfontein—stages of 58, 60, 29, 29 and 60 miles, covered respectively in 97, 113, 55, 55 and 115 minutes. We left Warrenton at 8.24 a.m., and it is now 3.37 in the afternoon.

Johannesburg is drawing near, and evidences of the industry that has made the great city what it is are now around us on every hand. Great conical hills, like the china-clay mounds of Cornwall, rise for 30 miles on all sides of Johannesburg, along the "Rand." They are known as cyanide dumps, and consist of the crushed rock, heaped to waste to the tune of two million tons a month, from which has been extracted gold to a total value that now reaches no less than 920 million pounds sterling. Out of the development of this great industry there has arisen the largest and wealthiest town in South Africa, 81 square miles in area, containing over 800 miles of streets and a population of more than 300,000 people. At no great distance away in the Transvaal there are also abundant deposits of coal and iron ore, which between them are establishing an iron and steel industry.

We are once again on a busy stretch of railway. We may well marvel at the size of the wagons used by the South African Railways for the carriage of their heavy mineral traffic. There are no 10-ton four-wheeled wagons to remind us of the "toy" trucks of our own country. There are all-steel bogie hopper wagons, discharging from underneath, and bogie high-sided wagons, emptying themselves from three sets of side-doors in each side; both types are 40 ft. in length by 8 ft. in width and have a capacity of 100,000 lb., or 45 tons, and a tare weight of 18 tons. Even larger 12-wheeled wagons carrying 67 tons of coal apiece are also in use. Special "specie" vans are employed for carrying the precious freights of gold and diamonds down to the coast. These vans, which are of unusually strong construction, contain safes raised off the floors, so that the armed guards, who travel with every consignment, have a clear view of the safes on all sides. Many other most interesting types of vehicle on the South African Railways will have been seen en route, but there is no space left in which to describe them. We shall not have failed to note that every vehicle, freight vehicles included, is fitted with combined central buffers and couplings, and also—most important in view of the heavy grades traversed—with the automatic vacuum brake.

The last 28 miles from Randfontein require 53 minutes, and at 4.30 in the afternoon of our second day's journey we roll into Johannesburg. We can go on to the capital city of Pretoria if we like—through carriages are provided in the train to enable us to do so—but we shall have to wait 40 minutes for (*Continued on page* 694)

"Pacifics" on the Waverley Route

The L.N.E.R. route from Carlisle to Edinburgh, which is 98 miles in length, is well known as being among the very hardest sections of main line in the country. There are many long and heavy gradients as the line crosses the Cheviot and Lammermoor Hills, and so sharp are the curves in many places that fast downhill running is out of the question. Long stretches as steep as 1 in 70 are common, and going north there is an unbroken bank of about nine miles at this gradient.

For many years the express services have been most ably performed by the large North British superheated "Atlantics," the ability of these fine engines to maintain a steady speed up the long banks having been remarked upon by many travellers over the "Waverley Route," so called because it traverses the beautiful Scott country. The maximum load for these engines, unassisted, is 290 tons, but the weights of the through trains to and from the Midland main line south of Carlisle very frequently range up to 400 tons or more. When the famous Gresley "Pacifics" were introduced on the L.N.E.R. they were tried on these services, but were found incapable of keeping time with train loads of 400 tons. One of the rebuilt engines of this class, "*Shotover*," has, however, successfully worked a test load of 400 tons between Carlisle and Edinburgh, and it is likely that the heaviest expresses will be taken by these high-pressure "Pacifics" in substitution for the "Atlantics."

* * * *

The Greatest Railway Centre

Many of our readers will be surprised to learn that Chicago is the greatest railway centre in the world. Actually 38 railways, including 23 main lines, have their termini in the city. The remarkable feature of Chicago's eminence is that no line passes through the city, which is, by reason of its geographical situation, a natural terminal point. The city is served by more than 120 railway yards providing reception accommodation for 200,000 freight cars.

* * * *

Named Engines on the Metropolitan

With reference to the paragraph in our February notes regarding the adoption by the Metropolitan Railway of the practice of naming locomotives, the following engines are now in service:—Nos. 2, *Oliver Cromwell*; 3, *Sir Ralph Verney*; 5, *John Hampden*; 7, *Edmund Burke*; 10, *William Ewart Gladstone*; 12, *Sarah Siddons*; 13, *Dick Whittington*; 14, *Benjamin Disraeli*; 16, *Oliver Goldsmith*; 17, *Florence Nightingale*; 18, *Michael Faraday*; 20, *Sir Christopher Wren*.

The Tour of the "Royal Scot"

An interesting report of the recent tour of a "Royal Scot" engine around the large cities of England and Scotland, is given in the *L.M.S. Railway Magazine*. This shows that a total of 172,484 persons paid to inspect the engine, the individual figures for English cities being as follows:—Manchester, 23,066; Birmingham, 16,284; Bradford, 14,806; Sheffield, 13,048; Liverpool, 10,962; Derby, 7,670; London, 7,493; Leeds, 7,311; Preston, 5,700; Crewe, 4,184. The total amount raised for charity by the engine's tour was nearly £5,000.

The engineers in charge of the engine were called upon to answer some amazing questions. Perhaps the best of all was put by an individual who, taking hold of the 6 in. diameter handle that operates the soot blower for the boiler, and which is fixed under the regulator handle, said: "I suppose this is the steering wheel?" A dear old lady created considerable amusement among her friends when describing her visit. "Yes, it was really splendid," she declared. "We climbed into the cab and came out through the smokebox!" Some flue tubes, to be sure!

* * * *

Staff Suggestions

One of the interesting features of the progressive policy of the London Underground Railways is the Staff Suggestions Scheme, which provides facilities for every employee of the company to offer suggestions relating to methods of increasing traffic and improving the working of trains, omnibuses and trams. The scheme was inaugurated in 1917, and by the end of 1927 over 42,000 suggestions had been received and considered. Of this number, more than 3,000 were adopted in their entirety, and many others were modified and introduced in some form.

* * * *

"The Whitewash Special"

There is a mysterious train travelling the main lines of the G.W.R. that never figures in a timetable and never stops to pick up passengers! It does occasionally stop, but only occasionally, and then between stations! It rarely carries more than a dozen passengers and none of these has been known to pay a fare!

To railwaymen, however, there is no mystery concerning the identity of the train. It is "The Whitewash Special!" Its job is to detect faults on the permanent way, and for this purpose it runs between Paddington and Plymouth and Newport and other parts of the line with different types of rolling stock, representative of those that regularly cover the routes.

Over each bogie of this train an observer stands and whenever he feels the slightest jolt he drops a spot of colour wash on to the track. Different coloured washes are used to identify each type of bogie so that it is known which type is the most affected and the spot on the track that requires inspection. In the rear coach of the train is an ingenious instrument invented by a French railway engineer, named Hallade, which acts as an inspector of the permanent way. This instrument makes a graphic record of every inch of the run indicating clearly every jolt and every swaying motion. On the return journey the train stops at every point on the line where colour wash has been dropped, and technical experts examine the track and make their recommendations according to what they discover.

* * * *

Combined Air and Rail Route

A syndicate consisting of business men interested in railroads and aeroplane companies in America has been formed to open up an air and rail route to carry passengers between New York and Los Angeles, affording a 48-hour trip from point to point.

The proposals are for a service in which passengers will leave the New York terminus of the Pennsylvania Railroad in the evening, travel overnight to a point in Ohio where a change will be made to aeroplane, and then fly to a point in Missouri or Kansas. Here a change will be made to the Atchison, Topeka and Santa Fé Railroad for the second night's trip, which will carry the passengers to a point in New Mexico where a second aeroplane will provide direct connection with Los Angeles. The actual points in Ohio and New Mexico have not yet been decided.

* * * *

A New Internal Combustion Locomotive

An interesting new type of locomotive has recently been constructed by Hudswell Clarke & Company Leeds, for a firm of sugar manufacturers for use on their estates at Sydney, N.S.W. It is of the internal combustion type and is equipped with six cylinders, $5\frac{3}{4}$ in. in bore by $6\frac{1}{2}$ in. stroke, and is geared for speeds in both directions of 3, $4\frac{3}{4}$, $7\frac{1}{2}$ and 12 miles an hour at 800 r.p.m.

The engine is for use on a 2 ft. gauge track and has six coupled wheels. Its total loaded weight is 14 tons but it is capable of hauling 400 tons. Petrol, alcohol or paraffin may be used for fuel, and the design is such that a Diesel engine may be built in if preferred.

* * * *

Contracts were recently placed by the L.N.E.R. for the supply of over 100,000 towels for use on the company's trains during the 1928 summer season.

A Railway Excursion in 1844

In these days of cheap, well-organised excursions we are apt to forget the conditions under which similar trains were run in early days. A press report of the first railway excursion to Brighton on Easter Monday, 1844, read as follows :—

"The ordinary 8.30 train from London Bridge was delayed for nearly half an hour by the immense number of passengers. It at last started with 45 carriages and four engines. At New Cross it was joined by six more carriages and another engine; and at Croydon by another six carriages and a sixth engine. The greatest apprehensions prevailed at Brighton until 1.30 when the immense train of 57 carriages and six engines steamed safely into the terminus."

* * * *

G.W.R. Goods Depot Development

In anticipation of the big development of the vacant industrial sites in the north end of Birkenhead that will follow the opening a few years hence of the new road tunnel under the River Mersey, the Great Western Railway have decided to remodel and modernise their Morpeth Dock Goods Station. This station is the G.W.R. main goods depot on Merseyside and serves both Birkenhead and Liverpool, the traffic for the Liverpool side of the river at present being carried across by motor vans using the goods ferries, and by barges. The present Morpeth shed and yard provide accommodation for about 540 trucks on roads clear of connections, but the new scheme will provide accommodation for nearly 850 trucks. At the same time the layout is to be improved to facilitate the reception and marshalling of trains, and the present road approach will be widened to give more room for road vehicles entering and leaving the station.

At present an average of over 1,700 tons of traffic are dealt with each day and on busy days as many as 300 road vehicles cross the river to and from the depot.

* * * *

A Railroad Symphony

An enthusiastic musician in an American railroad service, writing to the "*Railway Age*," strikes a note that will interest those of our readers who are musically inclined. He says :—

"I have noticed at times some gossip about a 'railroad symphony.' Now it's a pretty sure bet that when Edward Grieg, the great composer of Peer Gynt Suite, Op. 46, wrote Part Four of the suite, 'In the Hall of the Mountain King,' he did not have in mind the poetry and music of some great brute of a locomotive labouring to tug a sullen string of heavy Pullmans into motion. But it seems to us that here he created a 'railroad symphony' of unsurpassed beauty and expression. Listen to it once.

"Can't you hear the first slow, deliberate explosions from a short, stubby stack, and see the rigid blast of smoke climb straight and high ? Then she begins to feel the rail. The exhausts become faster. There is a ponderous, rhythmical clank as side and main rods alternately thrust and pull on the pins. Faster . . . Faster . . . The increasing drone of flashing drivers. The quickening beat of oscillating crosshead—like the sweep of a baton. The perfect syncopation of valve gear. Woodblocks clicking as wheels meet joints. Sharp tongued squeals from between swaying tender and thumping engine. Faster . . . Faster . . . The click of blocks becomes the con-rattle of snares, punctured with an irregular one-toned thud of axles taking up the end play. The soprano song of the wind shrilling out above the hoarse bellow of the exhaust. Faster . . . Faster . . . Until all is blended into one mighty chorus of rushing sound . . . Confused . . . Yet thundering with measured accent . . .

"It's all there ; and more ! Try it."

* * * *

Some Owl !

The "*Railway Age*" tells the following alleged Russian story :—

Strange tales come out of Russia. For instance, report has it that every engineman involved in a wreck is executed. It is to be wondered what punishment Engineman Vladimir Vlasko drew for being involved in the following case. It appears that Vladimir, at the throttle of the Vologda-Leningrad express, was buzzing along at some 50 miles an hour, when the train came to a most abrupt stop, piling them (the coaches) up in the front end. Vladimir climbed out in the snowdrifts to investigate. He found that an owl had perched on the locomotive and had clutched the cock of the airbrake valve, letting out the air and stopping the train. The owl was captured alive and the train proceeded. It may be that "owl stories" are the Russian counterpart of American "fish stories."

* * * *

This Month's Railway Story

Engine Driver's Sweetheart: "And do you always think of me during your long night runs ?"

Engine Driver: "Do I ! I've wrecked two trains that way already !"

E. D. S.: "Oh ! You darling !"

Courtesy] [*L.N.E.R.*

Discharging wool from ships direct into trucks for conveyance to Bradford from the L.N.E.R. docks at Hull. In 1926 nearly 75,000 tons of wool were landed at Hull, the bulk of this quantity being from Australia and New Zealand

The L.N.E.R. March Yard

Rapid progress is being made with the construction of the new marshalling yard at Whitemoor, near March, on the L.N.E.R. Out of a total of 29 miles of track seven miles have been laid, and approximately 80 per cent. of the 200,000 cu. yds. of excavation necessary to level the ground and to provide material for embankments has been completed. When finished the new yard will be the biggest and most up-to-date marshalling yard in Great Britain. It will be operated on the gravitation system, and "retarders" are being installed.

The "retarder" is a novelty in British railway practice, and its installation is the outcome of exhaustive inquiries made into every type of marshalling yard operation in the world. Under the retarder system the wheels of the wagons running down the incline on to the sorting "grid iron" are braked by a pair of rails that press against the sides of the wheels. The pressure can be varied as required.

Retarders have been used for several years in various American goods yards and with them it is claimed that the marshalling process is speeded up by nearly 50 per cent. In addition, the risk of injury to shunters, who hitherto have been compelled to ride down the sidings with the trucks to apply the brakes by hand, is eliminated, and the danger of damage to the contents of trucks due to the impact of wagon meeting wagon is very largely overcome.

* * * *

Strengthening G.W.R. Bridges

The G.W.R. are modernising many of their older main line bridges, with the object of making them available for the working of "King" class engines. Recently the skew underbridge west of Bath station was taken in hand and it is expected that, with the inauguration of the summer services this month, the first "King" engine will be able to work through Bath.

Ordinary strengthening operations were out of the question with the bridge at Widney Manor, eight miles south of Birmingham, and the brick structure has been replaced by a steel girder bridge.

* * * *

G.W.R. "St. Martin" Type

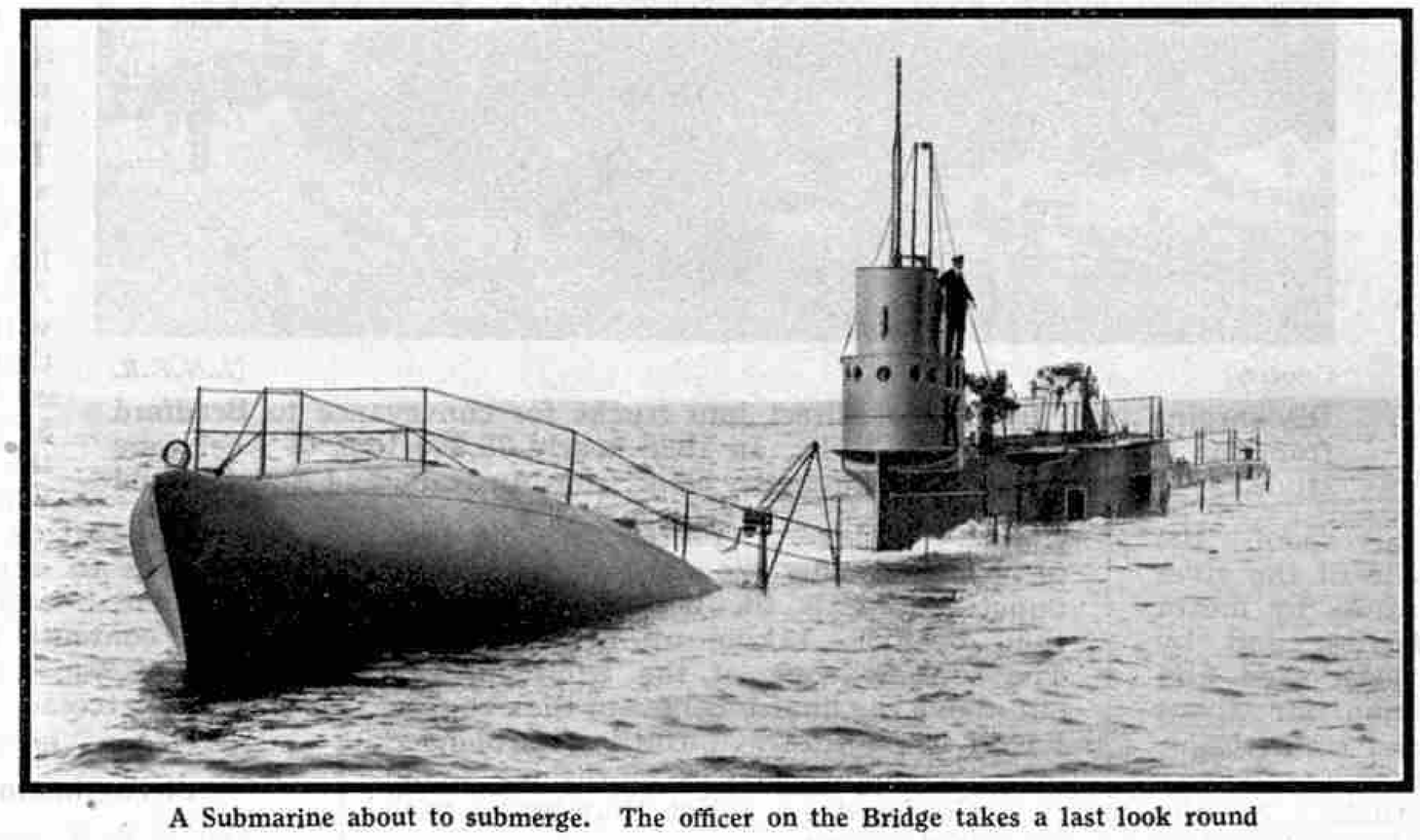
The names allotted to the first 20 engines of the new G.W.R. "St. Martin" 4-6-0 type are as follows :—4900, *Adderley Hall* ; 4901, *Aldenham Hall* ; 4902, *Astley Hall* ; 4903, *Binnegar Hall* ; 4904, *Barton Hall* ; 4905, *Bradfield Hall* ; 4906, *Broughton Hall* ; 4907, *Broome Hall* ; 4908, *Blakesley Hall* ; 4909, *Blaisdon Hall* ; 4910, *Bowden Hall* ; 4911, *Berrington Hall* ; 4912, *Baglan Hall* ; 4913, *Cranmore Hall* ; 4914, *Condover Hall* ; 4915, *Crumlin Hall* ; 4916, *Crosswood Hall* ; 4917, *Dartington Hall* ; 4918, *Donnington Hall* ; and 4919, *Dumbleton Hall*.

Work has been commenced on these engines and several will be ready for the road shortly.

V.—THE SUBMARINE

LAST month we described the discouraging reception given to the submarines of Bushnell and Fulton by the various nations to which these were submitted. This official apathy was very disheartening to inventors and it was some time before any further progress was made.

In 1850 a German named Bauer invented a submarine, and as his own country was not interested he brought his plans to England. He submitted the details of his submarine to the British Admiralty, and although they were not at all enthusiastic about the matter, a Government committee was formed to consider his claims and proposals. The committee was formed of a number of prominent engineering experts and included the famous engineer I. K. Brunel. After carrying out their investigation the committee reported unfavourably upon the submarine. Bauer felt annoyed at having divulged the secret of his invention to no purpose, and he accused the British authorities of stealing his plans and of scheming to destroy his claim to be the inventor of the submarine. The controversy died down after a while, however, and it was not long before Bauer and his invention were forgotten.



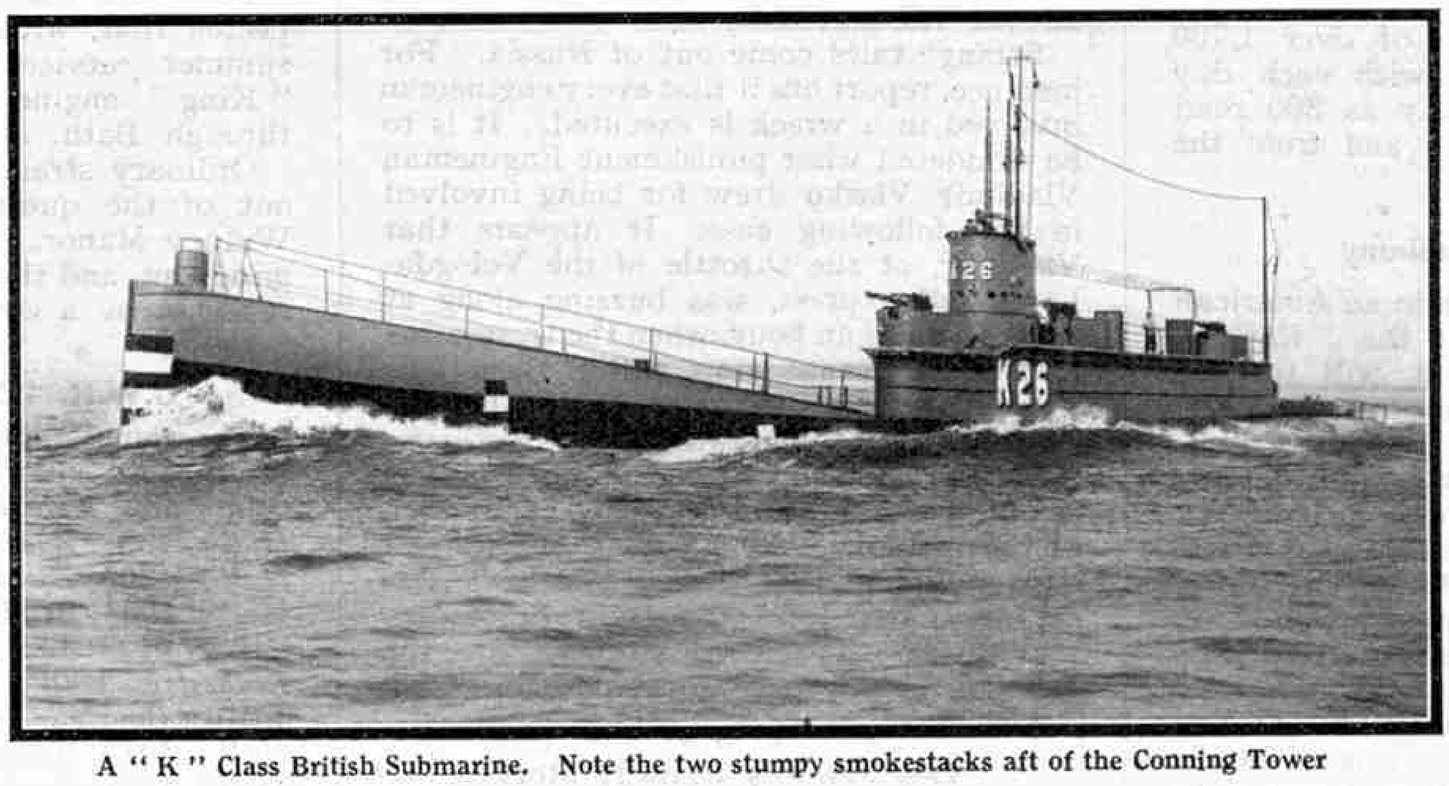
A Submarine about to submerge. The officer on the Bridge takes a last look round

A submersible boat propelled by compressed air was invented about this time by a French naval officer named Commandant Bourgeois. This was built at Rochefort in France, but when tested proved a failure.

During the American Civil War the Southerners sought to defeat the intense blockade carried on by the Federal forces by constructing and placing in commission several torpedo boats capable of being submerged when near their objective. Each vessel was equipped with movable planes or fins, the manipulation of which caused it to dive or rise to the surface as required, while special ballast tanks could be filled to aid submersion. Many of these boats could only be submerged to an extent that brought their deck level with the surface of the water, but this was sufficient to submerge the spar that projected from the bow and carried the torpedo. Each vessel had a crew of about eight men.

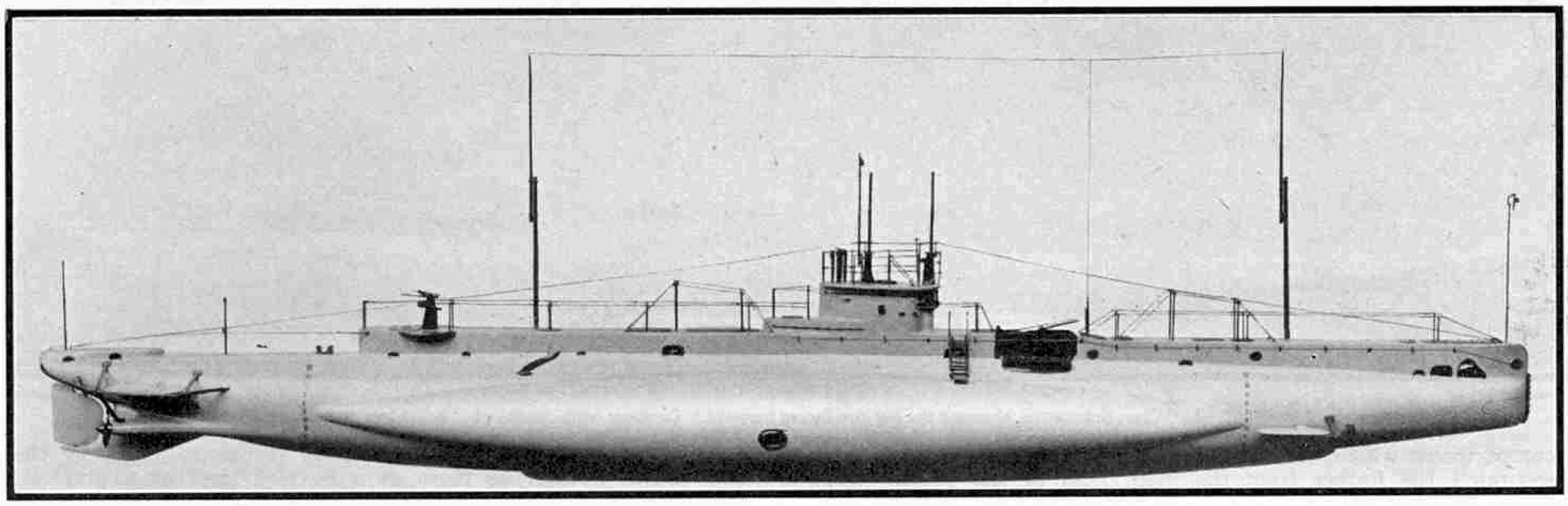
On the 17th February, 1864, one of these submersible boats succeeded in torpedoing and sinking, off Charleston, the "*Housatonic*," a Federal frigate of 1,264 tons and having an armament of 13 guns. The boat that carried out this feat was itself wrecked by the explosion, however, and only the Captain was saved. This unprecedented act of daring created a great sensation. The Federal authorities awoke to the significance of under-water craft and at once took steps to obtain torpedo-carrying submarines with which to retaliate, but the Civil War ended before their scheme matured.

In 1878 a submersible vessel was designed by a clergyman named Garrett and constructed at Liverpool. Successful tests were carried out in the River Mersey, and among those who witnessed the manœuvres was the Swedish engineer Thorsten Nordenfelt, the inventor of the gun that is named after him.



A "K" Class British Submarine. Note the two stumpy smokestacks aft of the Conning Tower

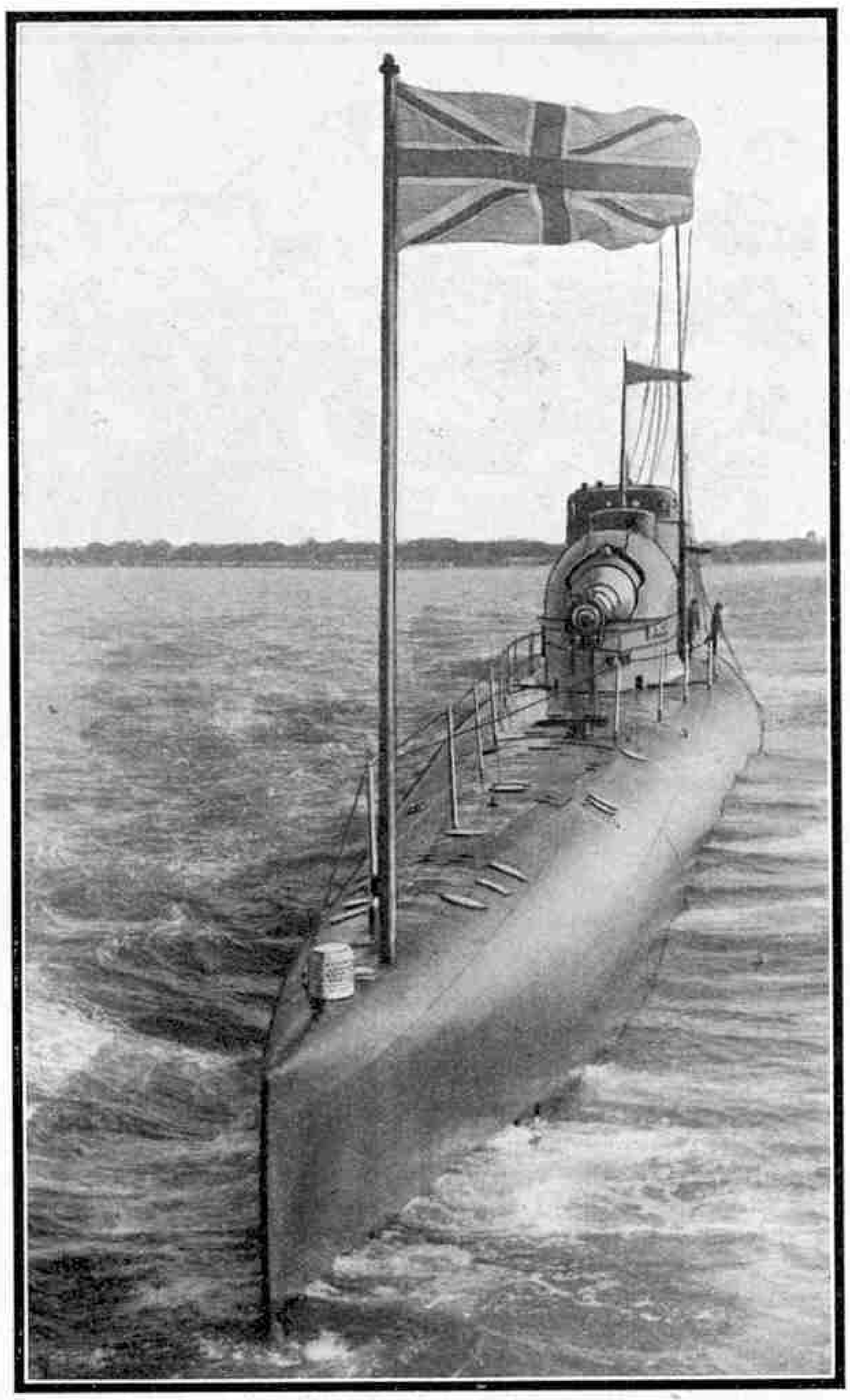
Nordenfelt was greatly impressed by the success of Garrett's craft, and after carrying out experiments on his own account he constructed a small submarine 64 ft. in length and of 60 tons displacement. The motive power for both surface and under-water propulsion was obtained from steam engines. The success achieved with this vessel led to the construction of a larger one, 100 ft. in length and of 160 tons displacement. Steam engines were again adopted to drive the propelling machinery and the boat achieved a surface speed of 12 knots. She was equipped with two Nordenfelt 25 m.m. quick-firing guns and carried two torpedos. Normally the vessel was caused to dive or rise to the surface by the operation of vertical propellers, but she showed such a frequent tendency to dive, irrespective of the action of the propellers, as to be of little practical value.



Courtesy] **Model of "E" Class British Submarine, showing the horizontal rudders fore and aft** [*Board of Education*

In spite of this defect the two Nordenfelt submarines created a very favourable impression among foreign powers, and the original vessel was purchased by Greece. The Turkish Government immediately ordered two similar submarines, and when they were completed they were conveyed to the Bosphorus. There they were put through various manœuvres in the presence of Mr. Garrett, who took command of one of the vessels. The tendency to dive and to oscillate that had been evident in the original submarine was present in these two vessels and Garrett had difficulty in controlling the vessel of which he was in charge. Water frequently invaded the conning tower before the lid could be closed down. These unsatisfactory features were realised by the Turkish Navy and the Government found it impossible to persuade or compel sufficient men to man the submarines to operate them efficiently. Eventually the vessels were withdrawn from service.

The efficiency of all these early submarines was greatly impaired by the lack of engines combining both lightness and power, but developments in the use of electricity and oil fuel opened up new possibilities to inventors. One of the first to design an electrically-driven submarine was the famous French engineer Depuy de Lôme, who was one of the pioneers of rigid airships. Unfortunately he died before he had completed his submarine designs, but years later his plans were revised and completed by his friend Gustave Zede. The submarine built to this design was of cigar shape, 59 ft. in length, almost 5 ft. in breadth, and of 60 tons displacement. A battery of 564 cells supplied current to a 55 h.p. electric motor, which provided the motive power for propelling the vessel both on the surface of the water and when submerged. The submarine had a maximum surface speed of six knots, at which she had a radius of action of 35 miles on one charge of the batteries. By reducing speed one-third the radius was increased to about 100 miles.



Bow View of "M" Class British Submarine. The narrowness of a Submarine is clearly shown in this unique photograph

The French Admiralty were so impressed with the excellent performance of the "*Gymnote*," as the vessel was called, that they decided to add submarines to the Navy and a submarine almost three times the length of the "*Gymnote*" was built. The new vessel was 160 ft. in length, 12½ ft. in width and of nearly 270 tons displacement. Electric motors giving a total of 270 h.p. were installed and the armament consisted of three 17½ in. Whitehead torpedoes. The craft was named "*Gustave Zede*" after the builder of the "*Gymnote*," and it marked the beginning of France's fleet of submarines.

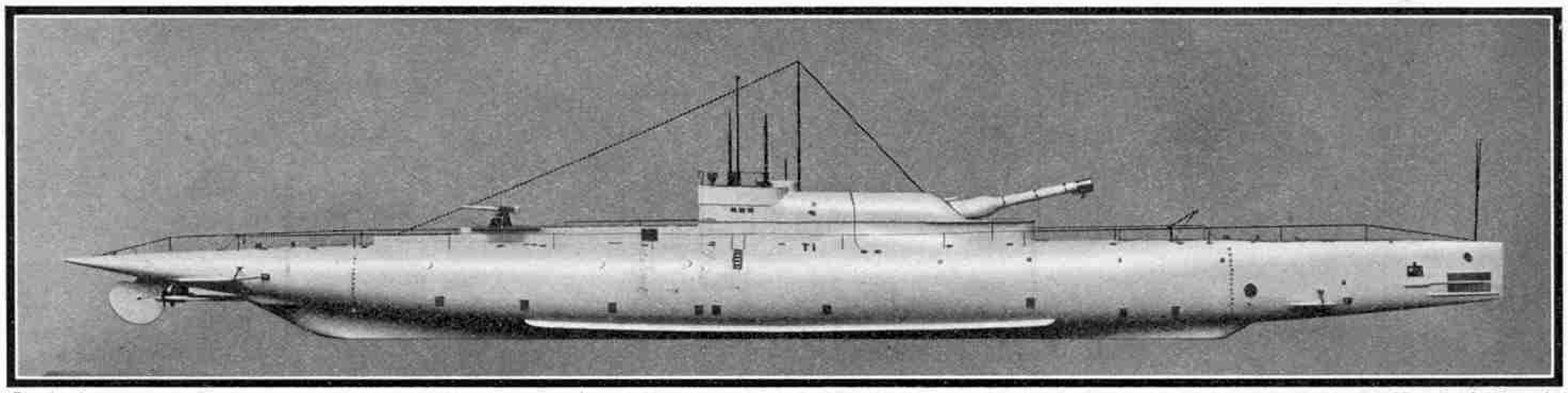
While these developments were in progress two inventors in America were independently engaged in perfecting submarines of their own design. These men were Simon Lake and John P. Holland.

Lake constructed his first submarine in 1894 and named it the "*Argonaut Junior*." It was built of wood and was 14 ft. in length, 4½ ft. in width and 5 ft. in depth. This inventor saw in the submarine a means of salvaging the great number of sunken wrecks strewn around the American coast, and the "*Argonaut Junior*" was entirely different from any submarine built as a weapon of war. It was fitted with three wheels to enable it to travel like a car along the bottom of the sea, while in the bow was a watertight compartment by means of which divers could enter or leave the boat as it rested alongside a wreck on the sea-bed. The submarine was capable of submerging to a depth of 20 ft. and could remain under water for several hours, an adequate supply of compressed air being stored on board. When the vessel was completed, experiments in the nature of minor salvage tasks were successfully carried out and the profit obtained from these ventures enabled the inventor to build a larger and more powerful vessel.

Lake's second submarine was 36 ft. in length and 9 ft. in width, and was named the "*Argonaut*." This vessel, like its predecessor, was not a submarine in the full sense of the term as it could not be propelled through the water. It was only capable of travelling on the surface by means of its screw, or along the sea-bed by means of three wheels that were fitted, two forward and one at the stern. A 38 h.p. petrol motor was installed, together with an air compressor and a dynamo to provide current for lighting the vessel and also for a searchlight.

Two long pipes, which from a distance might have been thought to be masts, towered above deck to a height of about 30 ft., sloping slightly towards each other. The fore pipe served as an intake for fresh air, and the stern pipe, reaching down to the engine room, provided an outlet for the vitiated air, and the gases from the motor. The fuel tanks were situated below deck and outside of the hull proper in order to eliminate any danger of ignition from within the vessel. Glazed apertures in the bow provided a look-out for the pilot when the submarine was under the water and also enabled the searchlight to illuminate the sea-bed.

Immediately behind the look-out compartment was the diving

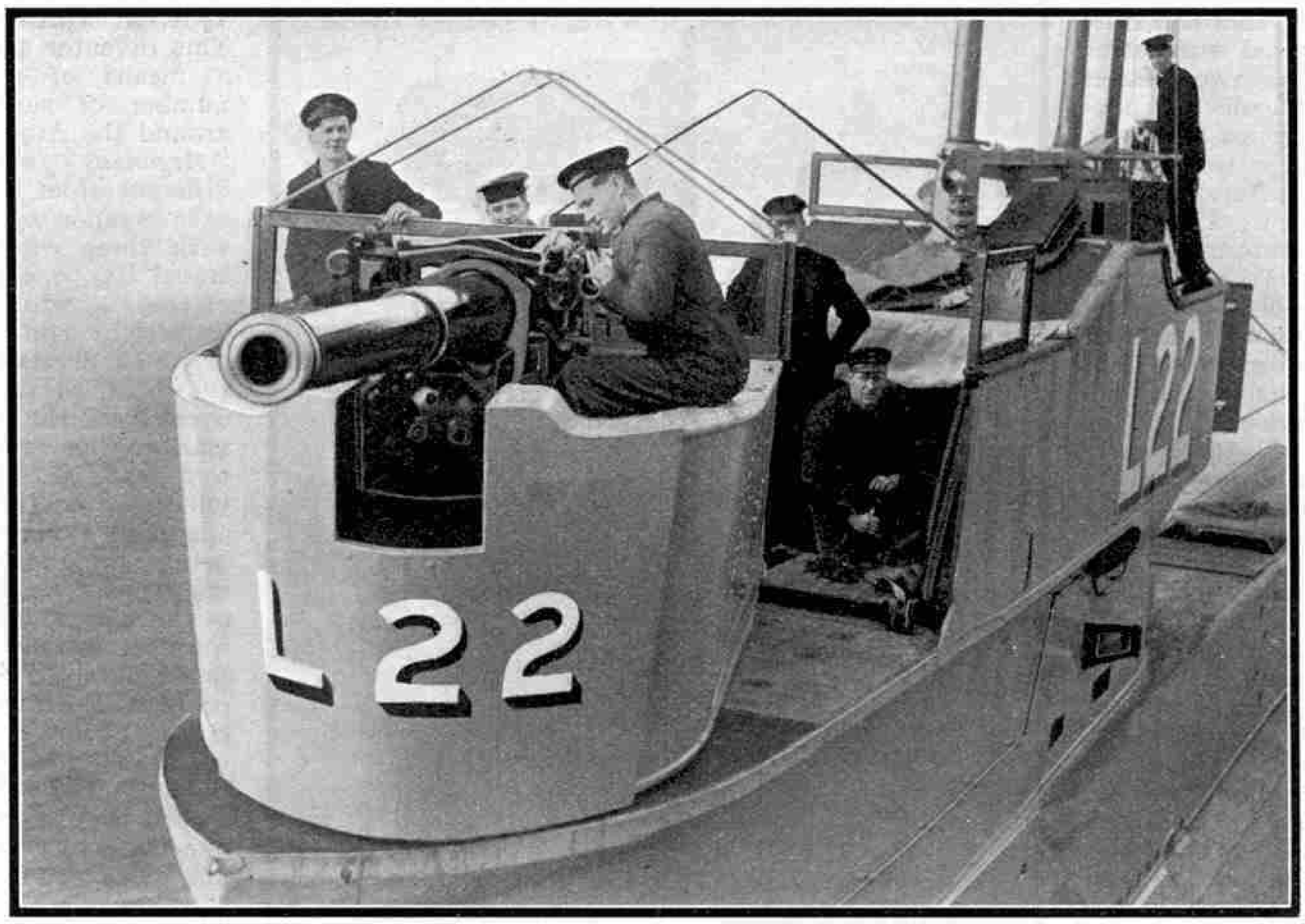


Courtesy] [*Board of Education*

Broadside view of Model of " M " Class Submarine, showing the big gun facing forward. Compare with Model of " E " Class Submarine on previous page

compartment which, in turn, was succeeded by an air-lock that separated the former from the main hold of the vessel. The diving compartment was filled with compressed air, and the air-lock enabled a person to pass from the main hold to either of the two forward compartments irrespective of whether the diving compartment entrance to the sea was open or closed. This entrance consisted of a hinged trap-door in the floor of the compartment, through which the diver passed out to the sea-bed to explore a sunken wreck. The trap-door was built-in flush with the hull of the submarine and was opened from the inside of the compartment. When opened it was dropped down to the sea-bed and formed an inclined path for the diver to pass along to and from the vessel. When the diving compartment was in use the lookout man communicated with his comrades in the main hold of the submarine by means of a portable telephone, and a similar means was utilised by the diver to communicate his reports to the crew, thus saving himself the time and trouble of passing to and fro through the air lock.

A novel method was employed to effect a descent to the bottom of the sea. The trap-door in the conning tower was shut down and the water was admitted into the ballast tanks. Two heavy weights, one fore and one aft, and recessed in the keel of the vessel, were then lowered to the sea-bed by means of long cables. When the weights reached the bottom, the motion of the winding machinery in the vessel was reversed. As the filling ballast tanks steadily reduced the buoyancy of the submarine and bore it downward, the cables were slowly wound in again until the vessel rested upon its keel on the sea-bed and the weights were again accommodated in their recesses.



The gun superstructure of an " L " Class British Submarine

An extensive survey of the Atlantic coast of America was carried out in this submarine during 1898, approximately 2,000 miles being traversed. Later the vessel was lengthened by cutting her in two and inserting a new section amidships. As a result of this and other alterations she was increased to 66 ft. in length over her superstructure and 10 ft. across at the widest part. A 60 h.p. petrol motor was substituted for the original one of 30 h.p., while the other units of the engine room plant were replaced by more powerful components. The increased space enabled a greater supply of compressed air to be accommodated on board and sufficient was now stored to enable the submarine to remain submerged for 48 hours.

Although the "*Argonaut*" behaved quite well and successfully carried out some minor salvage tasks, it was regarded by the U.S. naval authorities more as a novelty than as a practical salvage unit, and was never adopted seriously. Lake came to realise that the authorities considered that the true purpose of a submarine was that of a weapon of war, and in 1901 he turned his attention to constructing a torpedo-carrying submarine.

This vessel was appropriately named the "*Protector*," and it could travel either on the surface or through the water. It could also travel along the sea bottom by means of four wheels mounted in pairs upon what have been described as "swinging axles"; that is, recesses were provided in the hull at the points where the wheels were situated, so that when the wheels were not in use they could be swung or drawn up into these recesses. This ensured that the contour of the hull was rendered as smooth as possible and resistance to the water reduced proportionately.

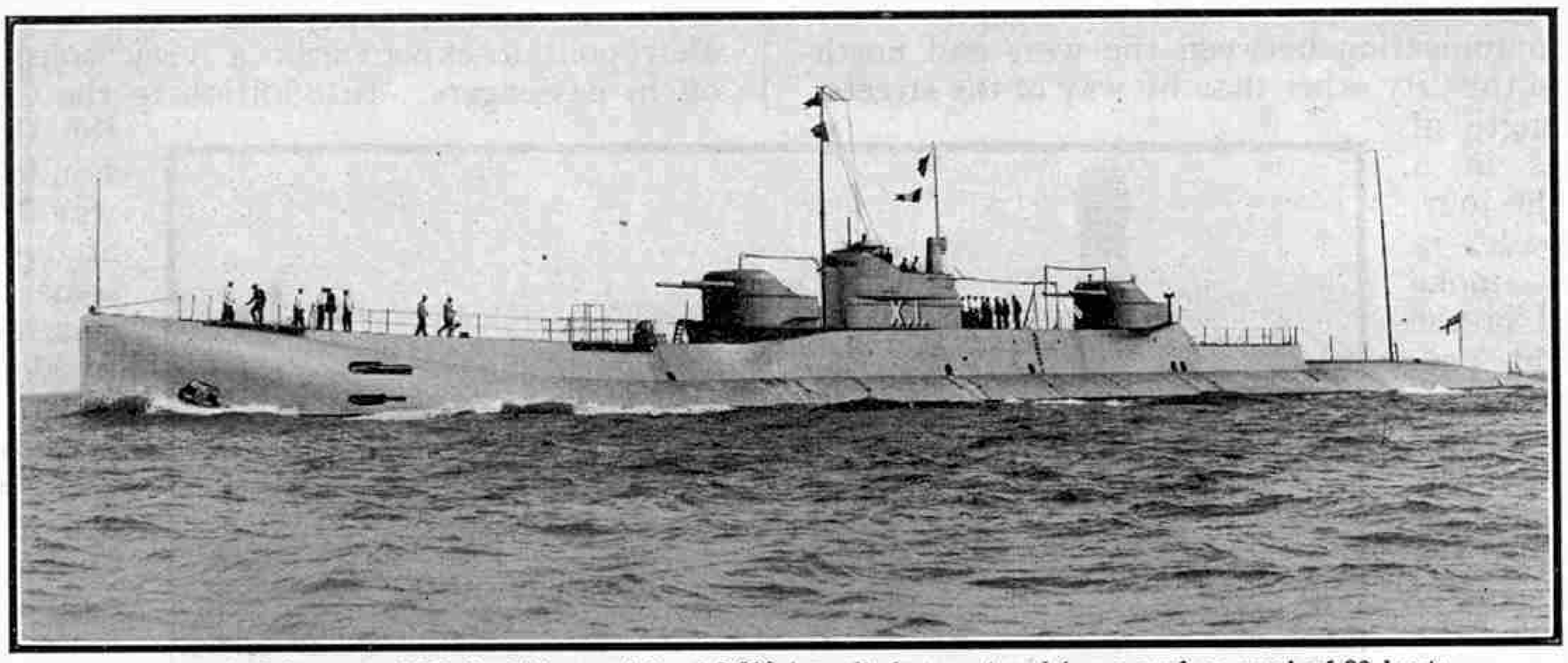
The "*Protector*" attained a surface speed of 8½ knots when propelled by her petrol motors, and a maximum speed of 9.3 knots when driven by both petrol and electric motors. When totally submerged and propelled only by the electric motors she proved capable of a speed of 5.4 knots. Eventually the vessel was sold to Russia, renamed the "*Ossetyr*," and appointed for duty at Vladivostok.

John P. Holland had none of Lake's peaceable ambitions with regard to the future of submarines, and the type of submersible boat that he invented was designed solely as a weapon of war. Holland was born and educated in Ireland at a time when that country was the scene of considerable discontent and rioting. Hatred of England was being openly expressed, and Holland, a young man of excitable temperament, became imbued with the spirit of the revolutionaries. It occurred to him that with a number of submarines a severe blow could be dealt at England by attacking and destroying the British Fleet, and the more he thought upon the subject the more intense became his desire to strike the blow. He was then teaching in a school in County Clare, and he began to devote his spare time, night after night, to planning a submarine that should be capable of carrying out his purpose. During the following two years he completed his design and endeavoured to enlist the financial aid of his friends to enable him to construct the vessel, but his scheme was derided on every hand. Finally he decided to seek the aid of Irish compatriots in America.

In pursuit of his object Holland went to Boston, but he was no more successful there than he had been in Ireland. To begin

with he was confined to hospital for a long period as the result of an accident, and subsequently, when he tried to enlist the support of various newspapers, he met with nothing but ridicule. It appeared obvious that he would not be able to raise the large sum of money that he required to carry out fully his designs, and he therefore decided to build as good a submarine as he could with the small funds he already possessed.

This submarine was completed in due course, but misfortune followed it from start to finish. After being hauled to the Passaic River by a team of 16 horses, the vessel commenced its career by becoming fast in the mud on the river bank. With considerable difficulty it was freed and launched, and immediately its defects made themselves evident. Great care had been taken to caulk the seams thoroughly, but in spite of this the vessel leaked to an alarming extent, and to make matters worse the engine could not be persuaded to run for any length of time, but kept stopping suddenly and unexpectedly at awkward moments. These misfortunes brought further ridicule upon the inventor and finally, in sheer disgust, he destroyed the vessel.



The British Submarine "X.I." This vessel is of 3,600 tons displacement and has a surface speed of 22 knots

Holland was a man of great determination, however, and in spite of this serious setback he went forward with his scheme. He became a member of a secret society of strong anti-British views. The great ambition of this society was to do something that would cripple England to some extent, and its members even contemplated the invasion of Canada. Standing in the way of all their schemes, however, was the British Navy, and Holland succeeded in persuading them that they could only attain success by submarine attack upon the British warships. In due course the society provided the necessary funds to build a submarine. This vessel was only partially successful, but it was of sufficient promise to encourage the society to order a second and larger one, designed on the lines of Fulton's submarine and equipped with both horizontal and vertical rudders. Trials carried out in New York Harbour proved this vessel to be satisfactory, but the newspaper publicity given to the manœuvres resulted in the plot becoming known, so that the whole scheme collapsed.

Nearly 20 years elapsed before Holland's experiments with submersible boats brought him official recognition. In 1895 his design for a submarine to be built by the U.S. Government was chosen out of a large number of entries. The price agreed upon for the submarine was £19,000 and the construction was carried out by a company organised by Holland, under the supervision of Government engineers. These engineers made so many alterations in the inventor's plans, however, that when Holland saw the completed vessel before the launching ceremony he declared at once that it would be a failure. Subsequent trials proved that he was right, and in disgust he refunded the contract money and took back the vessel, which had been named "*Plunger*."

After the "*Plunger*" fiasco Holland determined upon a final endeavour to prove the merits of his invention. Another submarine was constructed by his company, this time in strict accordance with the inventor's designs, and was named the "*Holland*." This vessel established the basis for all the submarines of this class that have since been built.

She was of cigar shape, 54 ft. in length and 10 ft. 3 in. across at the widest part, and was of approximately 70 tons displacement when submerged. When cruising on the surface she could attain a maximum speed of six knots by means of a 50 h.p. four-cylinder petrol engine, and when travelling submerged she was capable of a speed of five knots, propulsion then being obtained from a 50 h.p. electric motor. She could travel submerged for a period of about four hours, equivalent to a journey of roughly 20 miles, and she carried sufficient fuel for a journey of 200 miles at maximum cruising speed. One torpedo tube was fitted.

The "*Holland*" proved a great success when tried out and was purchased by the United States Government for £30,000, although the construction had cost the company half as much again. This historic submarine was in active service until 1910, and was then withdrawn as obsolete and transferred to the Naval Academy at Annapolis.

The efficiency of the "*Holland*" led the U.S. Government to order seven similar but larger and more powerful vessels. These submarines were each of 120 tons displacement and proved capable of a maximum surface speed of 8½ knots and a submerged speed of seven knots. The single propeller of each submarine was driven by a 70 h.p. electric motor when the vessel travelled submerged and by a 160 h.p. petrol engine when travelling on the surface. The submarines were known as the "Adder" class, and each was equipped with a single torpedo tube and two spare torpedoes.

The experiments with submarines carried out in France and America were watched closely by the British Government and when the success of the "*Holland*" submarine made it clear that the development of submersible boats had passed from the experimental to the practical stage steps were taken to establish an efficient submarine fleet. Negotiations with the inventor resulted in the British Government obtaining the right to construct submarines of the "*Holland*" type, and in 1900 the Admiralty instructed Vickers, Sons and Maxim to build five vessels each of 120 tons displacement.

The hull of these submarines was of steel and was of sufficient strength to stand the water pressure at a depth of 100 ft., while watertight decks and bulkheads further strengthened the structure as a whole. The hull was surmounted by a deck for use when the vessel was cruising on the surface and an armoured conning tower 2 ft. 8 in. in dia. and 4 in. in thickness was provided for the use and protection of the navigator. Water ballast tanks were provided throughout the length of the submarine as a means of regulating the draught, preserving the longitudinal trim and keeping the displacement weight constant in different waters. As the use of fuel and torpedoes during a voyage gradually reduced the weight of the vessel, the ballast tanks were filled in sufficient proportion to compensate for the loss. Two vertical and two horizontal rudders were fitted for steering and driving purposes respectively. The single propeller was driven by a 160 h.p. petrol engine during surface cruising and by an electric motor when the vessel travelled submerged.

Each submarine was fitted with a periscope, consisting of a vertical tube about 10 ft. in height fitted at the top and bottom with an arrangement of lenses and reflectors. The periscope projected above the surface of the water when the vessel was submerged and gave a clear view of the surrounding objects to the navigator. A good supply of compressed air was maintained on board.

The "*Holland*" type submarines were speedily followed by the earlier "A" class of British submarines of 100 tons displacement, and having a surface speed of 20 knots and a submerged speed of eight knots.

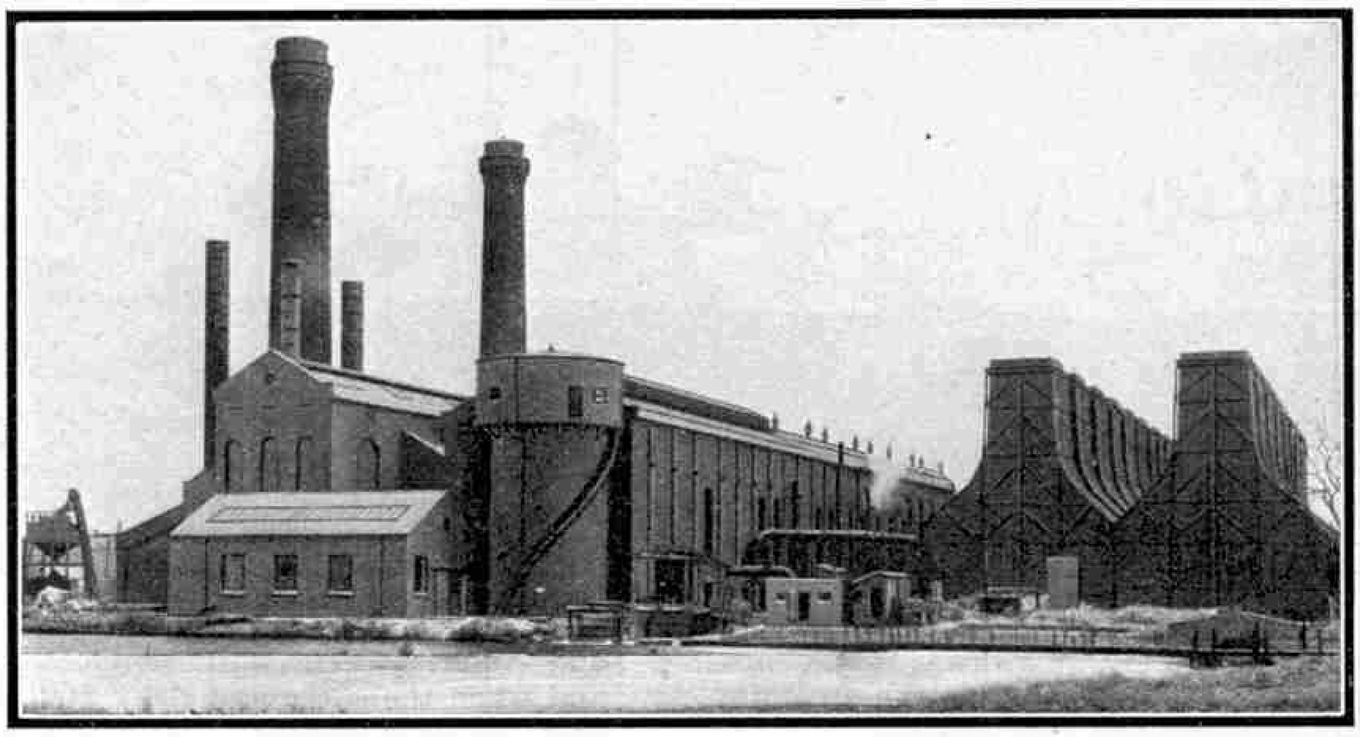
From this time the development of the British submarine was very rapid. The "B" class were of 50 per cent. greater displacement than the "A" class and had a speed of 13 knots, while the "C" class were capable of a much greater radius of action than their predecessors.

The "D" class was introduced in 1907 and the "E" class in 1912. The latter were the first British submarines to be equipped with Diesel engines, running on heavy oil instead of the petrol used in the engines of the earlier types. Each "E" class submarine was provided with five torpedo tubes and the later members of the class had also a 3 in. quick-firing gun, mounted so that it could be lowered inside the hull before (*Continued on page* 635)

The Electrification of the Metropolitan Railway

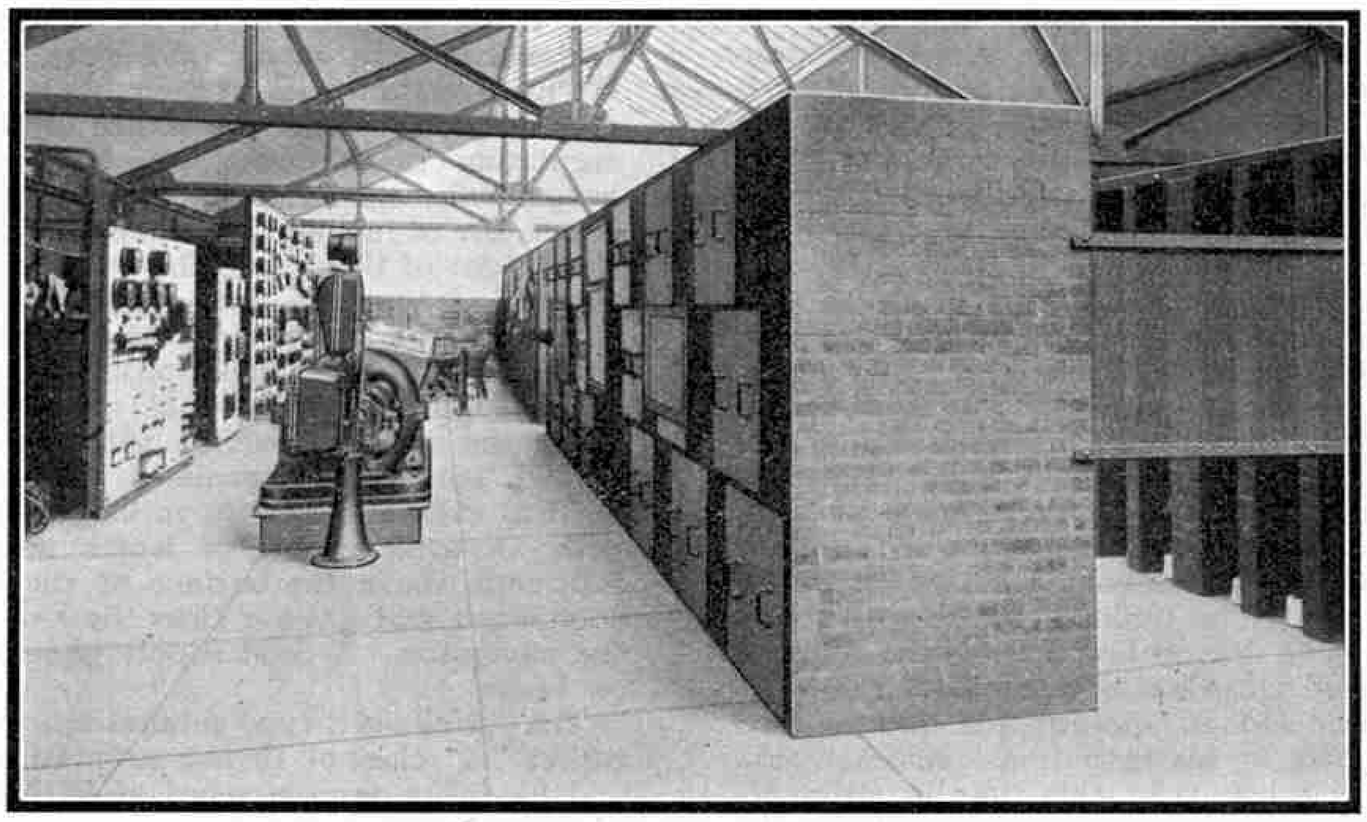
(1) The Power Station

IT is now some 75 years since the first section of what was then called the North Metropolitan Railway was opened to the public and provided the first means of communication between the west and north of London and the City other than by way of the streets. The whole length of the line was in a tunnel, and the journey was made in conditions of smoke and dirt, and in the miserable light provided by oil lamps. In spite of these serious drawbacks the railway succeeded because it provided the most rapid means of travelling from the West End to the City, and its success showed that in the public minds saving of time in travelling outweighs even quite serious inconvenience in other directions.



The Power Station at Neasden, near Willesden

The first section of the Metropolitan Railway was worked for six months by the Great Western Railway, and connected their Bishop's Road Station, Paddington, with Farringdon Street. The lines were laid for both broad and narrow gauge and the road was $3\frac{3}{4}$ miles in length. In consequence of a difference that arose between the companies the Metropolitan Railway had to provide rolling stock and to operate the line on the narrow gauge at short notice. The broad gauge was removed altogether some nine years later. The success of this short length of line resulted in an immediate growth of the system. Year by year it has extended its length of line and to-day has reached a position of enormous importance. Some idea of its growth may be obtained from the numbers of passengers carried annually. In 1863 the figure was nine millions odd; 37 years later, in 1900, it had reached over 93 millions; and to-day the figure is approximately 190 millions.



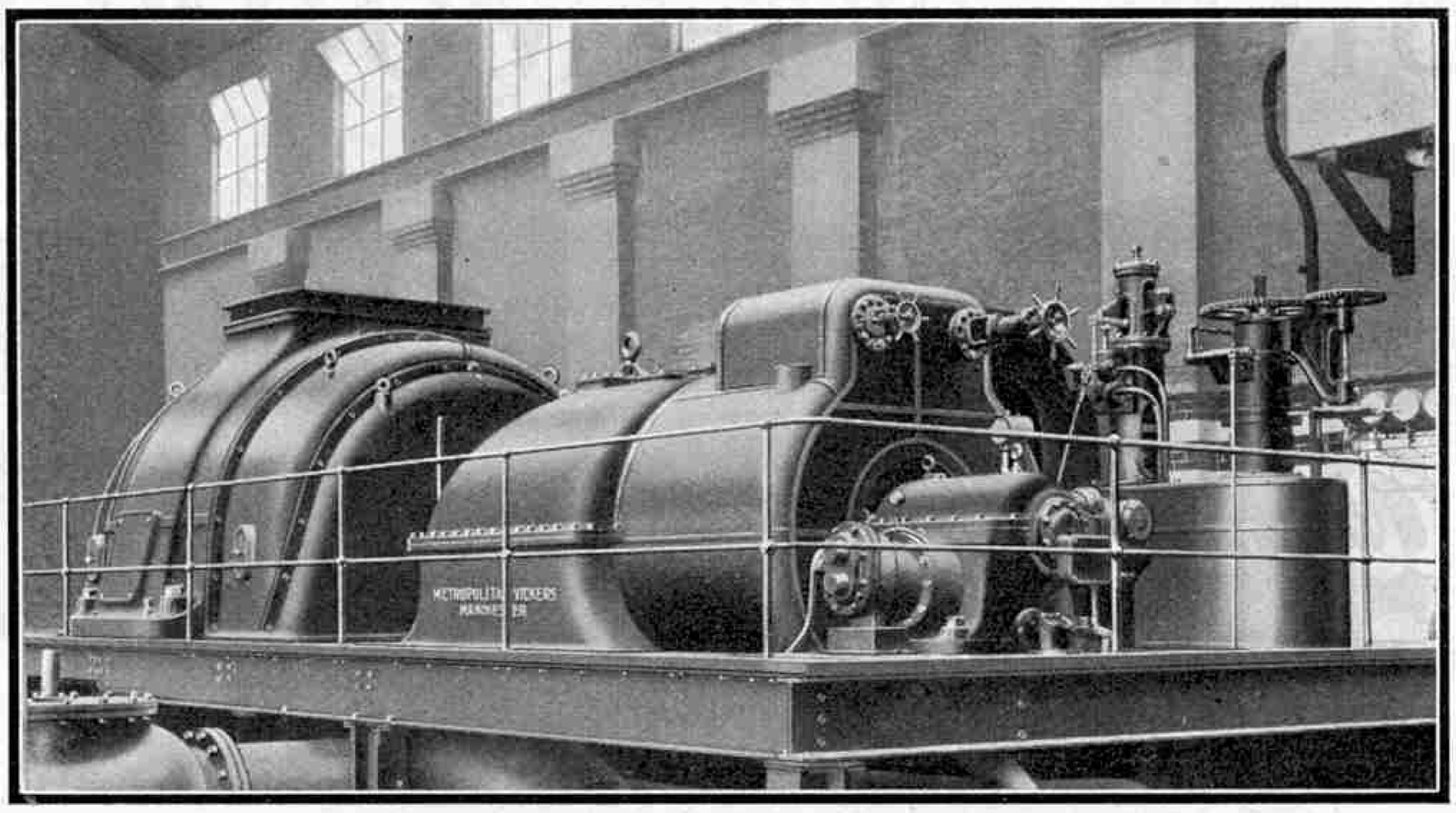
Switchgear on the top gallery, showing Cubicles, Control Board and Instrument Panels as originally arranged

In 1901 was opened the Central London Railway popularly known as the "tuppenny tube," and this proved a very serious rival of the Metropolitan Railway. It was run electrically and its cleanliness and speed made it extremely popular with the result that the Metropolitan experienced a very considerable falling off in passengers. In addition to the Central London, the City and South London Tube Railway had been operated electrically for some time with success, and other electrically driven railways in different parts of this country and abroad were demonstrating to the public that they were cleaner, quicker, and more comfortable than steam operated railways. At the same time railway managements had the fact pressed home to them that electric traction made possible considerable economies where traffic was heavy and frequent service was required.

As far back as 1898 the Metropolitan Company had obtained an Act of Parliament authorising them to run their line electrically, and subsequently the Metropolitan District Railway—whose lines, together with the Metropolitan Railway, completed what is known as the Inner Circle—had obtained similar authority. These railways combined to carry out an experiment in electrification and spent £20,000 in equipping and operating a short piece of track between Earls Court and Kensington High Street. This experiment proved satisfactory and electrification was decided upon, the only point undecided was the system to be adopted. The companies were so closely interlinked that it was essential that the same electric system should be adopted by both. The Metropolitan favoured three-phase alternating current and the Metropolitan District, continuous current. Finally the Board of Trade appointed an arbitrator who decided in favour of continuous current, and this decision was accepted and preparations for

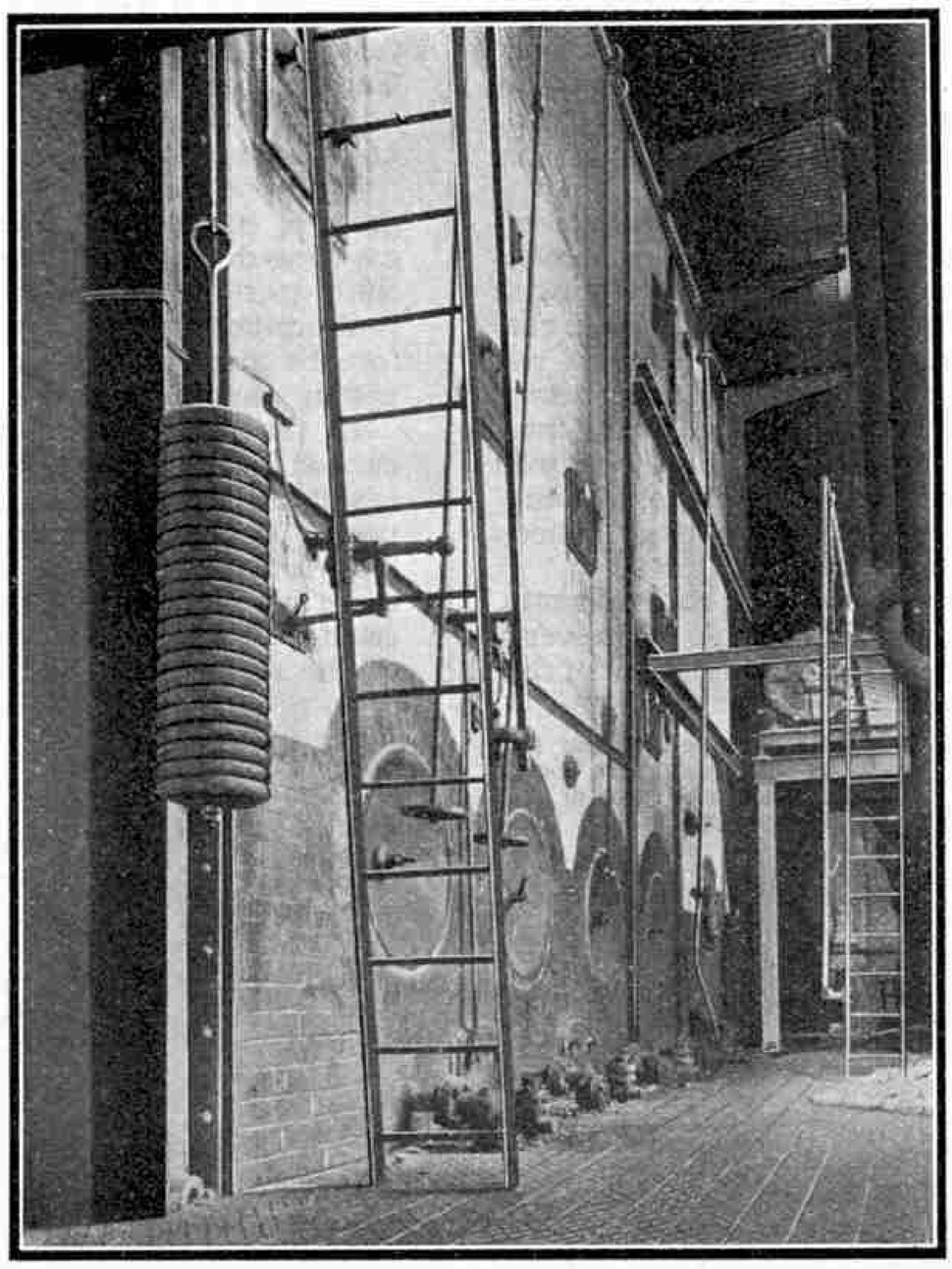
electrification were commenced without delay.

The first task was the erection of a central power station and it was decided to erect this at Neasden near Willesden, where the works of the Metropolitan Company are situated. The main building when erected covered an area of 3,660 square yards, being 325 ft. in length and 102 ft. in width. The Metropolitan - Vickers Electrical Company, at that time known as the British Westinghouse Electric and Manufacturing Company, obtained the contract for the entire electrical plant and work was commenced in 1902. Considerable alterations were made a few years later and further extensions of modern plant were installed in 1921 and 1922.



12,000 kw. Turbo-Alternator at Neasden Power Station

With the coal handling plant originally installed the coal was brought by railway sidings to one corner of the station building where the wagons were tipped into a hopper 16 ft. square. From this hopper the coal was dropped through crushing rolls if it happened to be of too large a size for mechanical stoking and from the rolls a chute conveyed it to a chain and bucket conveyor. Each bucket carried 28 lb. and was placed at a distance of 2 ft. from its neighbour. The conveyor travelled at all speeds up to 50 ft. per minute and its full carrying capacity was somewhere about 20 tons per hour. It conveyed the coal vertically some 60 ft. to the top of the hopper tower and then travelled horizontally the full length of the building distributing the coal into the bunkers over the boilers which had a combined capacity of 80,000 cu. ft. The conveyor descended vertically at the other end of the building and returned horizontally in front of the ash doors so that it could be used alternately for feeding coal to the bunkers and for removing the ash, the latter being raked by hand directly into the buckets which ultimately emptied themselves into an ashpan in the hopper tower over the coal truck siding. The total length of the conveyor chain was about 730 ft. and it was in sufficiently good condition in 1907 to be utilised to some extent when the power station was extended. From the bunkers the coal descended through automatic weighing chutes to the mechanical stokers which were driven by eccentrics on a longitudinal shaft driven by an electric motor at each end. The fuel was dropped evenly on travelling chain grates driven by the same shaft. The stoking arrangements in the extensions that have subsequently been added are carried out in exactly the manner just described.



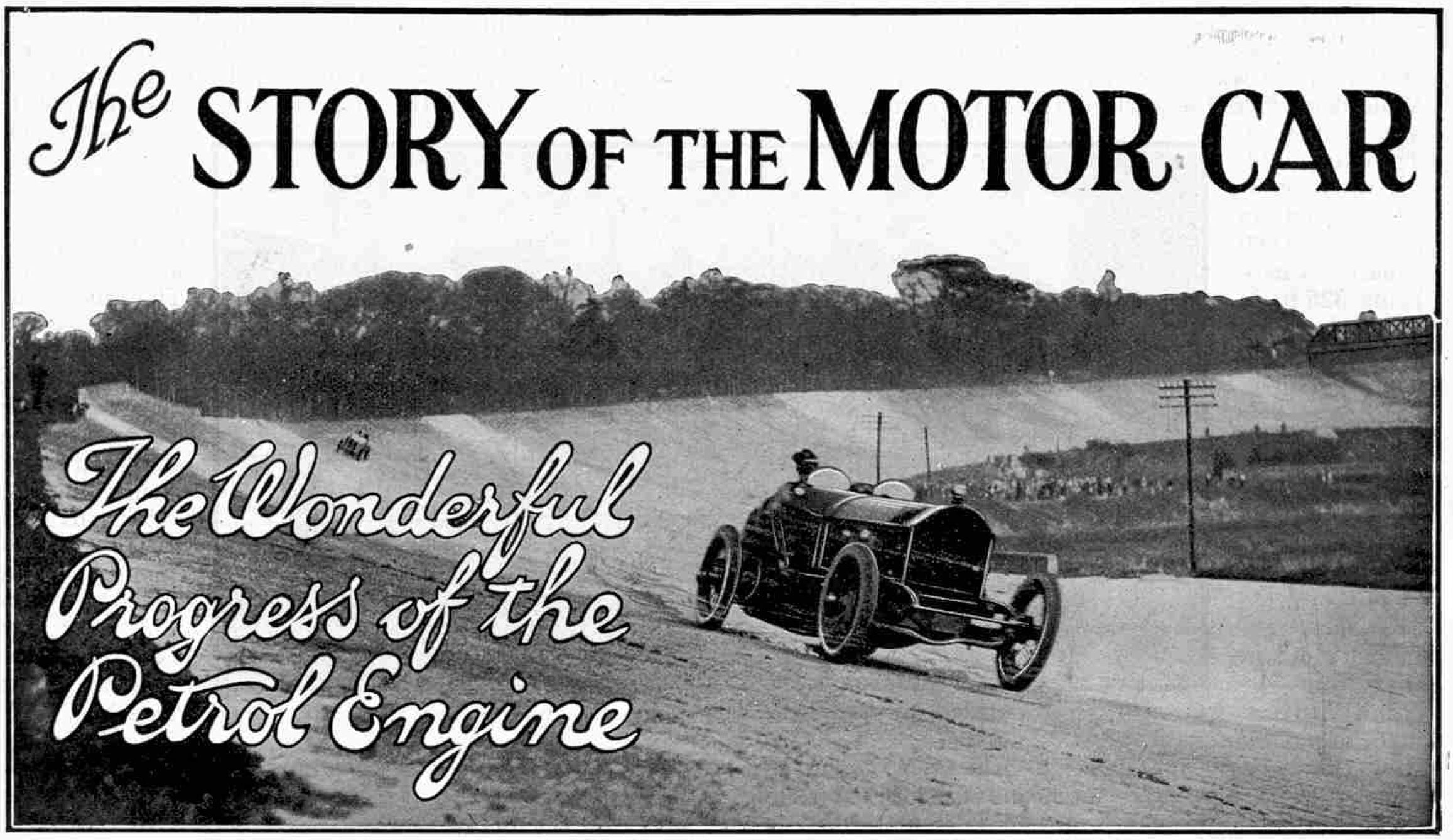
A view of the back of one of the Thomson Boilers

The electric train service was begun when only three turbo-generator sets were installed, but a fourth was added very shortly afterwards and all four sets were served by 14 water tube boilers of the Babcock and Wilcox type which operated at 180 lb. pressure per square inch gauge with 180° F. superheat. Each boiler had 5,730 sq. ft. of heating surface and its grate area was 100 sq. ft. The superheater of each boiler contained 128 tubes $1\frac{1}{2}$ in. in diameter giving 894 sq. ft. of external heating surface. The four turbines were of the single cylinder double flow Westinghouse re-action type, in which the steam entered at the centre and flowed both ways, thus eliminating end thrust. Each turbine had a normal full load capacity of 3,500 kw. and was capable of 50 per cent. overload for one hour. The speed was 1,000 revs. per minute with a permissible variation of $2\frac{1}{2}$ per cent. but the actual variation seldom exceeded $1\frac{1}{2}$ per cent.

Water softening plant had to be installed owing to the hardness of the well water used. This operated on the cold water and lime principle, and was capable of dealing with 13,000 gallons per hour.

The switchgear occupied three galleries at the west end of the generator house. The structure in the top gallery was designed for the reception of the main alternating current bus-bars and the instruments and control parts. The rheostats also were placed in this gallery. In the next lower gallery were placed (*Continued on page* 695)

The STORY OF THE MOTOR CAR



VI.—FRAME, SPRINGS AND STEERING GEAR

IN the previous article in this series the clutch, gear box and rear axle, the three chief parts of the transmission of a motor car, were described. Before passing on to deal with the frame, springs, steering gear, brakes, etc., a few more words must be said with regard to the rear axle.

The advantages that result from the use in the rear axle of the differential gear are so great that this gear is fitted almost universally, but it is nevertheless subject to one disadvantage. A little consideration will show that its effect is to transmit the power of the engine to the wheel that is encountering least resistance. If, for instance, one wheel is stationary, the other turns at twice the speed. If one of the rear wheels of a car runs into a greasy patch of road, therefore, the tendency is for the power to be transmitted to that wheel only, instead of being equally divided between the two wheels, with the result that one wheel spins furiously while the other remains stationary.

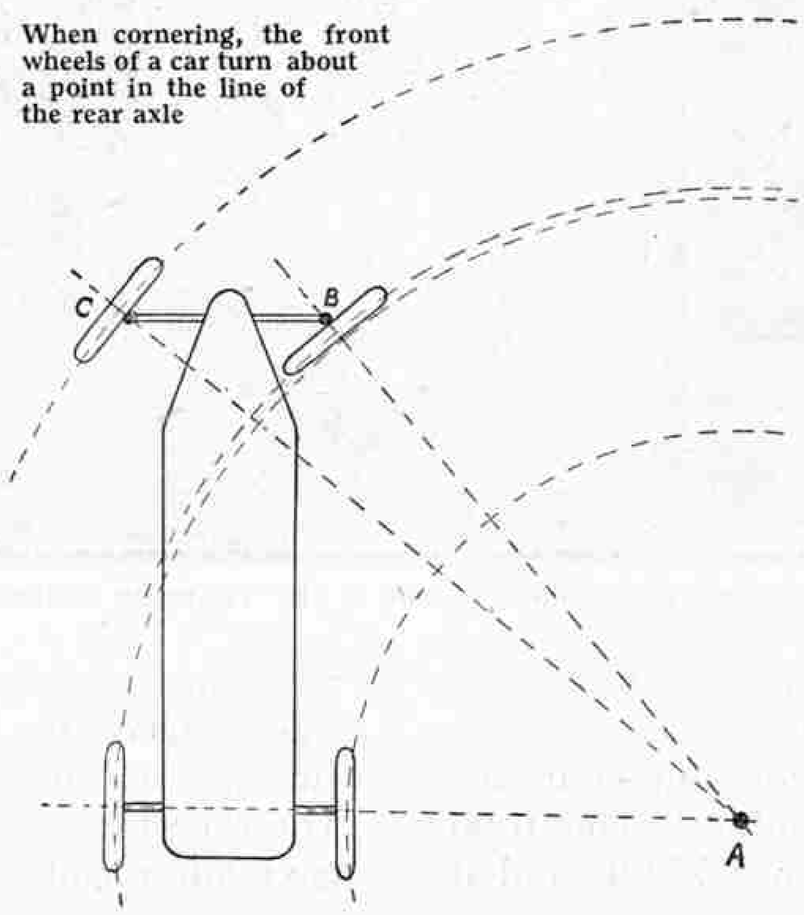
In ordinary running the forward impetus of a car prevents this from happening, but starting may be impossible from very muddy places because of wheel spin made worse by this action of the differential. Heavily loaded commercial vehicles are perhaps the chief sufferers. They are often required to work in muddy or slippery places off the roads, and in consequence many of them are fitted with an arrangement for putting the differential gear out of action. Some racing cars are made without a differential, the wear of the tyres due to wheel drag along the ground being disregarded in comparison with the loss of time due to wheel spin.

In addition to carrying the two shafts that turn the road wheels, the rear axle does other very important work. Considering it as a whole, it supports the greater part of the weight of a car, and is subject to severe road shocks owing to its position and to the fact that it is not carried on springs. In order to enable it to carry out this work effectively it must be strong and yet light. Its construction is comparatively simple. The final drive, differential gear and shafts are enclosed in a casing that becomes at each end an outer tube surrounding the axle shaft. This casing protects these mechanisms from damage and makes it possible to run them in a bath of oil. The shape of the casing and the material used in its construction both vary considerably, cost being an important factor in settling the design.

With the mere shape of the casing we need not concern ourselves greatly, but an important point arises in regard to the weight-carrying duties of the casing and of the axle shaft. In many cars the latter carries the whole of the weight on the rear axle, and is described as being of the semi-floating type. It must therefore be made strong enough to carry out the two duties of propelling the car and carrying a large proportion of its weight.

In the fully floating type of axle the whole of the weight is carried by the casing, the shaft merely turning the wheels. The casing is carried right into the hub of the wheel, which is supported on it by a pair of ball bearings. An intermediate type known as the three-quarter floating axle is also in use, in which there is a single ball bearing to support the wheel on the axle casing. Usually this ball bearing is placed on the centre line of the rear wheel, and in that case the axle shafts only support a portion of the weight of the car when a corner is being turned.

When cornering, the front wheels of a car turn about a point in the line of the rear axle



It is quite impossible to make the frame of a car so stiff that the parts of the mechanism mounted on it always retain exactly the same position relative to each other, and several simple coupling devices have been introduced to enable the connecting shafts to move slightly out of line. A form of ball and socket joint would effect this, but the usual coupling on motor cars is either a joint of the same type as the Meccano universal coupling (S.M. No. 272), or one in which a fabric disc is used to give the necessary play.

The principle of the Meccano universal coupling is very simple. The ends of the shafts are forked and pivoted on pins that are fixed at right-angles to each other, the lines of the pins intersecting at the point of intersection of the centre lines of the main shafts. This coupling usually takes one of two forms. In the star form the pins are provided by a cross-shaped forging, while in the second form, known as the ring coupling, short pins are mounted

at equal intervals on the circumference of a metallic ring. In the latter case the centre lines of the pins would intersect in exactly the same manner as the parts of the cross-shaped forging actually do.

With either method of forming the coupling, movement of each shaft by rotation on its pins is permitted, and as the two movements thus provided are at right-angles to each other, all possible relative positions of the shafts are provided for.

A fabric coupling is similar to those already referred to, the cross-shaped forging of a star universal joint being simply replaced by a disc of leather, or more usually of specially prepared fabric, which bends when the shafts connected by it move out of line. The use of fabric discs makes it possible to use three arms at the end of each shaft instead of the forks used in star couplings. The arms are usually known as spiders and are bolted round the disc at equal intervals, those from the shaft on one side alternating with those from that on the other.

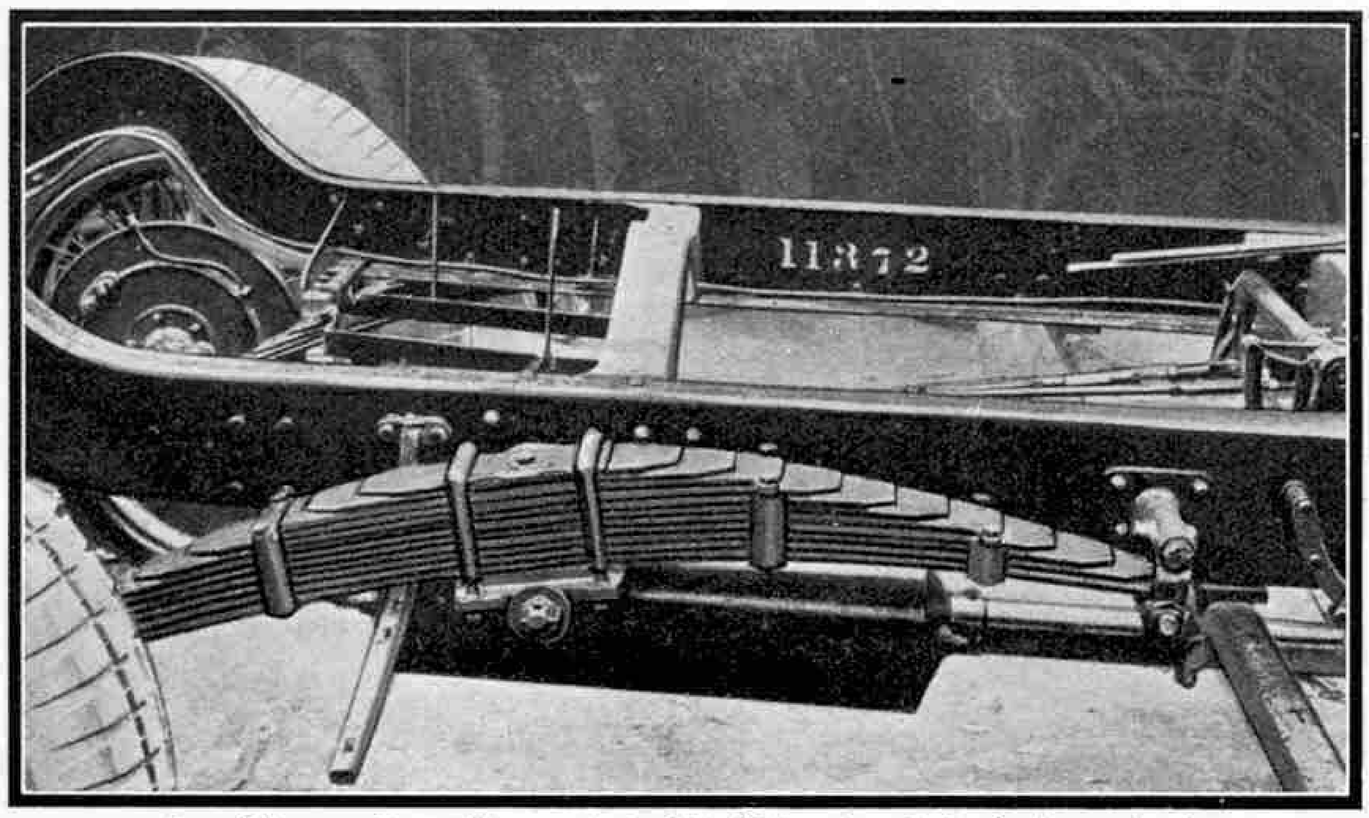
Two important engineering points in connection with the transmission have not yet been dealt with. The rotation of the axle tends to turn the axle casing also, but in the opposite direction, the bevel pinion tending to climb up the crown wheel that it thrusts down. This tendency is particularly heavy when starting the car. In addition, the thrust of the road wheels imposes stress on the framework of a car and on certain parts of the transmission, and due provision must be made to take up this thrust.

The simplest way of accomplishing this is to make use of the springs, which in that case are clamped rigidly to the axle at their centres and to the chassis at their forward ends. The rear ends are attached to the ends of the side members of the frame by shackles that permit a little play. It is thus the front half of the springs that prevents rotation and does the work of thrusting the car forward along with the axle casing.

Another method that is finding favour is to use a tube surrounding the propeller shaft for this purpose. This tube may be regarded as an extension of the rear axle casing and usually ends in a ball and cup joint at the rear end of the gear box. The use of a tube in this position relieves the springs of the double duty of taking the drive and resisting torque reaction, while at the same time it completely encloses and protects the driving mechanism between the gear box and the rear axle. One universal joint only is required, the whole of the transmission behind the gear box forming the unit. The method is cheap and efficient, although it adds to the weight of a car. It is used in the Ford car, in which the whole of the power mechanism and transmission forms two units only, the first containing the engine, clutch and gear box, and the second the propeller shaft and rear axle, a single universal joint connecting the two.

So far in these articles we have dealt with the engine and the parts of the transmission, which constitute the essential features of a motor car, without considering the framework on which they are carried. Various designs for the frame or chassis have been suggested from time to time, but the great majority of cars now make use of practically the same design. In this the framework is composed of two parallel channel girders, or side members, usually made of pressed steel, and connected at various points by cross members. The latter are either of similar cross section to the side members, or are tubular, and the joints are riveted.

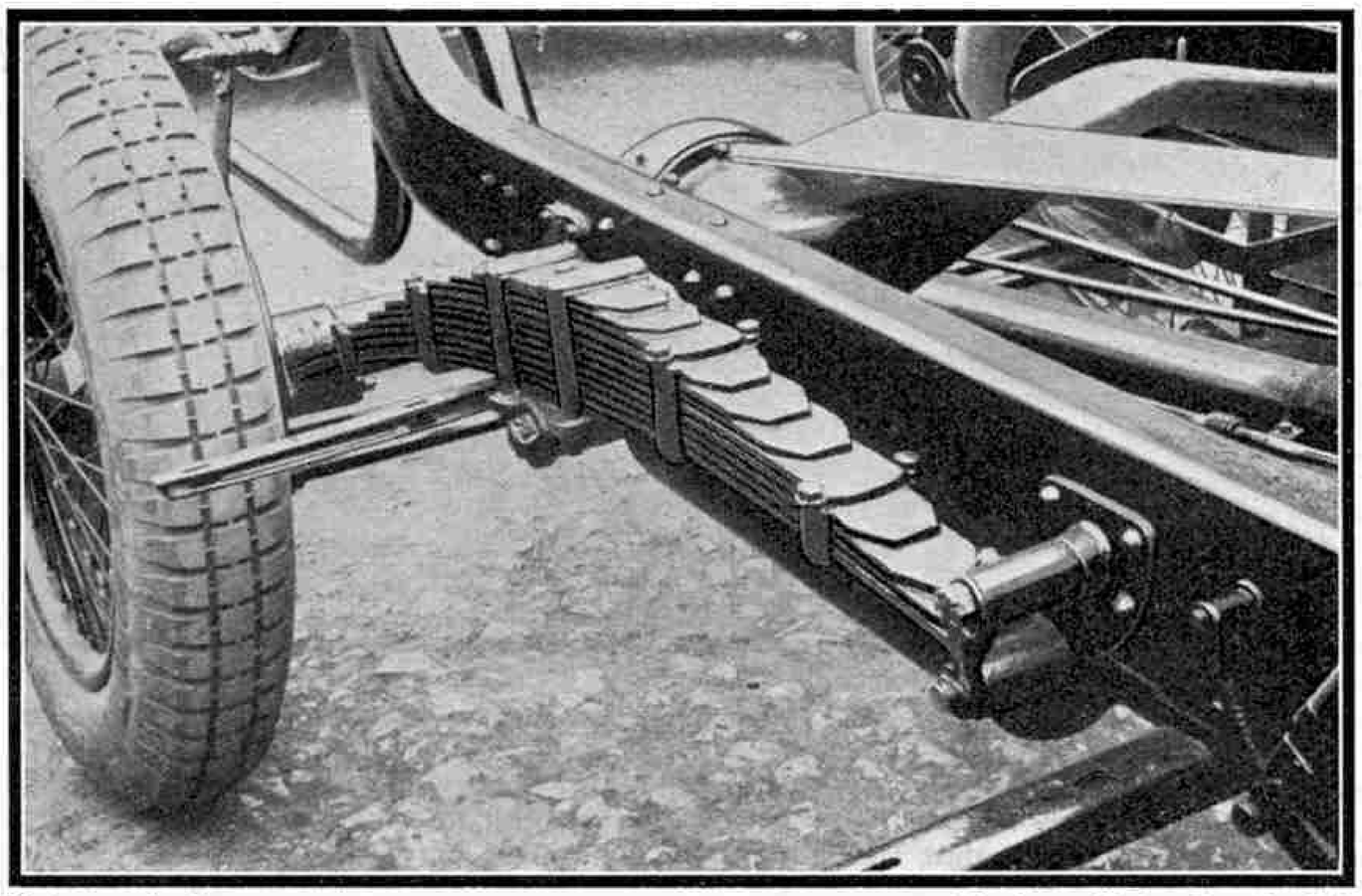
At the front end of the frame comes the engine. This is usually carried on a sub-frame supported at three points, one at the front and the remaining two as far back as the flywheel housing. This kind of suspension is used because distortion of the frame does not produce any corresponding distortion of the engine. If one point is raised, for instance, the engine simply pivots about a line passing through the other two. The same principle is made use of in supporting cameras and scientific instruments, which may be supported on tripods on any kind of ground without any distortion of the instruments themselves.



One of the massive cantilever springs of the 25 h.p. six-cylinder Sunbeam chassis

The gear box has considerable weight and is therefore suspended from stiff cross members of the frame. Towards the rear of the chassis the side members usually appear to be taken over the rear axle in a curve. In reality the frame is dropped, except over the rear axle, so as to give a low centre of gravity. In order to give the body of the car a good wide support the side members are curved inward, the widest part of a frame of this kind being in the middle.

The frame is carried on the axles on springs that intervene between the two, and these springs play a very important part. A springless car would not only be very uncomfortable for its occupant, but would continually hammer the road, a procedure that would be bad for both road and car. Some method of springing has been used for road vehicles of practically all kinds for hundreds of years past, and the springs used on motor cars are a development of these. In almost all cases they are longitudinal; that is they are parallel to the side members of the frame. The Ford car is an important exception in which transverse springs are used.

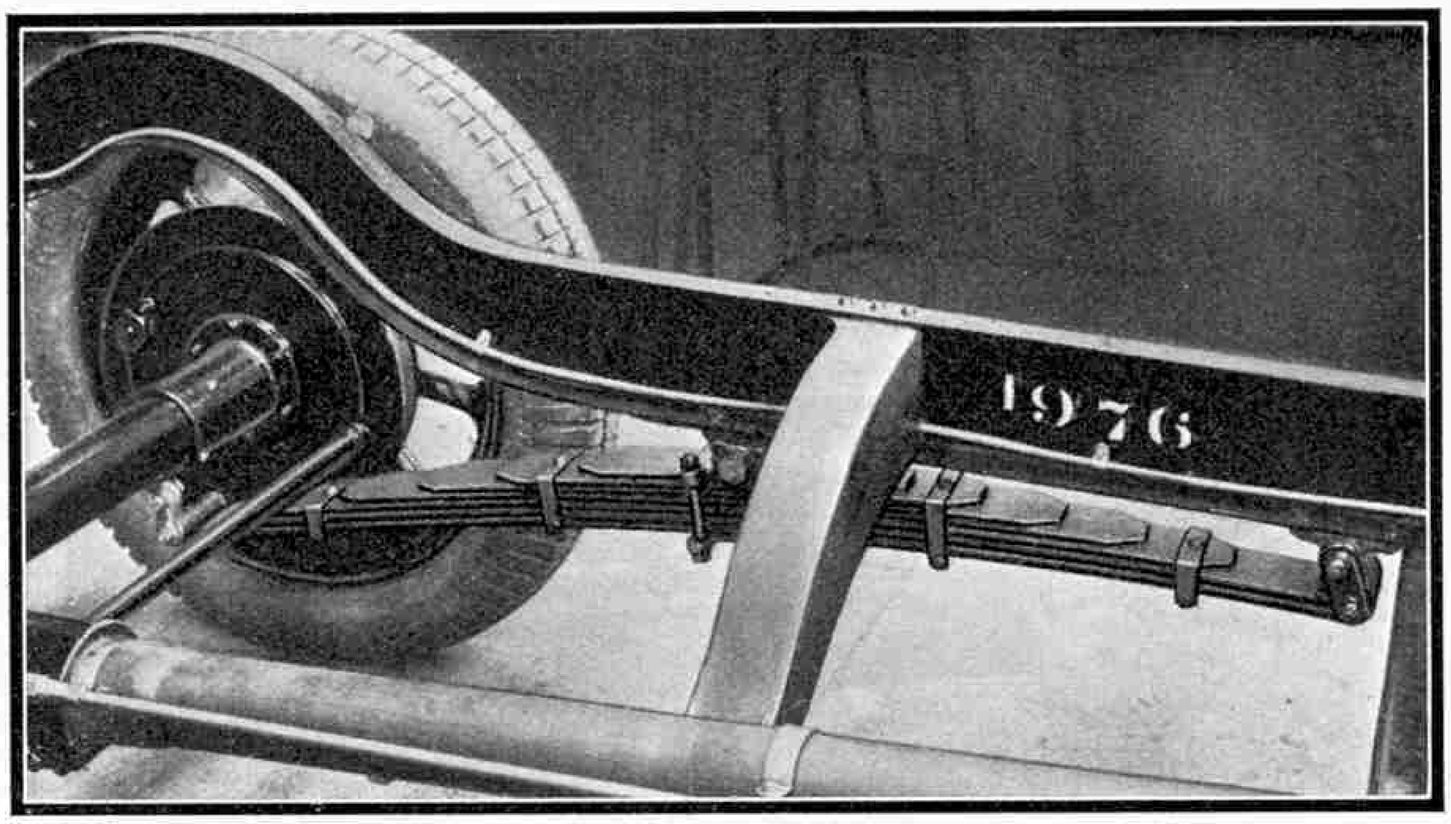

Photos courtesy] [*Sunbeam Motor Car Co. Ltd.*
This view of the rear part of a chassis shows how cantilever springs are attached to the frame at two points and to the axle at the end of the extension

Leaf springs are universal. They are built up of a number of well-tempered steel blades, sufficient of them to give the necessary strength being placed on top of each other. The leaves of a spring are not all of the same length, each leaf added in making up the assembly being shorter than the previous one. They are pinned in the middle and clamped at points along the blades.

The flexing of the springs naturally lessens the shock transmitted to the frame and body-work of a car when the road wheels strike any obstacle. The rebound after the initial bending is damped out by the friction between the leaves themselves as they pass over each other while the spring is bending and straightening out once more. The readiness with which this damping out of the vibrations of a leaf spring takes place is the chief reason why this type is used universally on motor cars and other road vehicles.

Formerly occasional coatings of graphite were applied to the frictional surfaces of the leaves, but it is the modern fashion to enclose them in leather gaiters and to lubricate them well with grease. This certainly prevents rusting and lengthens the life of the spring, but unfortunately it also reduces the damping effect. Extra friction is therefore advisable, and this is provided by fitting shock absorbers.

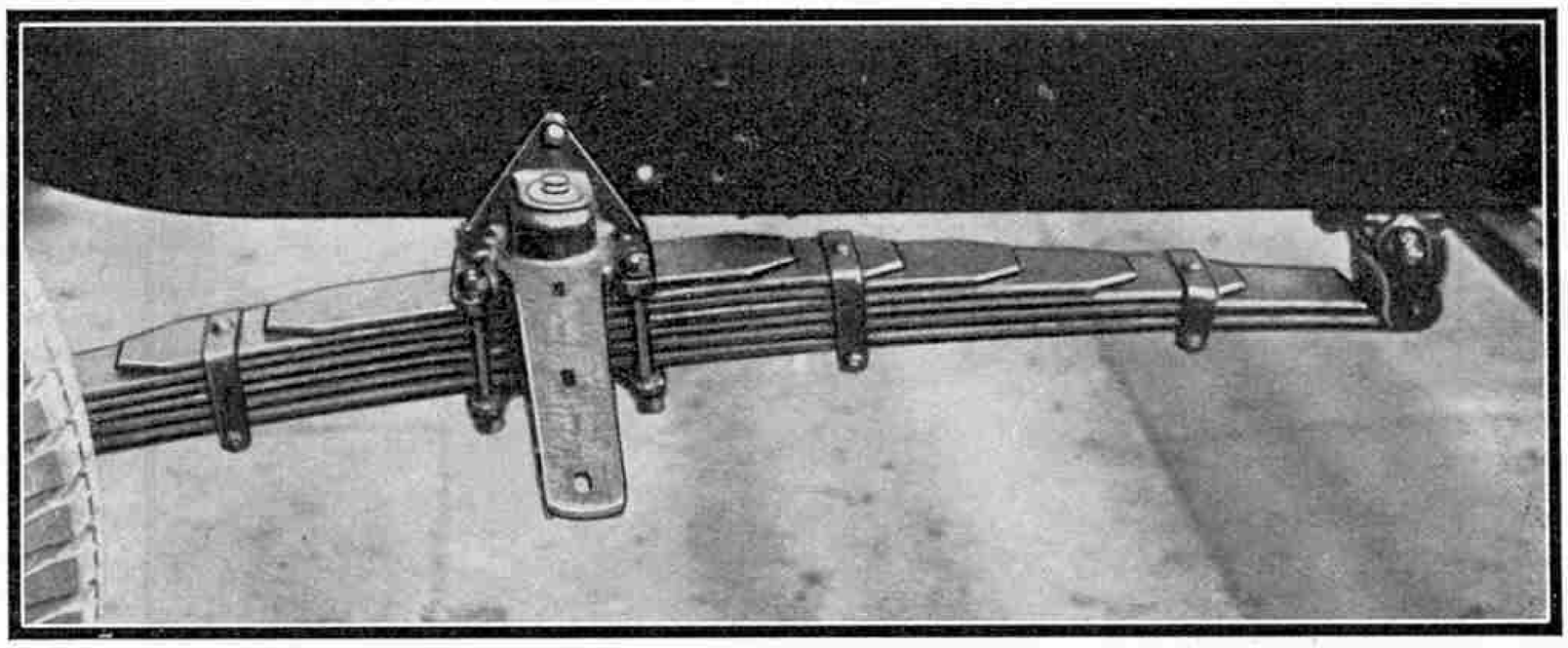
Three kinds of springs are in general use; the semi-elliptic, the quarter-elliptic and the cantilever. Of these the most popular by far is the semi-elliptic type. This is a curved spring that resembles in shape one of the long curved sides of a narrow oval or ellipse. It is usually attached to the frame at its ends and its centre rests on a flat on the axle, to which it is fixed rigidly. When used in this way the longest leaf is uppermost—the shortest leaf being on the outside of the curve—and shackles are used at the rear end to allow for the flexing of the spring. Four springs of this kind, one at each end of each axle, constitute the equipment of most cars.



The upward sweep of the frame of a modern car over the rear axle is well shown in the 16 h.p. Sunbeam chassis

A variation sometimes seen on the smaller and cheaper cars is the quarter-elliptic, springs of this type looking like semi-elliptic springs that have been cut in two transversely in the middle. The thick end of such a spring is fixed to the frame and the thin end to the axle, the shortest leaf on the outside of the curve being in this case uppermost.

It will be noted that the position of a quarter-elliptic spring is inverted in comparison with the usual position of a semi-elliptic spring. The latter type is used in an inverted position when transverse springing is adopted, as in the Ford car. The centre of the spring is then rigidly secured to the frame and the end attached to the axle through shackles. A car with transverse springs of this kind tends to roll, and they are now usually restricted to the front axle. Thus on the 7 h.p. Austin a transverse spring is used on the front axle and a pair of quarter-elliptic springs at the rear. The Ford is the only car that makes use of transverse springs on both front and rear axles.


Photos courtesy] [*Sunbeam Motor Car Co. Ltd.*

A closer view of a cantilever spring of the 16 h.p. Sunbeam chassis, showing the method of attachment

One of the difficulties of transverse springing is that the front axle tends to turn under the chassis when the road wheels strike any obstruction or when front wheel brakes are applied. In order to prevent this radius rods are necessary.

Cantilever springs are used mainly on large and expensive cars. In appearance they resemble inverted semi-elliptic springs and are only used on rear axles. The centre is pivoted on the frame and the front end attached to it through a shackle, while the rear end is rigidly attached to the axle. The rear part of a spring mounted in this fashion thus extends beyond the points on the chassis on which it is supported, in the same manner as the girder structure of a cantilever bridge extends beyond the piers on which it is carried. The extended portion may be made much longer than the front part and great flexibility thus secured. The Sunbeam cars, illustrations of which accompany this article, are typical British cars in which cantilever springs are used.

The springs on which the front of a car is supported are fixed to the front axle, at their centres if the springs are semi-elliptic, and at the thin end if quarter-elliptic. Clamps are used to hold them and they are prevented by a pin from moving forward relatively to the axle under the thrust of the rear wheels. The front axle is not called upon to do nearly so much work as the rear axle and is much simpler in construction. Usually it is a forged steel beam of I section, but sometimes it is tubular. At the ends are stub axles on which the wheels themselves are mounted. In the most usual form taken by these, either the stub axle or the end of the axle beam is T-shaped, and works in a fork on the end of the other.

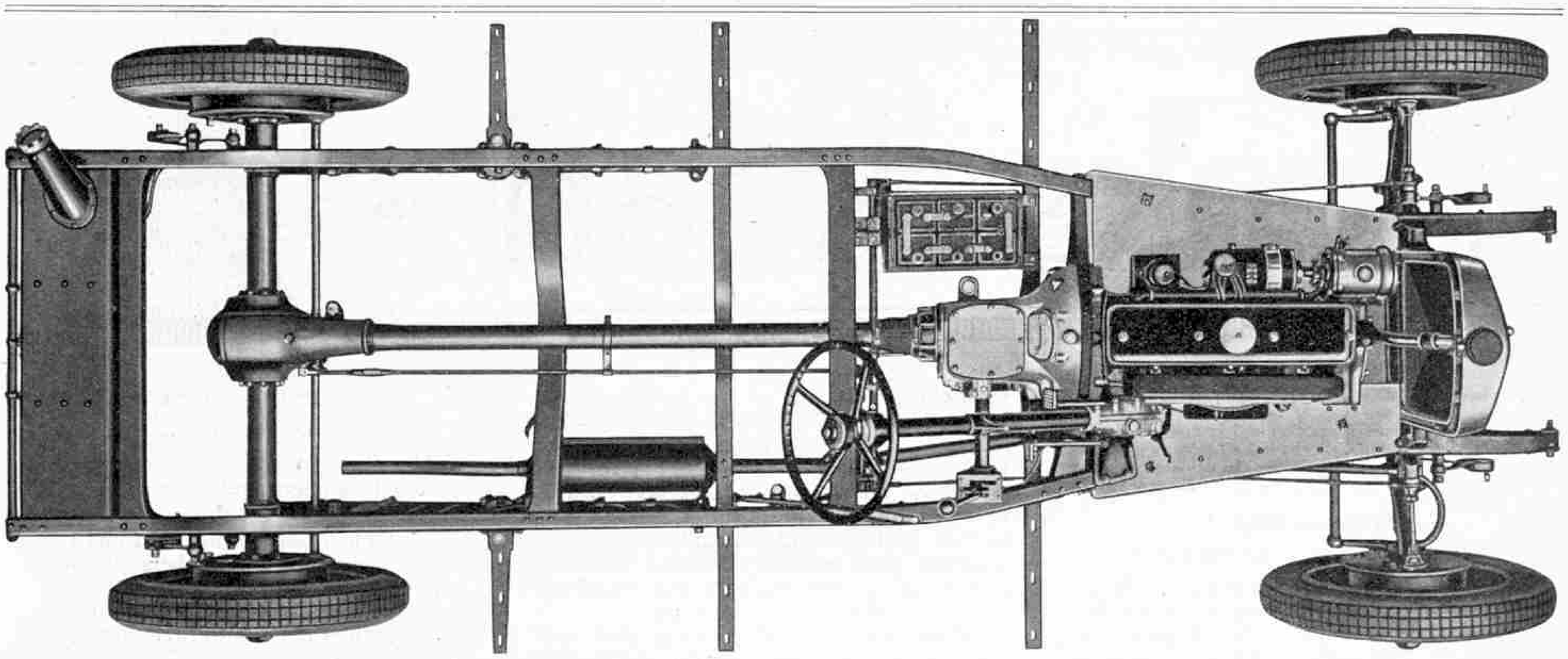
The wheels complete a motor chassis. The various forms taken will be familiar to all readers of the "*M.M.*" and little comment is necessary. The wooden artillery wheel formerly in favour is not now so often seen in Great Britain, where it has been largely superseded by a similar wheel made from two steel pressings welded together. It is still popular in the United States where a suitable wood, hickory, is available. This type of wheel is held in position by three or five bolts distributed round the hub. The disc wheel, in which the spokes are replaced by a metal disc, is attached in a similar manner. The chief objection to this type of wheel is its weight.

Undoubtedly the most interesting of all types is the wire wheel, an application of the principle used in the construction of a bicycle wheel. Two or three lines of spokes are arranged for the larger wheels and give a strength and ability to withstand side strains that make the wire wheel an almost certain choice for expensive or racing cars.

The next requisite of a motor car to which we must turn our attention is the steering gear. The provision of an efficient and reliable means of steering is in some respects the most important consideration in building road vehicles intended to attain high speeds, as the experiences of Major Segrave and other drivers of high-powered cars have shown. When the famous Sunbeam racing car broke the existing speed record on Daytona Beach in 1927 the only real difficulty encountered was in holding the car on a straight line in the face of the enormous wind pressure, and special provision was made in Capt. Campbell's "*Bluebird*" to minimise the risks due to steering troubles. The difficulty is not, of course, so great in the case of ordinary motor cars, but when it is remembered that at a speed of 30 miles per hour a car travels 44 ft. in one second, it will be realised that quick-acting steering gear is essential.

The methods adopted in early cars seem strange to us and would be quite inadequate to-day. Some cars had tiller steering and others were handled like bath-chairs! The steering wheel rapidly became universal, however, as it proved by far the most suitable means of handling heavy and fast cars.

In order to explain the form taken by steering gear in modern cars it will be best to consider first what is required from the front wheels when a corner is to be turned. As the wheels are



Courtesy] [*Sunbeam Motor Car Co. Ltd.*

Plan of the chassis of a typical modern car. The engine and gear box form one unit and the cardan shaft is enclosed in a torque tube. Other interesting features clearly visible are the length of the rear cantilever springs, and the lay-out of the "gate" in which the gear lever moves, while the convergence of the steering arms is also plainly shown

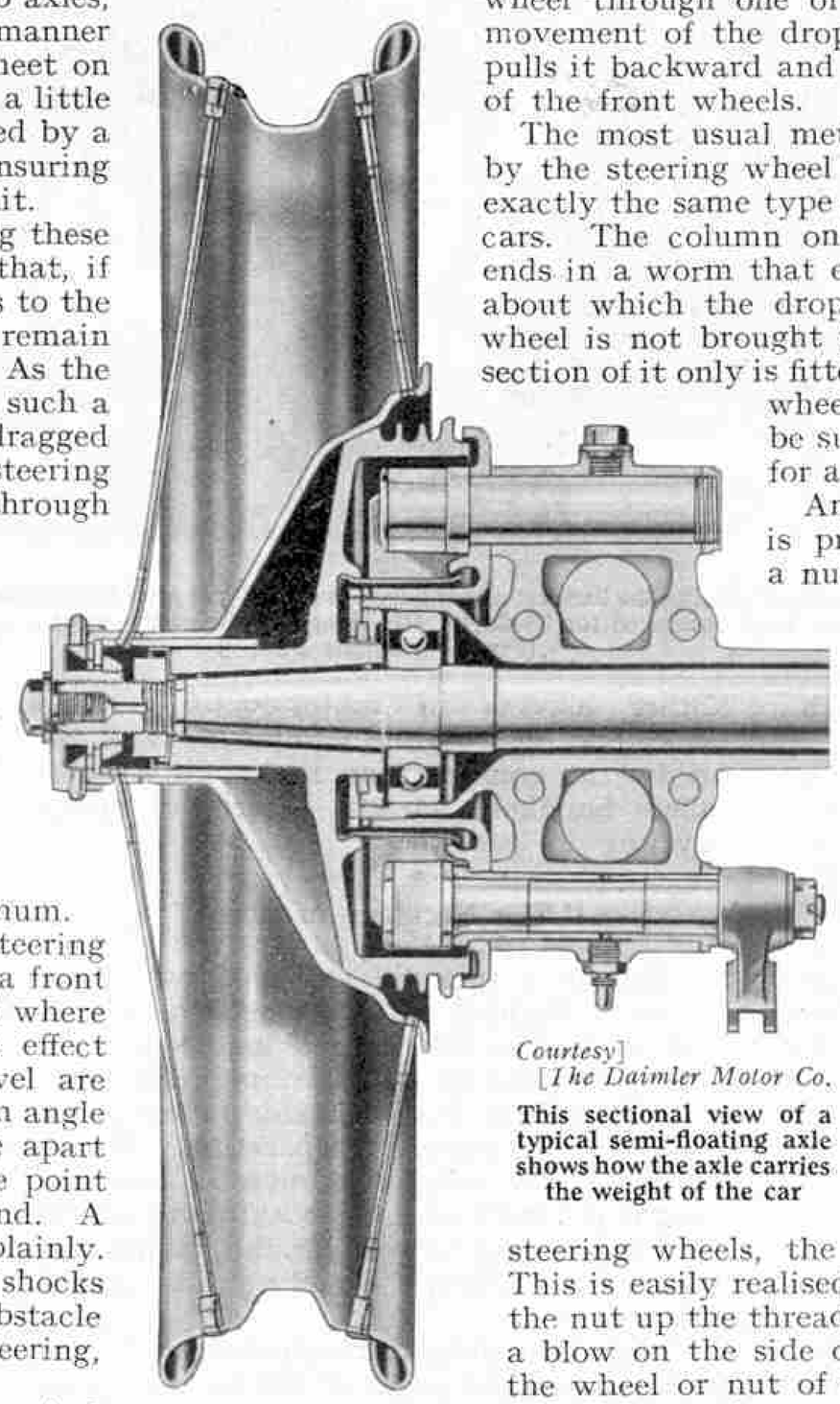
pivoted separately on the ends of an axle that does not alter its position relative to the car, they must be connected in such a manner that they turn together. From the inner ends of the stub axles, short shafts or steering arms are attached. These are not at right-angles to the lines of the stub axles, but are made to converge slightly in such a manner that their centre lines, if produced, would meet on the centre line of the car, usually at a point a little in front of the rear axle. The arms are joined by a tracking rod pivoted on their rear ends, thus ensuring that the two wheels swivel together as a unit.

In order to appreciate the effect of making these steering arms converge it should be noted that, if they were exactly parallel and at right-angles to the stub axles, the two wheels would always remain parallel to each other as they were turned. As the outer wheel moves through a longer path in such a movement, it is quite clear that it would be dragged along the ground. The effect of making the steering arms converge is to turn the inner wheel through a slightly greater angle than the outer one, and the angle of convergence must be so adjusted that the lines of the stub axles, when produced, meet in a point that is also on the line of the rear axles. The diagram on page 654 makes this clear and from it the fact will be immediately realised that each of the four wheels is turning about the point A as centre. Neither of the front wheels therefore is dragged along the ground, and the muscular effort required for steering is reduced to a minimum.

Another important feature of efficient steering gear is that the line of the pin about which a front wheel swivels meets the ground at the point where the wheel also touches it. To obtain this effect the king-pins about which the wheels swivel are canted slightly and the stub axles are set at an angle so that the wheels toe inward, the distance apart at the top being slightly greater than at the point where they are in contact with the ground. A glance at many cars shows this quite plainly. Steering is made easier by this device, while shocks produced by the impact of the wheels on any obstacle on the road have practically no effect on the steering, as they exert no leverage.

Still another interesting point is that the swivel pins slope backward slightly. This brings the point of contact with the road slightly in front of the pins and the wheels therefore tend to straighten themselves out after turning.

The method by which the driver of a car controls the steering gear remains to be described. The essential thing is to swivel one of the wheels round its pin, when the other will be caused to turn through its proper angle by the gear already referred to. The stub axle of the off-side front wheel is therefore prolonged backward by a short arm on the end of which is pivoted a long horizontal rod, known as the drag link, the rear end of which is similarly pivoted to the drop arm. The latter is a vertical rod keyed at its upper end to a shaft that is turned by the steering wheel through one of several kinds of gearing. The rotary movement of the drop arm pushes the drag link forward or pulls it backward and thus controls the swivelling movements of the front wheels.



Courtesy]
[*The Daimler Motor Co.*

This sectional view of a typical semi-floating axle shows how the axle carries the weight of the car

The most usual method by which the drop arm is turned by the steering wheel makes use of worm and wheel gear of exactly the same type as that used for the final drive of many cars. The column on which the steering wheel is mounted ends in a worm that engages with a gear wheel on the shaft, about which the drop arm rotates. The whole of the gear wheel is not brought into play and on many cars a quarter section of it only is fitted. The advantage of fitting a complete wheel is, of course, that an unworn part may be substituted for that which has done duty for a considerable time.

An alternative to worm and wheel steering is provided by substituting for the wheel a nut slipping up and down the worm. As the steering column rotates the nut travels along the worm, and its movement produces a similar movement of the drop arm with which it is connected. In either case the mechanism is enclosed to enable lubricants to be used.

With both forms of steering gear considerable reduction is provided to make easy steering possible. The steering wheel rotates through an angle that may be from four to eight times as large as that through which the road wheels turn, the effort required to move the latter being correspondingly reduced. Further, the gears are almost irreversible, which means that while it is easy to twist the road wheels by twisting the steering wheels, the reverse process is almost impossible. This is easily realised by trying to rotate a bolt by pushing the nut up the thread, an almost impossible feat. Similarly, a blow on the side of the road wheels that tends to move the wheel or nut of the steering gear will have practically no effect on the worm, and there will be no tendency for the steering wheel to be twisted out of the hands of the driver, who will thus be able to retain control even when driving over very rough roads

There is a very slight reverse action, however. If there were none the steering gear would be too rigid and the car would feel absolutely dead. The effect of the rake of the swivel pins in automatically straightening out a car after turning would also be prevented if the steering gear were quite irreversible.

Books to Read

Readers frequently write asking if we can recommend books that are both of interest and of use. On these pages we review books that will specially appeal to readers of the "M.M." We do not actually supply these books, which may be obtained either through any bookseller or direct from the publishers.—EDITOR.

"Perilous Days"

By David Masters. (John Lane, 8/6)

Our readers will remember that in the "*M.M.*" of August last we reviewed Mr. David Master's book "*The Wonders of Salvage.*" The author's latest book is as interesting reading as is the book on salvage. In "*Perilous Days*" Mr. Masters relates some of the most astounding adventures of our time—adventures in which men have faced almost certain failure and death, and won success against tremendous odds.

These real life tales, each one of which is fully authenticated, concern adventures on land and sea, and in the air. But, no matter whether the drama runs its course on the high seas or in the blue sky, there are thrills and excitements that stir the imagination. The old saying that "Truth is stranger than fiction" was never so clearly proved than in this book, beside which ordinary sensational fiction grows pale.

Pierre Berthon—described as being the luckiest miner alive—is shown just after being brought up from the Courrières Mine in which he had been entombed for 25 days. His escape is one of the most remarkable in mining history. (From "Perilous Days")

One of the stories concerns a man who fell from an aeroplane six miles up! Another has to do with flying the Atlantic. Of the rest—A Fortune Snatched from the Sea; Afloat with a Madman; How Dover was Saved during the War; Life in the Depth of the Sea; Through an Inferno; Back from the Grave—these titles should be sufficiently attractive to make any reader "want more." We have rarely read a book that is more thrilling in its stories of marvellous triumphs and glorious failures.

* * * *

"How to Ride a Motor Cycle"

By J. Harrison, A.M.I.A.E.
(Percival Marshall & Co. 1/6 net)

At this season of the year the motor cyclist is very much in evidence, and in many cases it is easy to see that a little advice on the proper management and care of the machine would have saved a great deal of trouble. Advice of the kind required is to be found in Mr. Harrison's book. The writer is a practical motor-cyclist who has learned by experience all the wrinkles that enable the rider to get the best out of his machine, and here he passes on his knowledge. The accounts of the working of four-stroke and two-stroke engines, together with the notes and advice on the care and adjustment of the various parts of the modern motor cycle, should enable riders to maintain their machines in good condition and to deal with most of the problems that are liable to confront them.

Other sections of the book that will also prove valuable explain legal and other aspects of motor-cycling, while chapters on touring equipment and on riding in competitions make up a complete handbook on the subject of motor cycling in general.

* * * *

"The Necklace of Shells"

By David Ker. (R.T.S. 2/6)

This is a splendid story of two white boys in Madeira who, through the kindly act of binding the injured foot of a black boy, are aided by the warriors of the boy's tribe, when he has been able to rejoin his people after years of separation. We so often bestow nicknames more or less apt, but it is rarely we hit a vital truth as did the two young heroes, for they called the black boy "Prince"—and a prince indeed he was!

Some interesting descriptions are given of Madeira and of parts of Africa and many thrills, including a shipwreck (based on one of the author's own experiences); a ghostly vessel manned by devils that frightens a poor old native out of his wits; and black warriors who are burning with enthusiasm to aid the white ruler who has so justly restored disputed land to them. There are many exciting episodes in this thoroughly enjoyable story.

"British Spiders"

By T. H. Savory. (Clarendon Press. 6/-)

Nobody seems to be particularly interested in spiders and there seems to be a general dislike of them that prevents most people from taking anything but an unkind view of them. Others who do not share this feeling find it difficult to show any enthusiasm for the study of a group of animals, when there is so little literature to stimulate their interest. The aim of this book, perhaps an ambitious one, is directed to satisfy both these classes, and the author hopes to rouse a general interest rather than to produce a book of reference for the specialist. He tells us, however, there is a great need for such a work among such specialists as there are.

One of the great obstacles against anyone interesting themselves in the study of spiders seems to be the fact that—with a few possible exceptions in which the spider has a name in English, or even a nickname—all spiders seem to have been christened with long-sounding Latin names. There does not seem to be any method by which this objection can be overcome, however, and in the circumstances it would seem we shall have to continue to use the Latin names. It would be impossible to re-name the whole genera and even if they were re-named, regardless of the work involved, we imagine there would be wholesale objections from students of other countries.

Some people do not understand why anyone should take the trouble to study insects or spiders, as this seems to many to be a hopelessly trivial study. But so, also, does the fact that scientists have engaged themselves in counting the hairs on a gnat or studying the entrails of a mosquito. It was by the study of such apparently trivial matters that the building of the Panama Canal was made possible—by stamping out the fevers that were spread by the mosquitos that carried infection throughout the fever-stricken area. Nearly every boy keeps silkworms or even white mice at some time or another. These are both interesting, but if boys who feel so inclined, would keep spiders instead, and record their observations of these interesting creatures, they would be contributing to the advancement of knowledge

in addition to themselves gathering a great deal of interesting information.

The individual who studies spiders does not expect to attain any far-reaching results, but he feels that he is contributing to a structure of knowledge that, when reasonably complete, will yield results of a kind that he may only dimly perceive. Remembering this one may be encouraged to take an interest in spiders, more particularly so as we have in this book an interesting guide and one that makes everything clear.

* *

Warne's "Pleasure Book for Boys"

(Price 2/6)

This jolly book of stories is edited by W. J. Gordon and has four coloured plates and numerous black and white illustrations.

The stories include "Monty's Motor-Bike," being the adventures of three boys, a scarlet motor-bike and a bull; "The Haunting of 'L' Dormitory" which, as its name implies is a ghost story—with a reward of £20 at the end of it, to be divided between the joint heroes. "The Inca," a tale of Pizarro and Peru in 1553, or for boys who prefer the Roman Britain period there is "Through the Arena to Freedom" which tells how a Briton, taken slave by the Romans, was kept so for three years until he raced a chariot with a great Roman and was given his freedom as reward. Then there are bush-ranging tales, "Spies from the Sea," which is a tale of the Napoleon Scare, a Scout story and train stories, and just to complete the collection a story of Sherwood Forest.

From this it will be seen what a splendid assortment of stories this book contains, and it is well-named the "Pleasure Book for Boys" since in it can be found stories to please every mood.

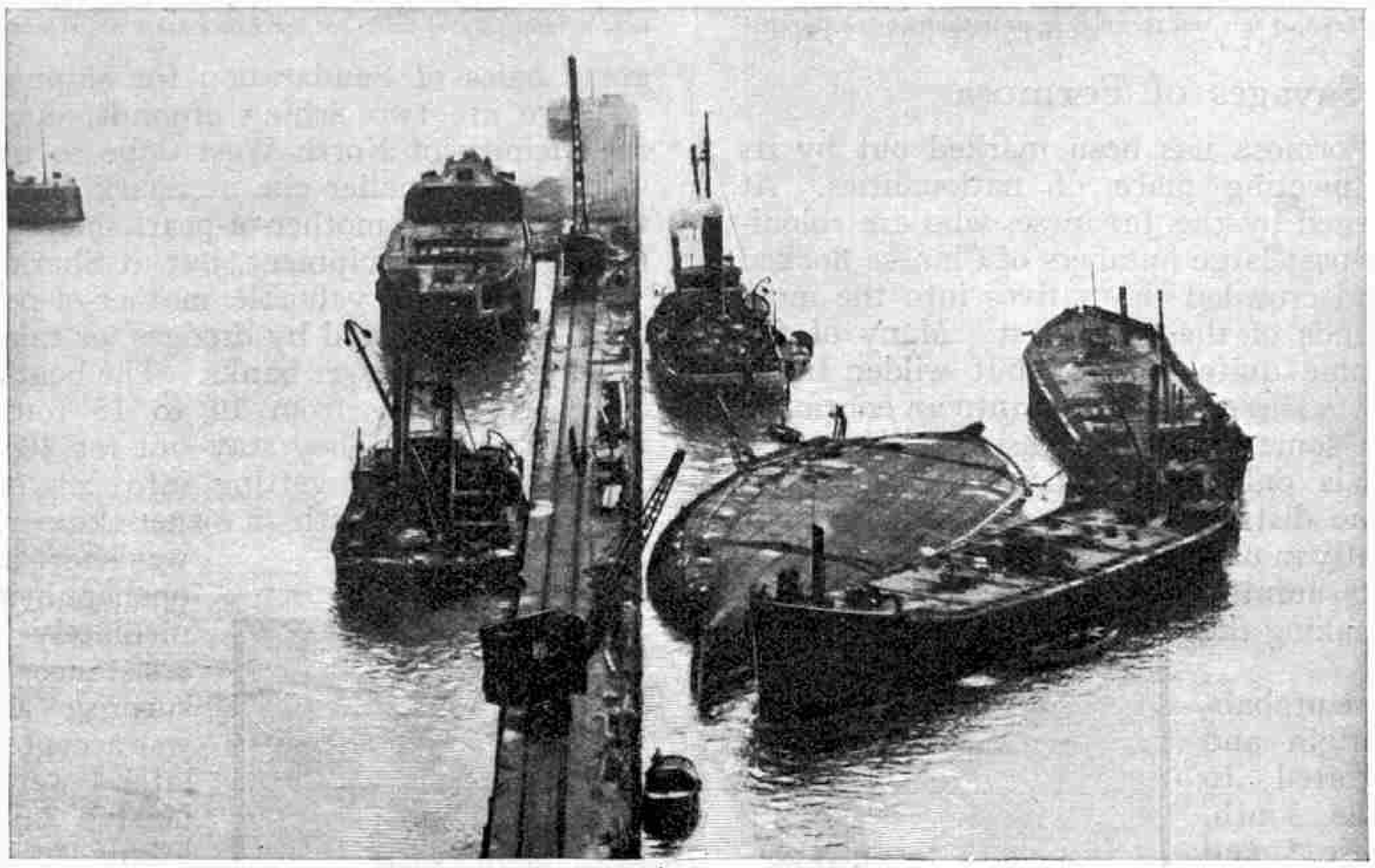
* * * *

"Pat of the Fifth"

By Mary Louise Parker. (Sampson Lowe. 2/6)

Of all the jolly imps and good sports, Pat is surely one of the best—and her chums are as good! Meccano boys having been liberally catered for, here is a topping story of school-life for Meccano girls. Girls can take sports just as seriously as boys when they settle down to it in grim earnest, as the boys' cricket team discovered to their amazement when they played Pat and her chums! They scorned any practice for weeks before they played the girls, but the girls trained hard, and consequently gave the boys' team a "run for their money"—in more ways than one!

Pat is quite a talented actress and not only excellent at make-up but also a good elocutionist. With such gifts the temptation to masquerade as a gipsy and waylay the girls when out for a walk is strong—the fortunes she tells the girls makes them gasp! Sports and pranks abound in delightful profusion, and there are good deeds too, and a few passage of arms between enemies, which is natural! We know many Meccano girls who will bury themselves in this jolly book, and have a few happy hours in consequence.



H.M.S. "Glatton," the overturned monitor, surrounded by salvage vessels. She is being coaxed alongside the eastern arm of the submarine harbour at Dover. The vessel was salved by the Harbour Master at Dover after many salvage firms had refused to undertake the difficult task. (From "Perilous Days" reviewed on the previous page)

"The Life of Sir Albert Hastings Markham"

(Cambridge University Press. 15/-)

Sir Albert Markham, a famous admiral and explorer who died in 1918, is chiefly remembered for the part that he played in the *"Alert"* expedition to the North Pole in 1875-6, and also for his part in the famous *"Camperdown"* and *"Victoria"* disaster of 1893. This disaster cast a gloom over the Admiral's later years, and though he was absolved from blame by the public, the Admiralty insisted upon blaming him for the disaster.

Markham was determined to become a sailor even in his early days but he nearly missed being one by the failure of his family to obtain the nomination before he reached the age of 14. Fortunately he was able to enter the service, by an alteration in the regulations—without which Britain would have been deprived of one of her famous men. He commenced his career in the *"Victory,"* Nelson's famous ship, from which he was transferred to the *"Camilla,"* a tiny vessel of 450 tons. In this ship, as cadet, Markham saw his first foreign service under conditions that have no parallel in a steamship.

During the following years he was engaged in numerous encounters with pirates, who were then the scourge of the China Sea. He was then transferred to the *"Retribution,"* which was then laying the line of the first submarine cable to India. After five years of active service in the Far East he was promoted to the rank of Acting Lieutenant through an act of conspicuous gallantry. Meantime, his interest was aroused in Arctic exploration, and after he had served a further five years under the Southern Cross in the suppression of slave traffic, he undertook a voyage as a member of a whaler's crew, in order to gain experience of the Arctic. He then embarked on what was to be one of the greatest achievements of his life in command of the *"Alert"* Expedition to the North Pole in 1875-6. We read in these pages the story of the heroic sledge parties and the almost incredible hardships they overcame in the far north, sometimes in temperatures over 100° below freezing point.

Other chapters of the book deal with years of varied adventure, ranging from travel in the prairies to voyages in the Kara Seas, and remarkable exploration work in Hudson Bay, ending with Sir Albert's appointment as Rear-Admiral in the Mediterranean. In 1918 his death closed the career of a fine seaman, intrepid explorer, and one whose deeds deserve to be remembered.

* * *

"Maurice Pomeroy"

By H. Elrington (Ward, Lock. 3/6)

This is a story of the trials and tribulations of Maurice, a leader and a favourite at his old school, who when the school closes down is sent to a new school. He is quite convinced, before he even sees the place, that the new school can never possibly come up to the one he has left! In that frame of mind, it is not surprising that his life is not of the happiest, but when some of his old friends join him his spirits are revived considerably.

Maurice is treated as a rank outsider by the boys because of his behaviour at his first football match—he was brilliant at Rugby but his new school happened to be playing Association, with which he was not familiar—and on many other occasions he gets into hot water because the ways of Waltham are not the ways of Mortham. It is a pity he goes on misunderstanding and misunderstood for so long. for had he but known it, he had one very powerful ally in the school. Notwithstanding all his difficulties, Maurice and his friends manage to have a jolly time on the whole—and so will the boy who reads this story if he is looking for a school yarn a little off the beaten track.

Interesting New Books

We hope to deal with the undermentioned books in an early issue.

"The Fundamentals of Astronomy" *by* S. A. Mitchell and Abbott (Chapman and Hall) 15/-

"Hermes or the Future of Chemistry" *by* T. W. Jones (Kegan Paul), 2/6

"The Land of Magellan" *by* W. S. Barclay (Methuen)

These pages are reserved for articles from our readers. Contributions not exceeding 500 words in length are invited on any subject of general interest. These should be written neatly on one side of the paper only, and they may be accompanied by photographs or sketches for use as illustrations. Articles that are published will be paid for at our usual rates. Statements contained in articles submitted for these pages are accepted as being sent in good faith, but the Editor takes no responsibility for their accuracy.

The Savages of Formosa

The island of Formosa has been marked out by its position as the meeting place of nationalities. At present it is governed by the Japanese, who are colonising it, but in the past large numbers of Chinese flocked into the island and crowded the natives into the more inaccessible highlands of the east coast. Many of the natives have become quite civilised but wilder tribes may still be found. These are divided into an enormous number of clans, some of them consisting of a few hundred individuals only, whose languages differ so greatly that in one district alone no fewer than eight dialects were recently in use, each of which was unintelligible to those speaking the others.

These savages are probably of Malayan origin and must have migrated to Formosa from the south, while the Chinese and Japanese have come from the west and north respectively. Tattooing is a universal custom and head-hunting was formerly common among them, as it was among the Dyaks of Borneo, another Malayan tribe. The heads were hung to dry in a large hut, in which the youths of the tribe were accustomed to sleep in order, as they thought, to increase their courage and strength!

A Formosan Orchestra! The music is made by beating heavy wooden poles on flat rock

To-day the natives are more docile and may be visited in complete safety. In one of the accompanying photographs some of them are seen afloat on Lake Jitsugetsutan in canoes made by hollowing out the trunks of large trees, while the other photograph shows a group preparing to entertain the onlookers with "music" made by beating down on a flat rock with long wooden poles. Their singing is very good, however, and much to be preferred to the accompanying music.

W. E. Broadbridge (Formosa).

Pearl-Fishing off the Australian Coast

Some time ago I was fortunate enough to visit Broome, the centre of the pearling industry in Western Australia, and the source of nearly three-quarters of the world's output of pearls. Broome boasts a population of 2,000 people only, but even this small number includes Englishmen, Japanese, Malays, Roepangers, half-castes of varying hues, and even turbaned Afghan camel-drivers, whose charges come rolling into the town with great bales of Sandalwood for shipment to the East.

There are two fishing grounds, one extending from the vicinity of North West Cape to beyond Admiralty Gulf, and a smaller one at Shark Bay. At the former the large white mother-of-pearl shell is taken by divers using modern equipment, but at Shark Bay the smaller and less valuable mother-of-pearl shell oysters are gathered by dredges, or taken by hand from the shallower banks. The boats used are luggers averaging from 10 to 15 tons and are ketch rigged. They stay out for 10 to 15 days at a time. On getting into conversation one day with an owner-skipper, I found that he was short-handed, his shell-opener being sick. I immediately offered my assistance, and to my surprise and delight this was accepted. Half an hour later I went aboard and we hoisted sail, a land breeze taking us out of the bay just as the Sun was setting.

Bearing round to the north-west we soon struck the long ocean swell and the lugger began to roll and dip. At one moment we were on top of what seemed to me an enormous wave, the next we were rushing down the slope to meet the oncoming wave with a tremendous splash that enveloped the boat in flying foam. It was enough to make me qualmy, but by morning I was alright again and enjoyed a hearty breakfast like the veterans of the crew.

As soon as the meal was over, preparations were made for descending. The air compressor was started and our diver soon had his diving gear on. The ladder was slung over the side and he went down. His progress could be followed by a constant stream of bubbles that rose to the surface. Soon afterward a bag was lowered and presently raised full of shell. From that time I lost all interest in the diver, as I had to turn to and open the oysters. I was surprised at the number that it was necessary to open before even a small pearl was obtained, and quickly realised that there is much hard work as well as romance in the pearl-fishing industry.

Altogether we were afloat for eleven days before the captain considered we had taken enough. With a favourable wind we raced home at a spanking pace that soon carried us back to Roebuck Bay, upon the shores of which Broome stands. When the shell was sold I received quite a substantial cheque to compensate me for much hard work and seasickness.

D. Morrison (Arncliffe. N.S.W.)

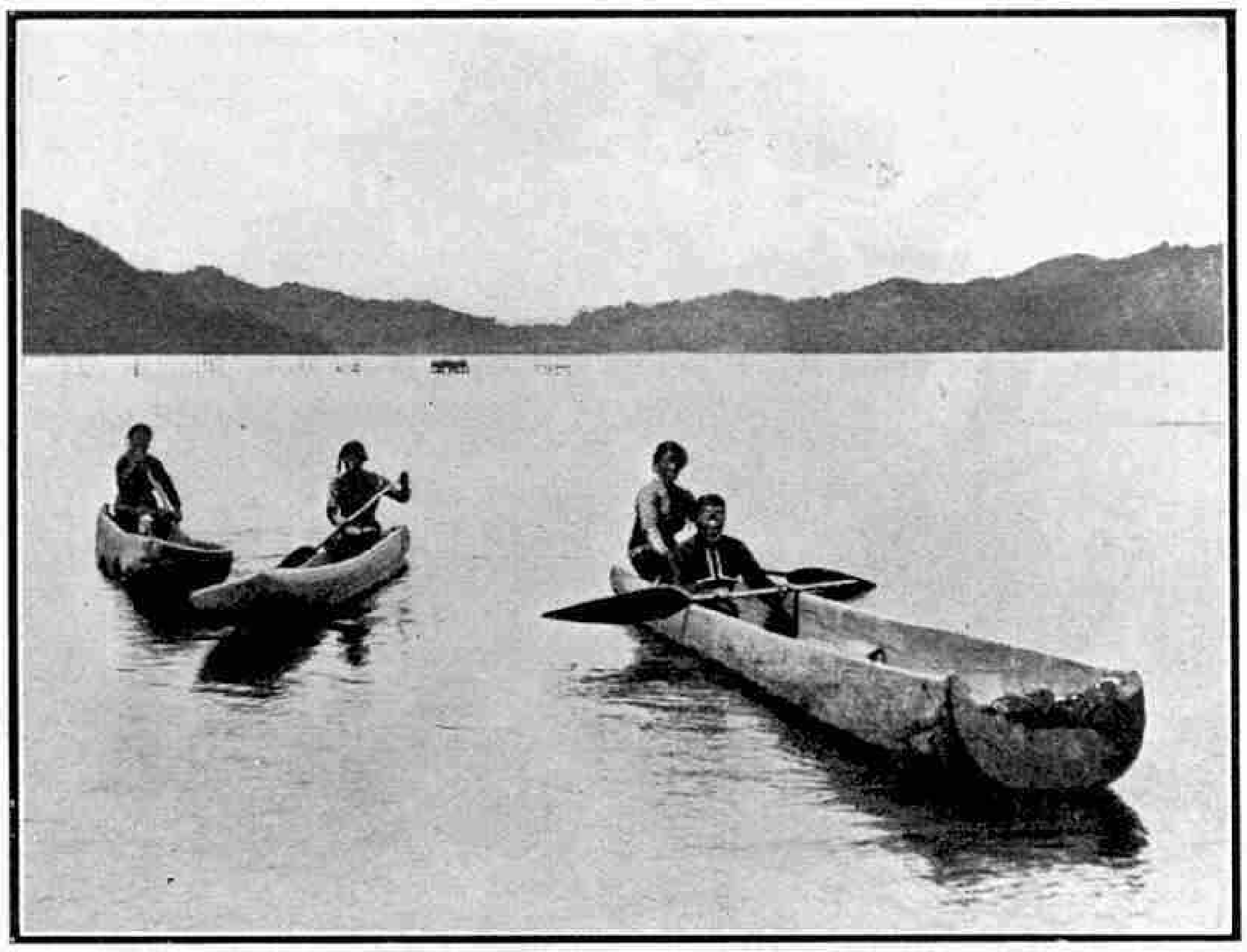
Round a Granite Quarry

During a recent holiday I had the good fortune to form one of a party to visit some large granite quarries at Penmaenmawr. We were taken around by one of the quarrymen and commenced our journey at a new quarry at the back of Penmaenmawr Mountain. There we saw how granite sets are made. The work is done by hand with a hammer having a concave head, and we were told that one man can prepare about a ton of sets in a day, which is roughly equivalent to from 350 to 400.

We then walked round to the older quarries at the front of the mountain. These quarries are joined by a 3 ft. gauge railway. We had to walk carefully because a fall would mean a drop of several hundred feet on to a lower ledge, and we were not surprised to be told that during a fog or a severe gale the workmen have to crawl about on hands and knees. At the front there are five levels in terrace formation. From each base sidings run to a main line and on one level there are about 40 sidings. Compressed air is employed to operate the drills, which pierce the rock to a depth varying from 2 ft. to 20 ft. The drills are hollow and at each blow are given a quarter of a turn. We saw the engine shed that houses the huge compressor and the forge where the drills are ground and tempered and the hammer heads forged. The crushing and screening plant is at the foot of the mountain and the stone is sent down in trucks running on long inclines. Two loaded trucks running down pull two unloaded trucks up, and the steel cables that are used are wound on a 6 ft. drum controlled by a powerful brake. Some of the sets and chippings are loaded into small steamers at two special jetties.

A new industry has recently sprung up in which use is made of the enormous amount of waste material that previously had been tipped down the mountain side. This material is now made into bricks. The chippings are mixed with portland cement and water in a mechanical mixer and the wet mixture is then placed in a very ingenious machine. Two wooden boards are placed on a table and a lever is moved that drops moulds on to the boards. The mixture is put into the moulds by means of a sieve that is slipped backward and forward above the moulds. The sieve then moves out of the way and by the operation of another lever a heavy stamp is dropped on top of the moulds several times, compressing and hardening the bricks and at the same time impressing them with the company's name. The moulds are then lifted by the turn of a handle and the bricks are taken away to dry.

PHILIP WILLISON (Birmingham).



Formosan Natives in primitive dug-outs on Lake Jitsugetsutan, the only large lake on the island (see previous page)

A Visit to a Fish Hatchery

During my holiday last year I visited the fish hatchery at Nailsworth, Gloucestershire, along with several friends, in order to see how trout are reared. The building containing the offices also houses the egg-hatching tanks. The spawning season is in October and November and the eggs number about 800 for every pound of flesh of the parent fish. We did not see any eggs or recently hatched fish, as our visit was made in August, when the egg-hatching rooms were empty.

We then went out to the rearing tanks. There were 15 of these, each about 15 yards in length and 10 yards in width, and fresh water ran through them continually. In the water were thousands of brown and rainbow trout, those in the first tank being one month old, those in the second two months old, and so on, the last tank containing fish 14 and 15 months old. When necessary the trout are removed from tank to tank in a large gauze box, that looks like a meat safe and has a movable top.

Our guide informed us that we had been fortunate enough to arrive at feeding time. The food consists of beef and fish-meal ground into a fine paste, and he wheeled sufficient of it for one meal for his charges in a barrow as he conducted us round the tanks. We noticed that as each tank was reached the fish swarmed to the side, as though they heard the attendant coming, and rushed greedily at the food when it was thrown into the water. It was only in the case of the older fish that this did not happen. They took very little notice of us as we approached the tanks containing them and did not show half the energy of the younger ones in swimming for their meal.

Even in this peaceful-looking spot the fish have enemies. The most destructive are rats. Our guide told us that these pests consume great numbers of fish yearly and that he is compelled to resort to shooting and trapping to keep their numbers down.

When old enough to maintain themselves the fish are sent to stock various English rivers, in the waters of which they live a much more adventurous life and provide great sport for our anglers. Care has to be taken to keep the water in the large cans in which the fish are transported well aerated, and on arrival at their future home the change of water is made very gradually.

The trout is noted for its delicate flavour and is easily recognised by its brownish-grey scales. In its natural state it is found in clear-running streams and shallow parts of rivers, and the tanks of the premises I visited are made to resemble its natural home as much as possible.

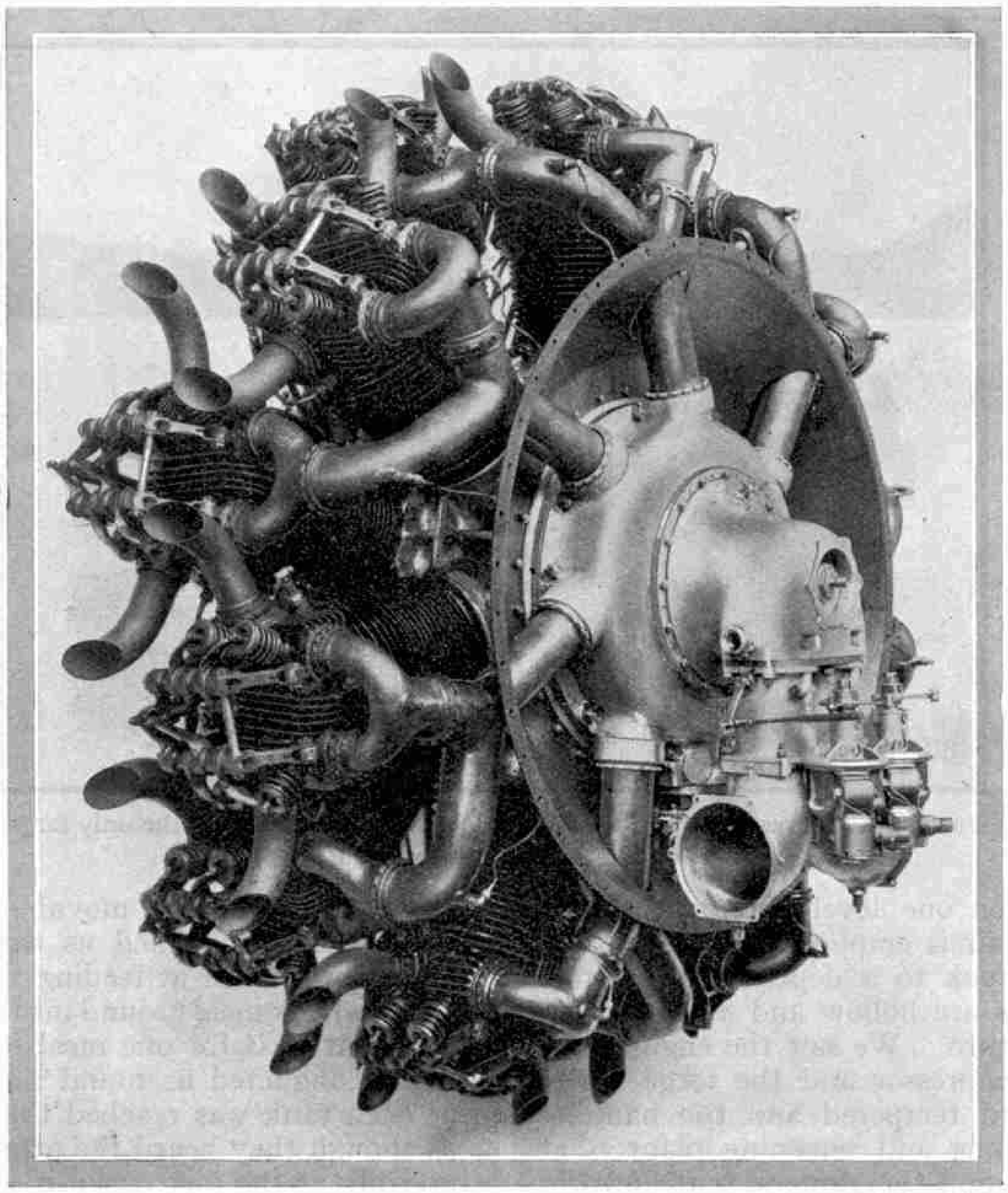
G. W. BROWN (Gloucester).

Famous Aero Engines

II.—Armstrong Siddeley 700 h.p. "Leopard"

THE 700-750 h.p. "Leopard" engine has been designed and developed by Armstrong Siddeley Motors Limited, of Coventry, for use in aircraft intended for torpedo work, heavy bombing and load carrying, and the makers believe it to be the most powerful air-cooled radial engine in production in the world.

The general layout and design follows very closely that of the same company's well-known "Jaguar" engine, and consists of two banks or rows each comprising seven cylinders mounted radially on the crankcase. The principal departures from the "Jaguar" design are that the induction fan is geared to run at a higher speed than the crankshaft in order to obtain a better volumetric efficiency; and that four valves are fitted to each cylinder instead of two, this being rendered necessary by the increased cylinder capacity.



An interesting photograph of the rear of the 700-750 h.p. "Leopard" engine showing complexity of the system of inlet and exhaust pipes necessary

The crankcase is a one-piece aluminium casting, the front portion carrying the tappet guides, a spigot that supports the front cover, and the front crankshaft bearing. The central portion, or barrel, which carries the cylinders, is very heavily webbed both inside and outside. The rear portion has a spigot that supports the induction fan and casing, the petrol pump, the carburetter and the rear crankshaft bearing.

The steel cylinder barrels are secured to the crankcase by clamping rings of wedge-shaped section, these details following standard Armstrong Siddeley practice. The cylinder head, an aluminium casting heavily finned to secure a maximum cooling effect, is screwed and shrunk on to the cylinder barrel, where it is secured permanently by a screwed locking ring, the joint being steel to aluminium without joint washer.

Specification of 700 h.p. "Leopard"

Air-cooled Radial Left-hand Tractor.	
No. of cylinders	**14**
Bore	**6 in.**
Stroke	**7.5 in.**
Normal B.H.P.	**700 at 1,500 r.p.m.**
Maximum B.H.P.	**777 at 1,650 r.p.m.**
Compression ratio	**5 to 1**
Weight: Engine complete for installation including bearer plate, propeller boss, dual ignition, carburetter, air intake, and short exhaust pipes	**1,415 lb.**

There are two inlet and two exhaust valves per cylinder operated by rockers that pivot on two spindles mounted on the cylinder head. The spindles at their rear ends are anchored to the top of the head, their front ends being supported by a compensating bracket anchored to a point near the bottom of the cylinder head. This bracket is made of special steel that has a very low co-efficient of expansion, with the result that the longitudinal expansion of the cylinder has practically no effect on the tappet clearances. This means that adjustment to the tappets is very seldom called for, while starting-up is made much easier.

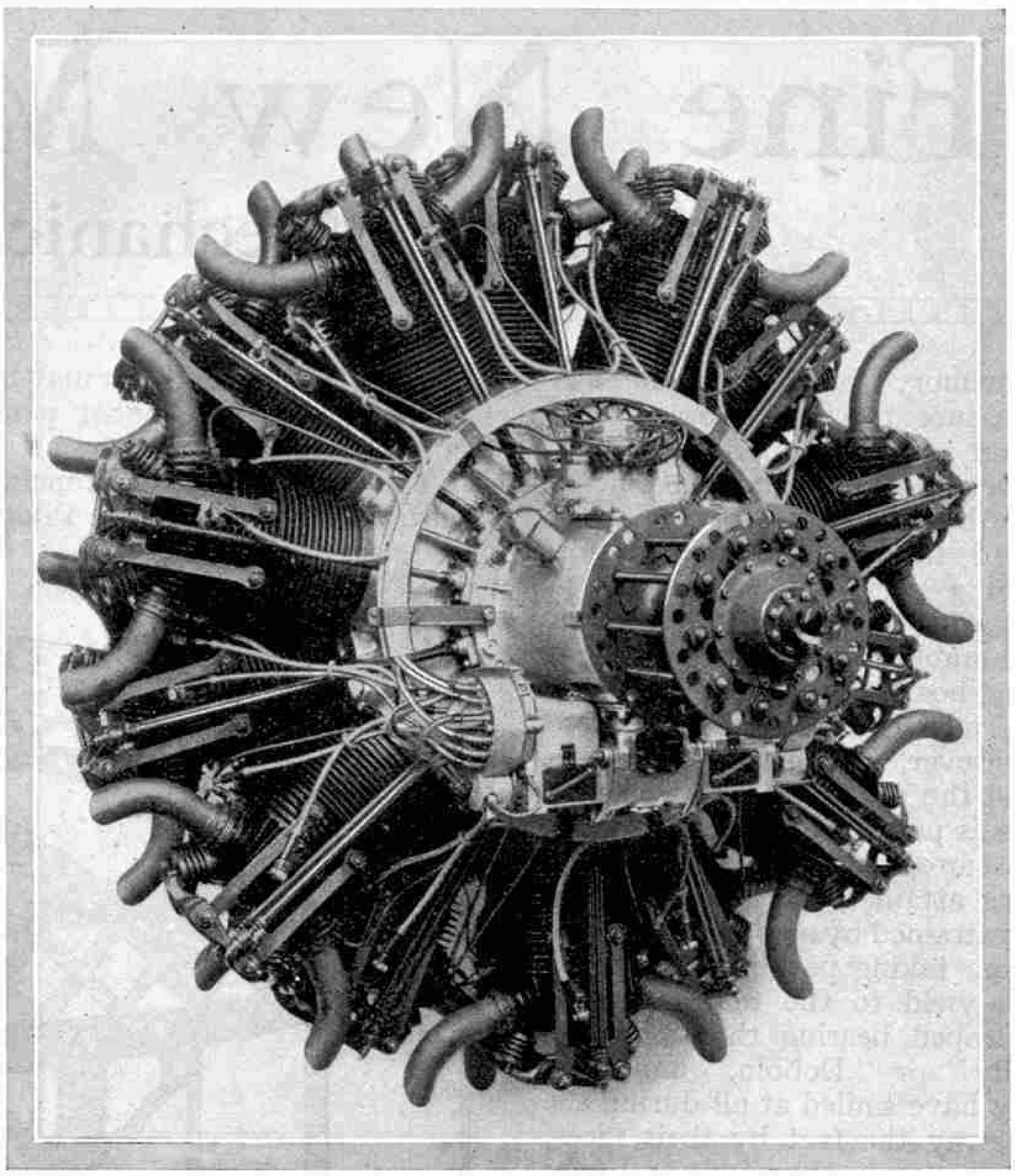
The valve rockers are operated by push rods and tappets from the cam drum, which is situated inside the front portion of the crankcase, the tappet clearance adjustment being provided in the push rods. The valve seats and valve guides are renewable, the former being screwed and shrunk into the heads, while the latter are a press fit. The sparking plugs are accommodated in adaptors screwed and pegged into the heads. The cam drum has three inlet cams and three exhaust cams and rotates at one-sixth crankshaft speed. Rollers and tappets transmit the cam motion to the push rods.

The pistons are machined all over from "Y" alloy forgings. Each carries two compression rings and one scraper ring, all three rings being situated above the gudgeon pin. The air hardening steel gudgeon pin floats in the piston and connecting rod bush and is located endways in order to prevent scoring the cylinder walls.

Each bank of seven cylinders and pistons drives the crankshaft by means of one master and six auxiliary

connecting rods. The large end of each master connecting rod carries six anchor pins, to which the inner ends of the auxiliary connecting rods are anchored. The master connecting rods are bushed to take the anchor pins that float in the bushes and are spaced so as to give an equal compression ratio in every cylinder. The master connecting rods bear on the crank pins by means of white metalled bushes that are made in two halves and prevented from turning in the master rods by dowels.

The crankshaft is made in one piece and has two throws set 180° apart, each crank pin carrying one master rod and six auxiliary connecting rods. It is bored out to save weight, and the holes serve the purpose of distributing the lubricating oil. It is carried by two large roller bearings, one being located just behind the rear crank throw and the other just in front of the front crank throw. The crankshaft extends beyond its front roller bearing and this portion carries the timing gear and cam drum, a bevel gear (which drives the oil pumps, magnetos, gas distributor and C.C. gun gear), and the air screw thrust bearing. The rear end of the crankshaft carries the spur gear that drives the induction fan. The front and rear webs of the crankshaft carry the necessary balance weights.

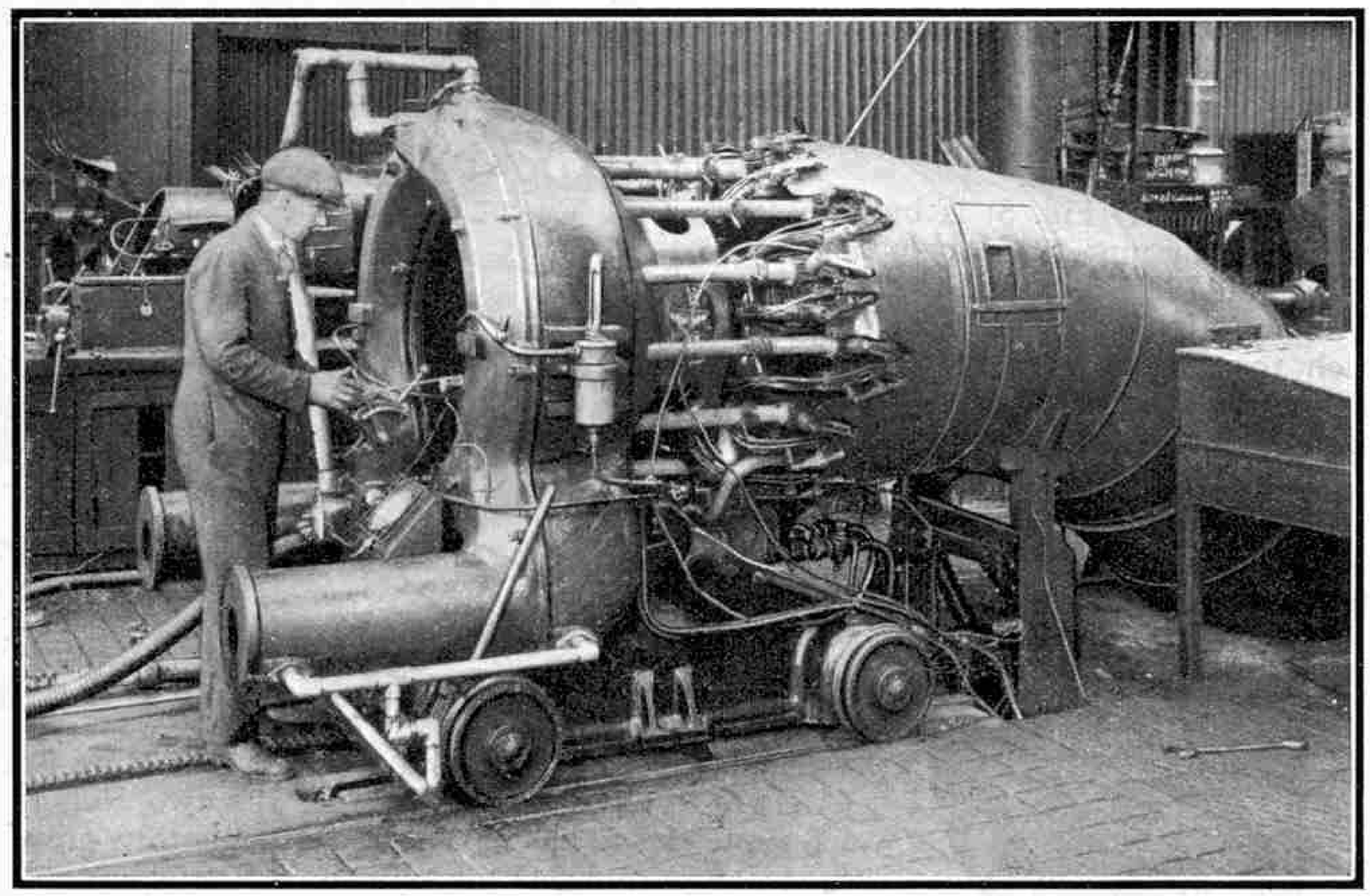


Front view of the "Leopard" engine, showing the position of the two magnetos

Mixture is supplied to the engine by a Claudel Hobson A.V.T.100 carburetter through the medium of an induction fan that delivers the mixture into an annular induction casing. Thence the mixture passes to the cylinders by means of induction pipes. Experiments have proved that the use of an induction fan of this kind very considerably increases the volumetric efficiency of the engine, and also gives a perfectly even distribution to all cylinders. The carburetter is supported on an induction elbow attached to the rear end of the engine, the controls and air intake pipes being integral with the carburetter and engine.

Ignition is controlled by two magnetos of the latest approved type, each having 14 terminals. The magnetos are accessibly mounted on the front of the engine and are bevel driven from the crankshaft. There are two sparking plugs per cylinder, the braided H.T. cables being supported in a wire carrier mounted on the crankcase. Fine adjustment of the magneto timing is provided by serrated couplings incorporated in the magneto drive.

The gas distributor, which is mounted on the front of the engine, is driven from the crankshaft, the cams for the C.C. gun gear being incorporated in its casing.



A "Leopard" engine undergoing test

The oil pumps are mounted on the front of the engine and are bevel driven from the crankshaft. The pressure pump which has a relief valve to govern the oil pressure, delivers oil under pressure through a filter to the centre of the crankshaft and thence to the connecting rods and bearings. At the bottom of the crankcase are an oil sump and

(Continued on page 694)

A Fine New Meccano

Another Mechanical Wonder th

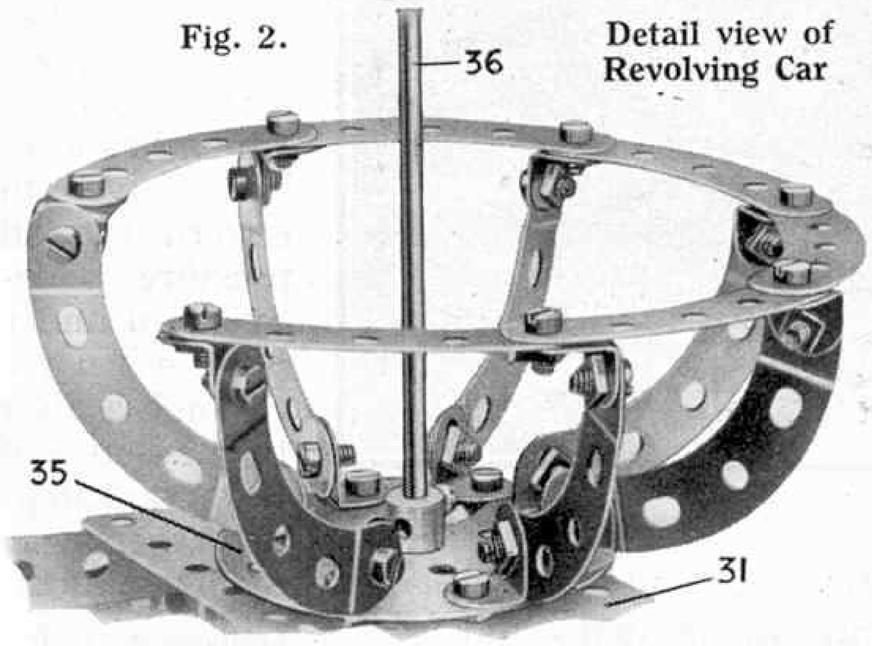
FROM times beyond memory the roundabout has been a source of pleasure to young people. The progress of civilisation has changed it, of course, as it has changed almost everything else, and it is difficult to recognise the huge whirling structures of to-day as the direct descendants of the creeking contraption which, at the instance of a perspiring operator, was induced to revolve slowly with its load of half-a-dozen children. Yet from this humble source have sprung all the hurtling dragons, flying boats, and similar ingenious devices with which our modern fairs are provided.

In its original form, however, with a few alterations such as increased size and the use of steam or electric power, the old favourite is as popular as ever, and it is a poor fair that does not boast an old-fashioned roundabout. Young people who, having attained the mature age of sixteen or seventeen, are restrained by an over-burdening sense of responsibility from taking part in the general "fun of the fair," often yield to the temptation to bestride a glorified quadruped bearing the somewhat fanciful inscription "Sally" or "Dobbin," and even staid old men who, if they have smiled at all during the last ten years, do not betray the fact by their faces, have been known to cast dignity to the winds and take a ride "for old times' sake." Modern amusement devices cannot completely oust from our fairs the old-fashioned roundabout.

The Meccano Roundabout is an excellent example of the adaptability of the Meccano system. The different movements, which include the rotating superstructure, the revolving cars, and the leaping horses, are all faithfully reproduced as in the prototype of the model, and its appearance when working gives an effect of realism that can only be fully appreciated by those who have actually seen the model in operation.

The base of the roundabout (Fig. 5) is built of two $24\frac{1}{2}''$ Angle Girders joined by nine $12\frac{1}{2}''$ Angle Girders 1, 2, 3, 4. A $5\frac{1}{2}'' \times 2\frac{1}{2}''$ Flat Plate 5, bolted to the Girders 3, carries two Trunnions joined by a $2\frac{1}{2}'' \times 1''$ Double Angle Strip 6, which, together with the Plate 5, provides bearings for a short Axle Rod carrying a 1" Sprocket Wheel 7 and a special-toothed wheel 8.

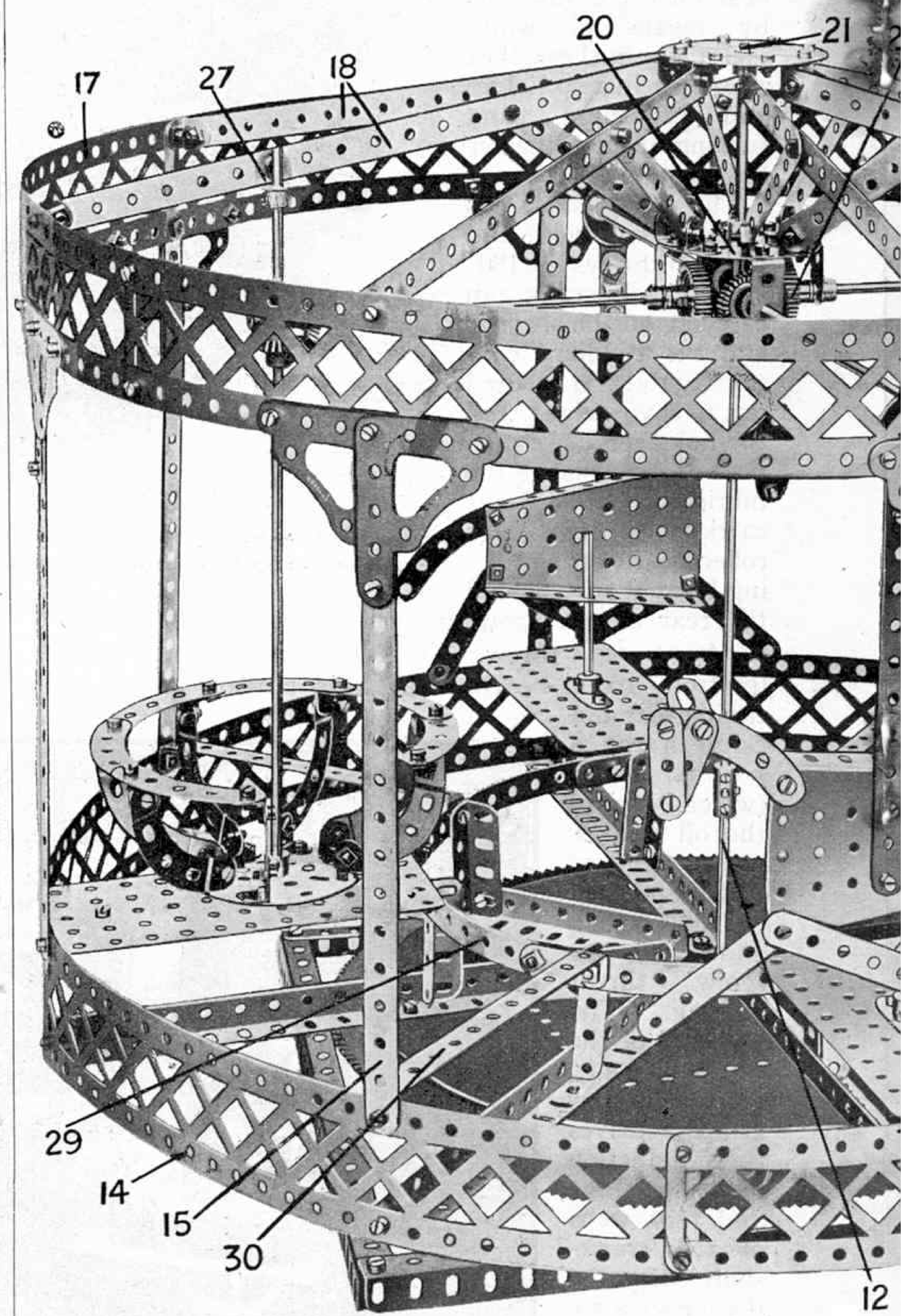
Fig. 2. Detail view of Revolving Car



The Roller Bearing

The large Geared Roller Bearing, on which the whole of the superstructure rotates, has only just been added to the Meccano system. It may be purchased as a complete self-contained unit under part No. 167 (see page 684 of this issue).

The $\frac{3}{4}''$ Flanged Wheels included in the Roller Bearing unit are journalled on the Pivot Bolts, which are secured



round the outer edge of the Ring Frame, and the latter is inserted between the two Roller Races so that the Flanged Wheels run smoothly on a shoulder near the edge of the lower Race 9, which is bolted to the Girders 2, while the upper Roller Race, by means of a similar shoulder resting on the $\frac{3}{4}''$ Flanged Wheels, revolves easily, yet steadily, about the Axle Rod 12. In this way no points in the moving surfaces are allowed to be in

o Model: Roundabout

that will provide Hours of Fun

sliding contact with each other; hence friction is reduced to a minimum. The Rod 12 is secured rigidly in the boss of a Bush Wheel that is bolted to the lower Roller Race 9, and passes through another Bush Wheel secured to the centre of the upper Roller Race. The set-screw of the latter Bush Wheel should be removed so that the upper Race is quite free to revolve about the Rod 12.

If the parts are not available the special Geared Roller Race may be substituted by roller bearings built up from Channel Segments and other existing parts. Roller Bearings of this type are described in the "Standard Mechanisms Manual" (see detail No. 101) and upon referring to this book, their construction should be quite clear. If the built-up bearings are adopted the following parts will be required in place of part No. 167: 8 of No. 2a; 8 of No. 3; 8 of No. 9a; 16 of No. 12b; 8 of No. 16a; 8 of No. 20; 76 of No. 37; 16 of No. 38; 8 of No. 48; 8 of No. 59; 3 ft. of No. 94; 2 of No. 109; 16 of No. 119; 8 of No. 125.

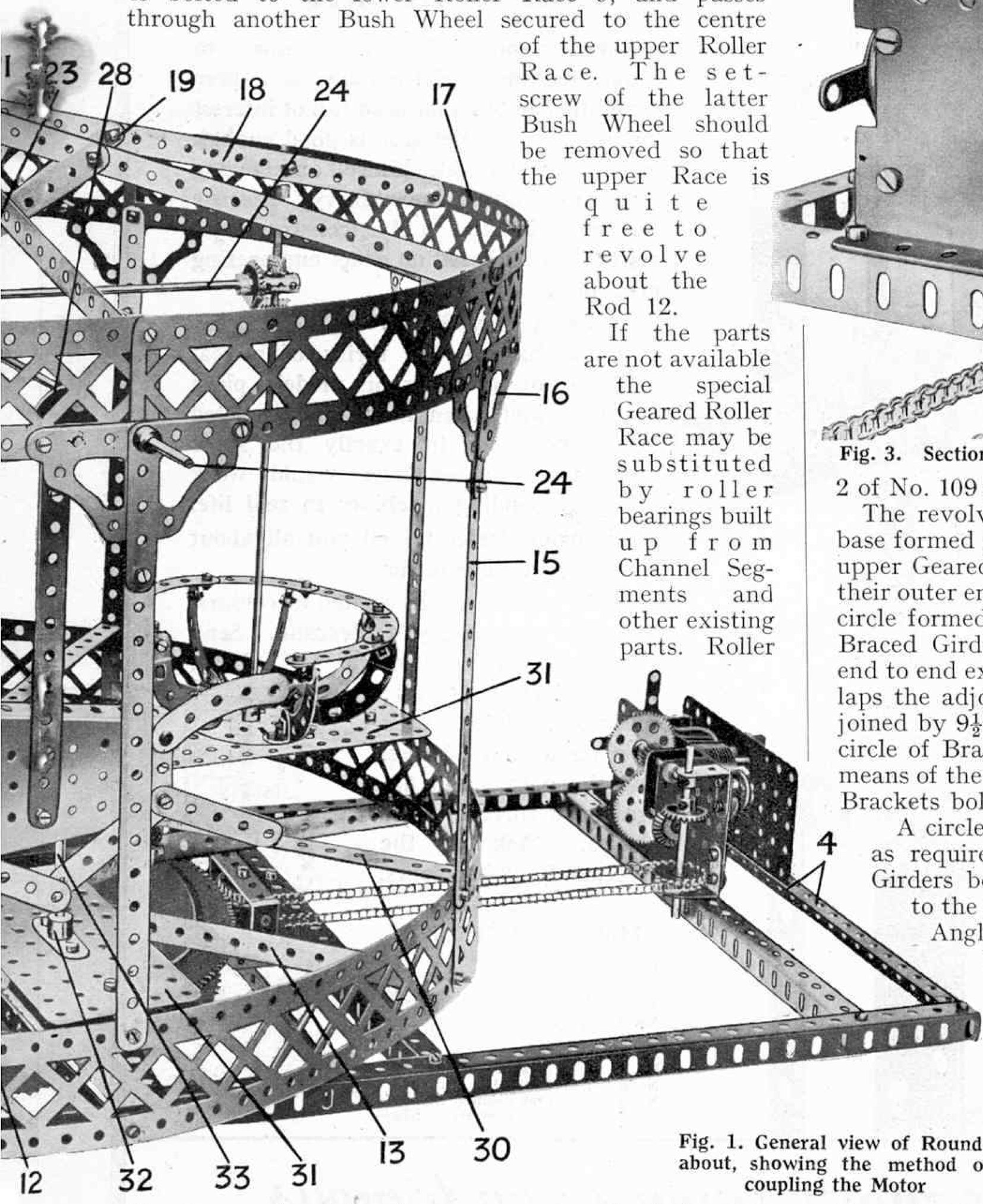


Fig. 1. General view of Roundabout, showing the method of coupling the Motor

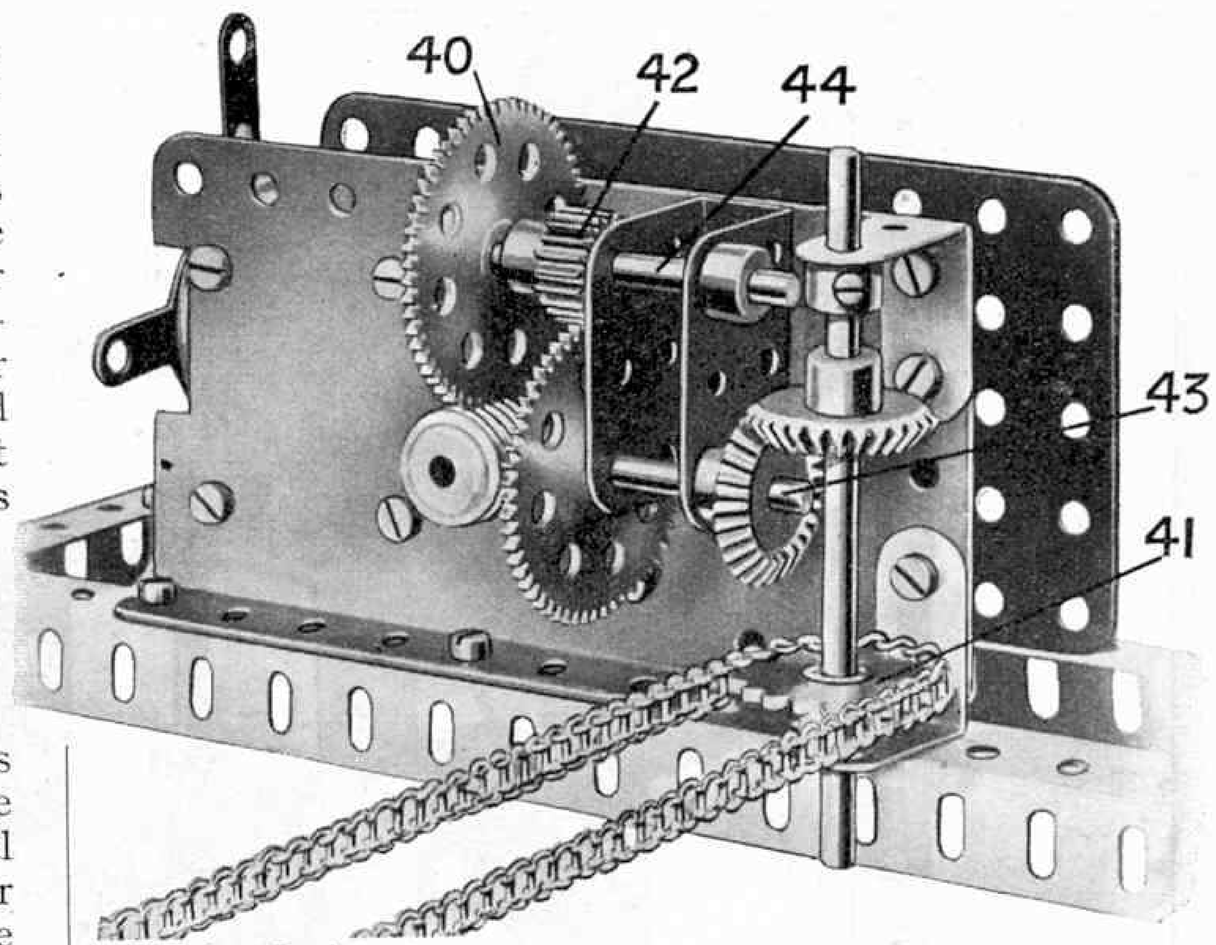


Fig. 3. Sectional view, showing gears mounted on Electric Motor

The revolving portion of the model is built on to a base formed of eight $9\frac{1}{2}''$ Angle Girders 13 bolted to the upper Geared Race 9 of the Roller Bearing and having their outer ends secured by means of Angle Brackets to a circle formed of five $12\frac{1}{2}''$ Braced Girders and one $5\frac{1}{2}''$ Braced Girder (Fig. 1). These Girders are all bolted end to end except the $5\frac{1}{2}''$ Girder, one end of which overlaps the adjoining $12\frac{1}{2}''$ Girder by three holes, and are joined by $9\frac{1}{2}''$ Strips 15 and Architraves 16 to a similar circle of Braced Girders 17, connected in their turn by means of the $9\frac{1}{2}''$ Strips 18 and the $3\frac{1}{2}''$ Strips 19 to Angle Brackets bolted to two Face Plates 20 (see Figs. 1, 6).

A circle composed of six $5\frac{1}{2}''$ Strips 29, overlapped as required, is carried on eight vertical 2" Angle Girders bolted to the Girders 13, and is connected to the Braced Girders 14 by four $5\frac{1}{2}'' \times \frac{1}{2}''$ Double Angle Strips 30.

The bosses of the Face Plates 20 form journal bearings for an $11\frac{1}{2}''$ Axle Rod 21 to which is secured a Contrate Wheel 22 (Fig. 6) that engages the teeth of the four 1" Gear Wheels 23 on the Rods 24. The Axle Rod 21 is extended by means of a Coupling 25 and the short Rod 12, which is secured in the boss of the lower Geared Race of the Roller Bearing, so that the Contrate Wheel 22 remains immovable, and the

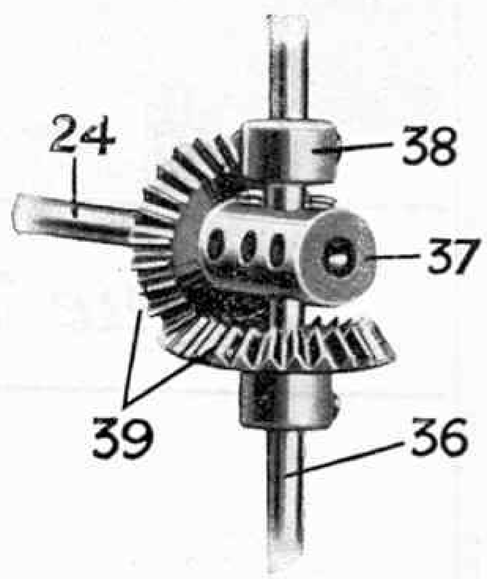
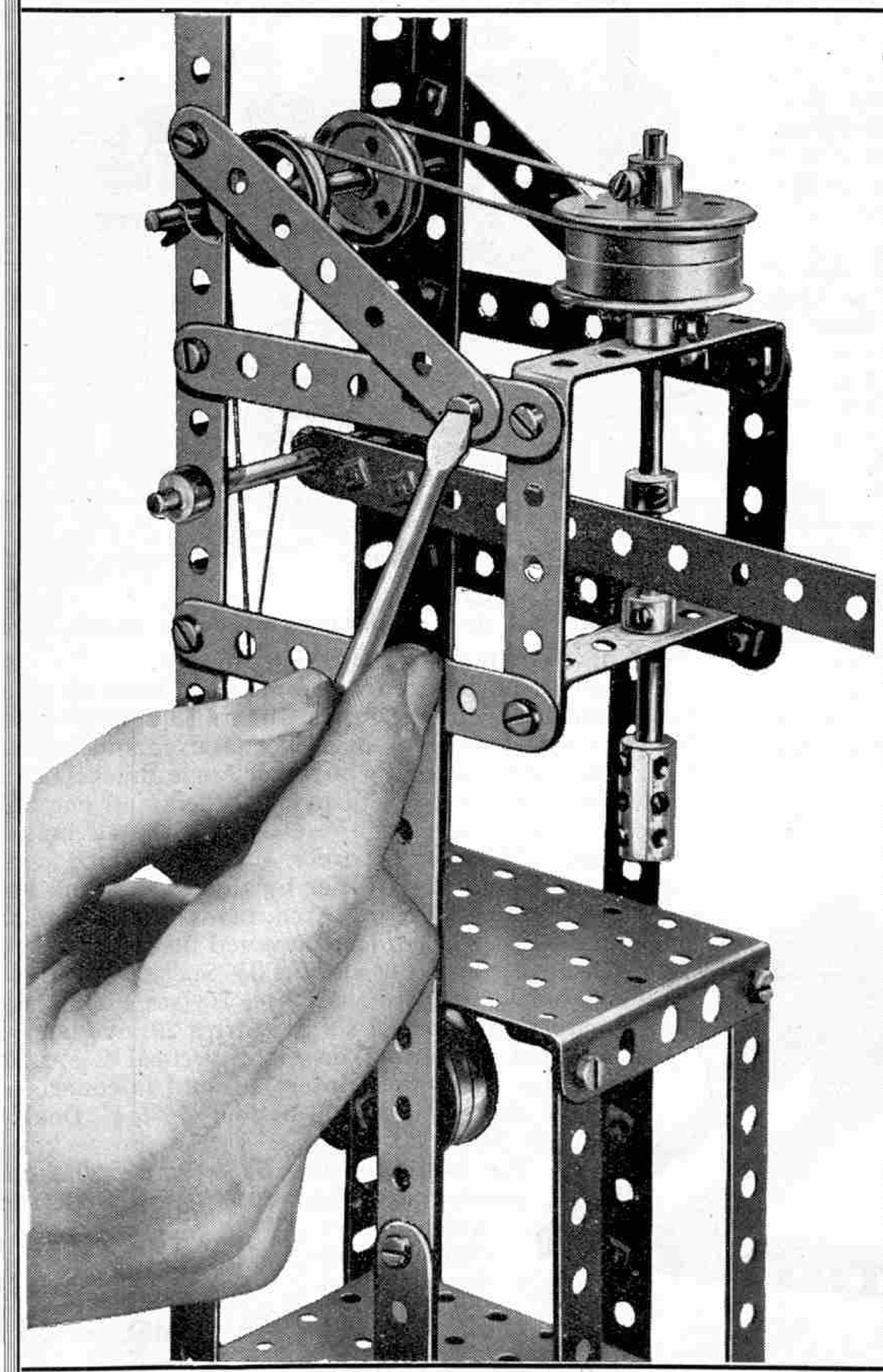


Fig. 4. Bevel Gearing operating revolving cars

MECCANO



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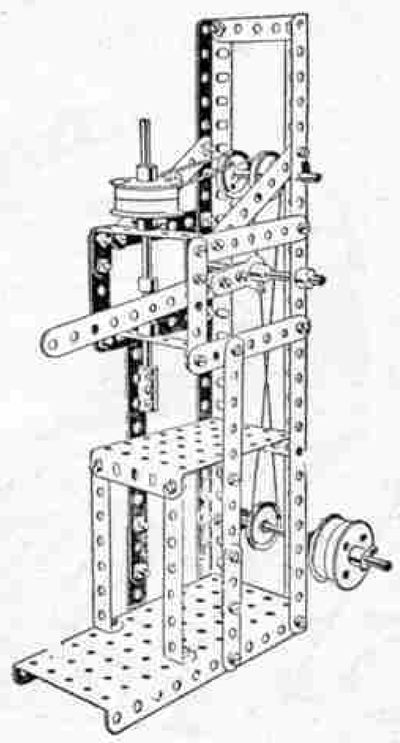

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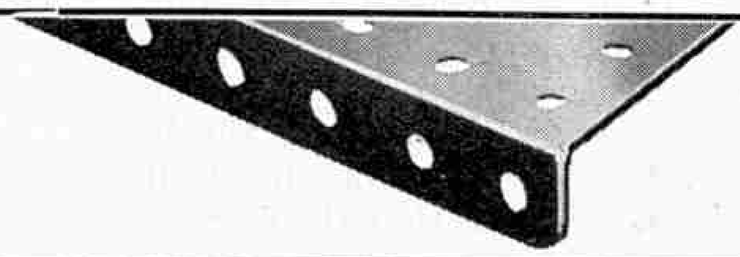
The Toy that made Engineering famous



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revolving structure causes the Gear Wheels 23 to travel around the Wheel 22, at the same time rotating about their own axes and operating the jumping horses and revolving cars.

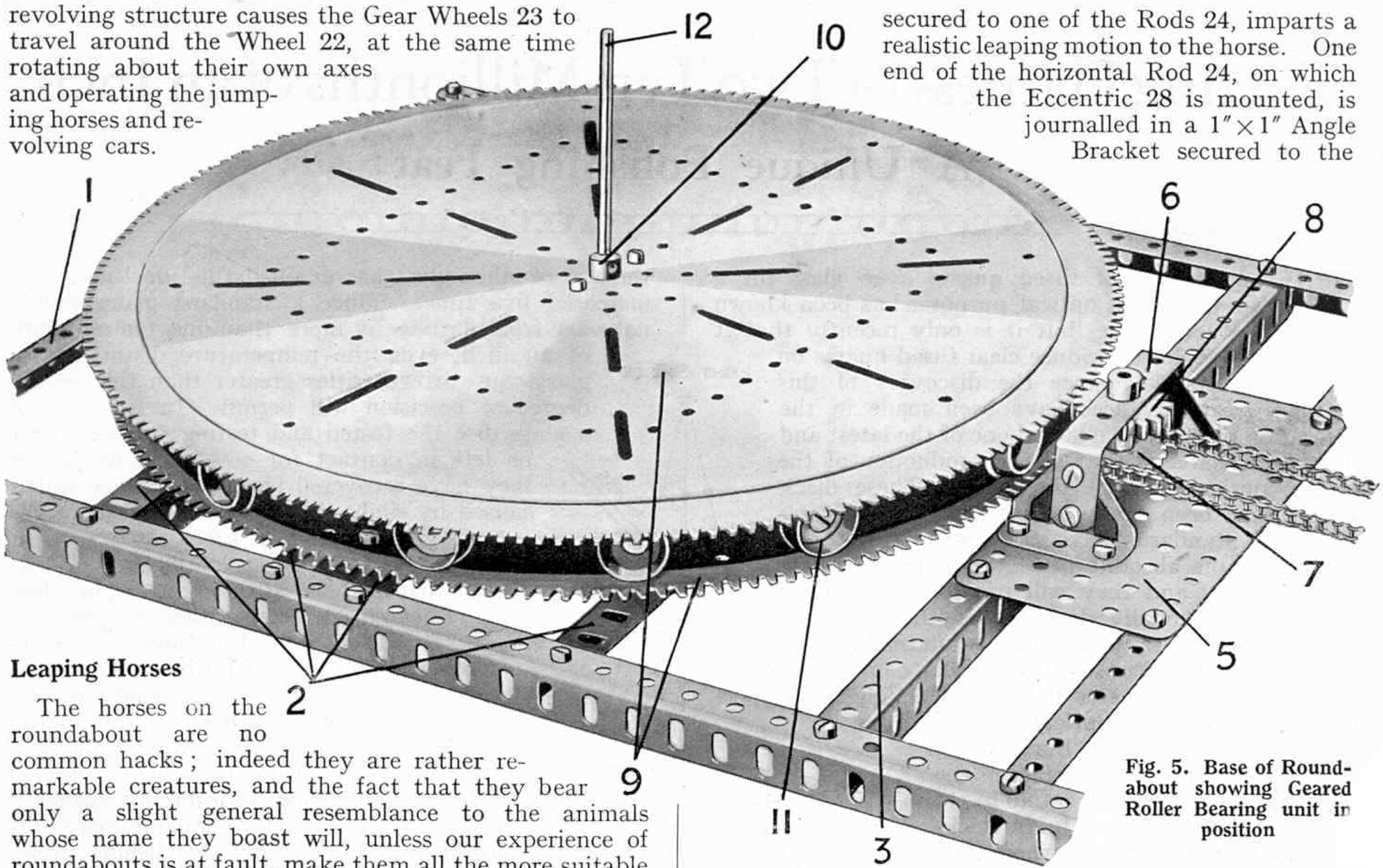


Fig. 5. Base of Roundabout showing Geared Roller Bearing unit in position

Leaping Horses

The horses on the roundabout are no common hacks; indeed they are rather remarkable creatures, and the fact that they bear only a slight general resemblance to the animals whose name they boast will, unless our experience of roundabouts is at fault, make them all the more suitable for incorporation in this model. The body of each horse, as will be seen from Fig. 7, consists of a Sector Plate, and is provided with a tail (a $2\frac{1}{2}''$ large radius Curved Strip) and four $2\frac{1}{2}''$ Strips representing legs. The passenger is expected to sit astride the horse immediately behind the supporting Strip. During "rush hours" no doubt an extra passenger could be squeezed in between the front of the supporting Strip and the horse's neck. The gracefully arched but rather ill-nourished neck may be distinguished from the tail by the fact that it bears a shapely head (two $1\frac{1}{2}''$ Strips) surmounted by a Flat Bracket with which the poor beast must do his best to hear.

Each of the horses is carried on a $5\frac{1}{2}''$ Strip bolted to a Single Throw Eccentric* 28, which, secured to one of the Rods 24, imparts a realistic leaping motion to the horse. One end of the horizontal Rod 24, on which the Eccentric 28 is mounted, is journalled in a $1'' \times 1''$ Angle Bracket secured to the lower of the Face Plates 20, while the Braced Girders 17 and the Architraves 16 provide a bearing for the opposite end. Eight $9\frac{1}{2}''$ Strips 15 are used to space the upper and lower Braced Girders apart.

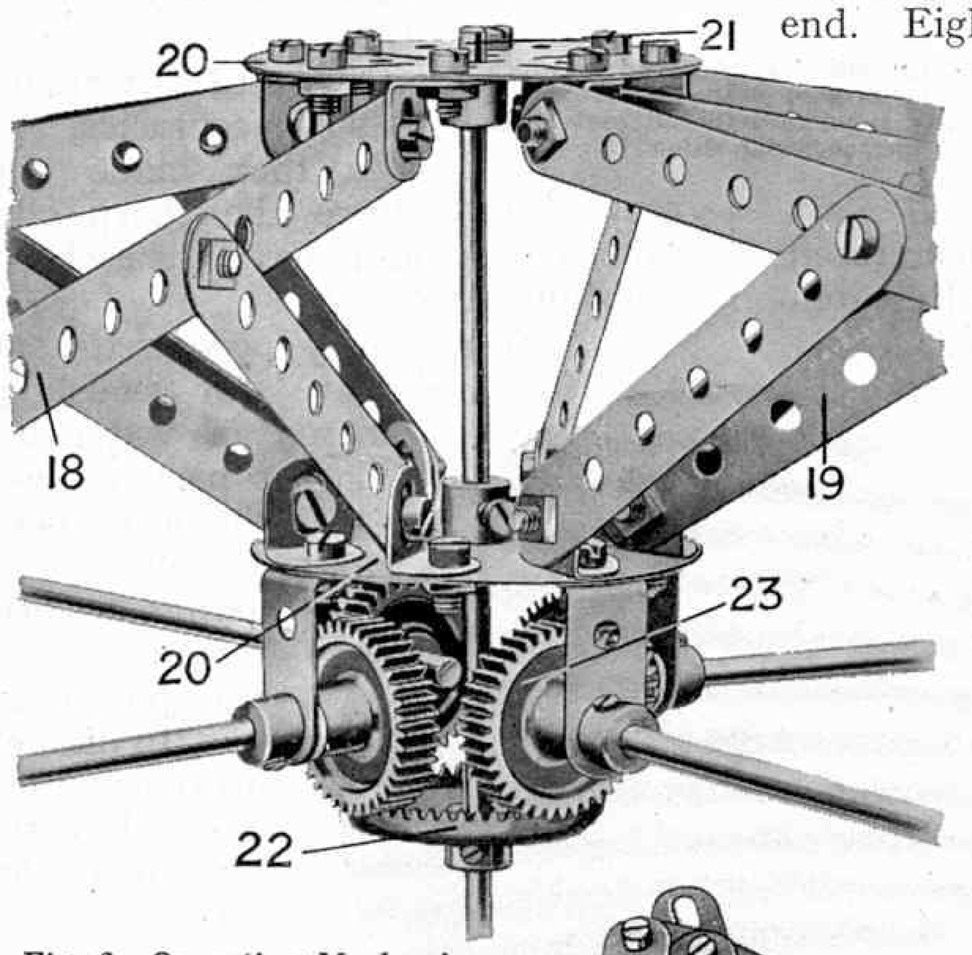


Fig. 6. Operating Mechanism at top of main stem

A $5\frac{1}{2}'' \times 2\frac{1}{2}''$ Flat Plate 31 is bolted to the Girders 14 and the Strips 29 by means o Angle Brackets, and carries a Double Arn Crank 32, in the boss of which is secured 3″ Rod 33 acting as a vertical guide for th leaping horse. The Rod 33 passes through th lower flange of the Sector Plate forming th body of the horse. This arrangement i identical for both horses, as can be see in Fig. 1.

Revolving Cars

Each revolving car (Fig. 2 comprises a Face Plate 35 to which seven $2\frac{1}{2}''$ small radius Curve Strips are affixed b means of Angle Brackets. Six $2\frac{1}{2}''$ large radius Curved Strips attached to the upper ends of the small radius Strips form an arm rest for the occupants of the car.

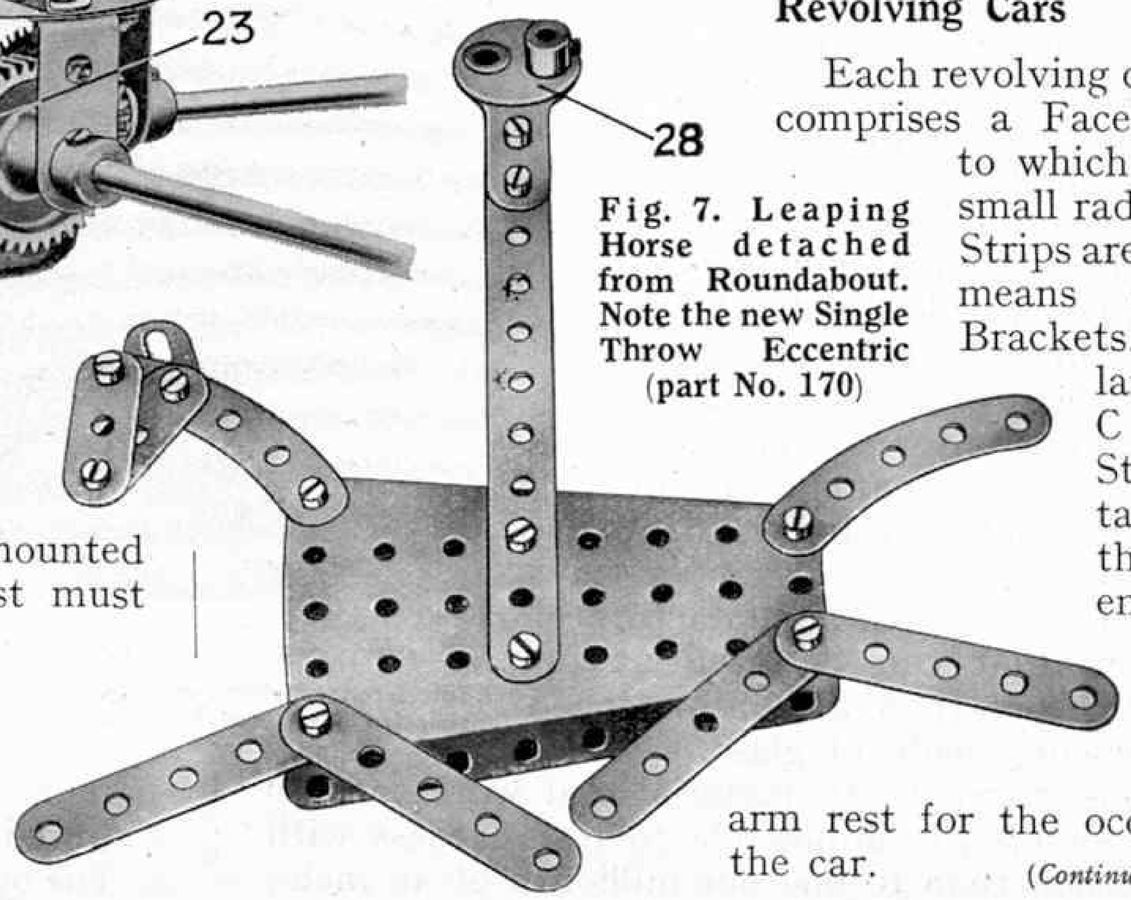


Fig. 7. Leaping Horse detached from Roundabout. Note the new Single Throw Eccentric (part No. 170)

(Continued on page 684)

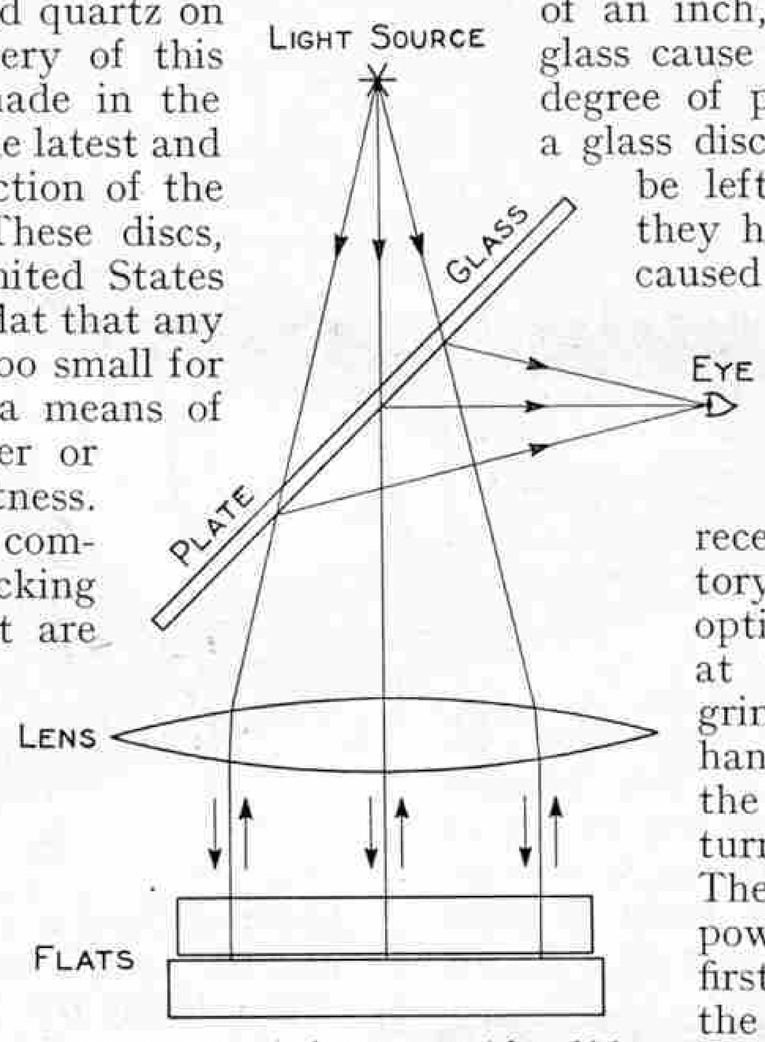
* *The Single Throw Eccentric (part No. 170) is a new addition to the Meccano system. It gives a total reciprocating movement of ½″ and will be found useful where the Triple Throw Eccentric (part No. 130) is too cumbrous. Price 9d.*

Testing Flatness to Two Ten-Millionths of an Inch

A Unique Polishing Feat

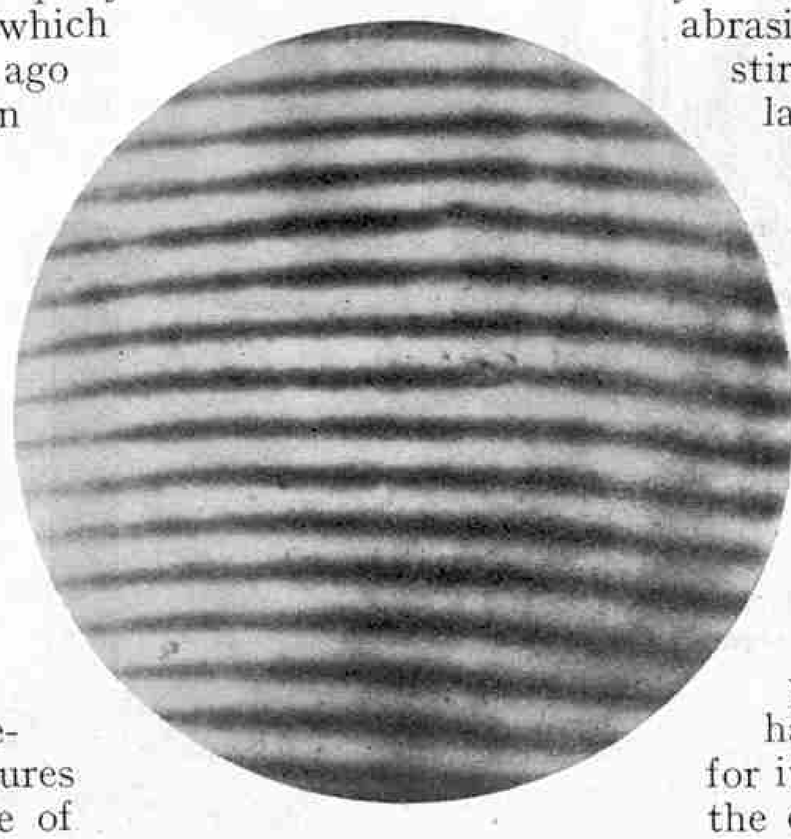
THE superiority of fused quartz over glass for a great variety of optical purposes has been known for a long time, but it is only recently that it has been possible to produce clear fused quartz on an adequate scale. Since the discovery of this method great advances have been made in the utilisation of fused quartz and one of the latest and most remarkable is that of the production of the largest optical flats in the world. These discs, which have been produced by the United States Bureau of Standards, have surfaces so flat that any deviation from absolute perfection is too small for measurement, and they will provide a means of definitely and finally deciding whether or not a surface really approaches flatness. The discs will not be used for direct comparisons, but as master flats for checking the accuracy of the optical discs that are used in the work of the Bureau.

Measurements on the surface of the three discs, which are from 10 in. to 11 in. in diameter and $1\frac{1}{2}$ in. in thickness, fail to show any place where they are more than two ten-millionths of an inch from absolute flatness. Such accuracy means that if the discs were magnified so as to extend from Washington to Chicago, a distance of 787 miles, no point except along the margin would be out of absolute flatness by more than one inch!



Illustrating the optical arrangement by which the eye can be focussed on the flats through a lens to view simultaneously all parts with perpendicular vision

These master optical flats are made from clear fused quartz, or silica glass, produced in the Thomson Research Laboratory of the General Electric Company at Lynn, Mass., U.S.A. This product, which was commercially introduced two years ago by the company, is much harder than optical glass and it expands much less than glass upon being heated. The glass formerly used for optical flats is so sensitive to heat that its surface changes considerably in shape when merely touched by the hand. Clear fused quartz, which expands only 1/15th as much as glass, can be handled with far greater immunity in this respect. Its low coefficient of expansion also recommends its use for astronomical mirrors, and for the manufacture of standards of length. Further, its resistance to change at high temperatures has led to its use in the manufacture of thermometers that can be used at far higher temperatures than can be approached with instruments made of glass.



Courtesy] [*General Electric Co.*

Interference fringes as seen by light reflected from contact faces of the flats

Limitations in regard to material and workmanship previously rendered it impossible to test flatness with greater precision than to one one-millionth of an inch; the use of silica glass has enabled this precision to be increased five times. Since a standard plane should not vary from flatness by more than one ten-millionth of an inch, even the temperature distortions of glass cause irregularities greater than the desired degree of precision will permit. In the case of a glass disc the tested and testing surfaces must be left in contact for several hours before they have recovered from the surface warps caused by slight handling or by temperature changes. Clear fused quartz, with its much lower coefficient of expansion, is affected to a far less degree by temperature changes.

The slabs of clear fused quartz, as received from the General Electric Laboratory, were first rough ground in the optical shop of the Bureau of Standards at Washington. After this preliminary grinding all the work was carried out by hand on a circular pedestal by swinging the 13-lb. discs in ever-changing loops and turns over a grinding or polishing table. The abrasive used was carborundum powder of three different sizes—coarse at first and finer for the later stages—and the three discs were ground against each other until a straight-edge failed to reveal any inaccuracies. A careful inspection was then made and all bubbles were reamed out, since the sharp edges of such cavities otherwise would have caused scratches during the polishing processes.

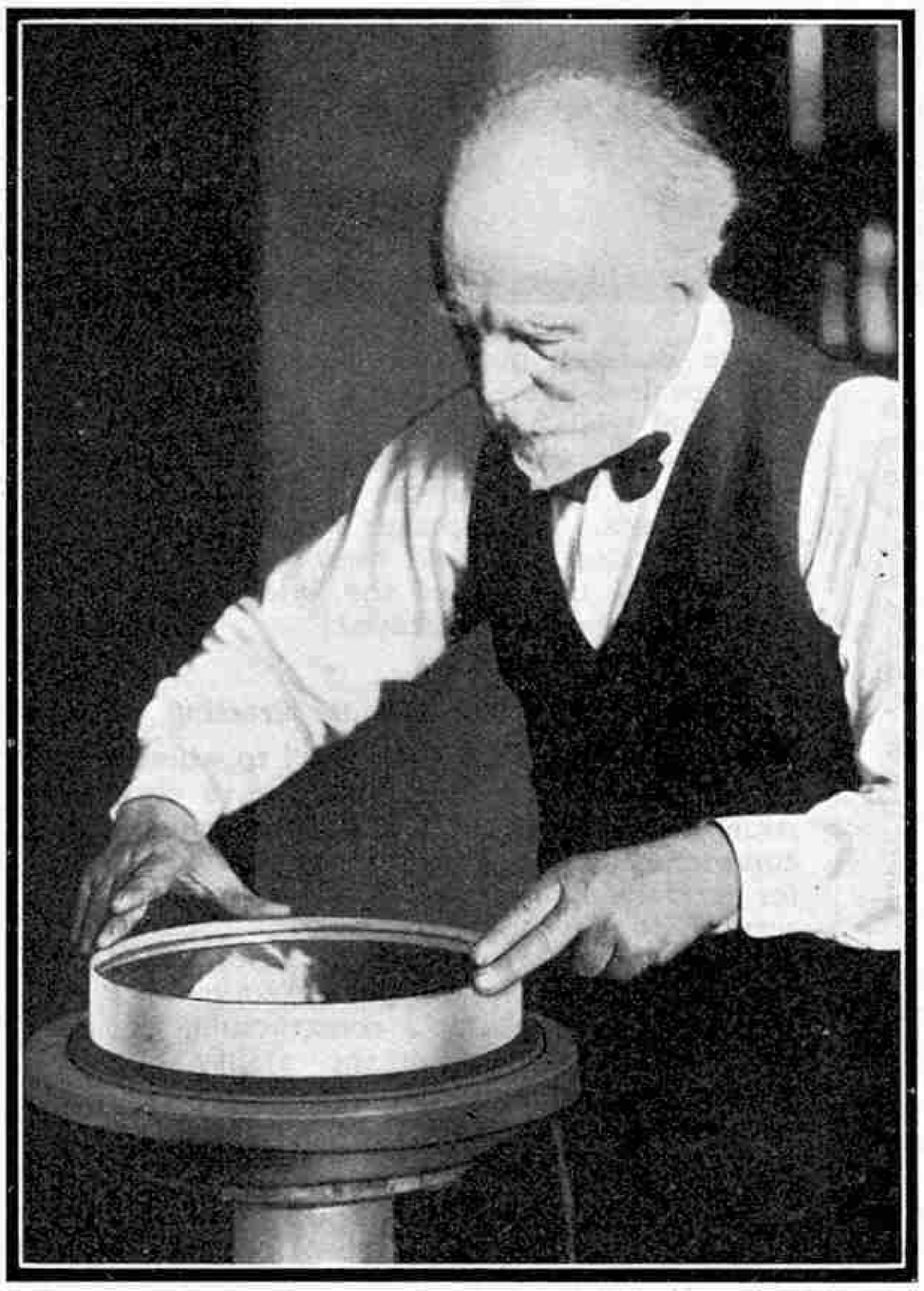
Very finely powdered rouge was used as the abrasive for polishing. The rouge was stirred in water and the heavier and larger particles were allowed to settle to the bottom of the tank. Uniformly fine rouge was then secured by dipping a brush into the tank, keeping it well above the bottom. For polishing, a cast-iron plate 9 in. in diameter, with a checkered arrangement of V-furrows and covered with a layer of pitch $\frac{3}{8}$ in. in thickness, was employed.

In the polishing work there were many things against which it was necessary to guard. The pitch had to be kept at a certain hardness and, since there was a tendency for it to heat up and soften under friction, the operator had to be alert for any sign of local or general softening of the pitch. This was accomplished by watching the surface of the pitch through the transparent disc and by noting any variation in the effort required to maintain the motion of the disc.

The operator also had to judge correctly the length and

type of stroke to be used—sometimes short and then long, sometimes oval and again circular. At times also there was needed pressure in addition to the weight of the disc itself, and occasionally it was necessary to stop the polishing until both the quartz and the pitch had returned to normal temperature. The pitch also needed to be reformed at times, and there again the expertness of the operator was called upon.

There were three steps in the polishing process. First both sides of the three discs were given a high-grade polish, but no tests were made for flatness. One face of each disc was then polished so that it was as near a true plane as could be indicated with the ordinary glass standard of reference. The flatness test was made by bringing the two surfaces together and observing the interference bands formed by monochromatic light or light of a single wavelength. When viewed perpendicularly, these interference bands are straight lines if the surfaces fit, whether plane or curved. If three surfaces brought together in pairs fit, they are plane; and this is why three surfaces are necessary. If viewed at an angle rather than perpendicularly the lines are curved, and since the line of vision is perpendicular at only one point at a time, a special device is needed in observing the lines.



Courtesy] [*General Electric Co.*

Manually polishing a 13 lbs. quartz disc by sweeping it in ever-changing loops and turns over the polishing plate

The explanation of the interference bands is that two trains of light waves from slightly separated images of the same light source neutralize each other at certain points, thereby causing alternate light and dark bands. This is because the separated images give two entirely similar and synchronous series of wave-trains of light.

If a slightly curved piece of glass, such as a thin lens, is placed in contact with a flat glass, a thin film of air is enclosed between the two, which increases in thickness outward from the point of contact. If examined in sunlight, or white light, coloured rings are seen surrounding the point of contact, the distance between the rings depending upon how rapidly the thickness of the air film is changing. If illuminated with light of a single wavelength, a series of alternate light and dark rings is seen, the distance between the rings depending not only on the thickness of the air film, but also on the kind of light.

Similarly, light of a single wavelength produces alternate light and dark bands when two flat pieces, rather than a flat piece and a thin lens, are used. These bands are straight and parallel if the glass plates are flat, and an extremely sensitive test for flatness is afforded by noting the straightness of the interference bands when one of the plates is known to be flat.

During the third polishing stage an instrument known as the Pulfrich interferometer was used in order to obtain perpendicular vision over the entire surface. The first comparison of the surfaces with this instrument showed that they were within twelve one-millionths of an inch of being perfectly flat. One was slightly hollow or concave, another was slightly humped or convex, and the third had a slight elevation between the centre and the edge. A single polishing operation reduced each of these irregularities by half, and a second one completed the work.

With the standards at hand it was not possible to test the new optical flats further, so that from then on it was necessary to test by comparing one with another. The polishing and measurements were continued until it was determined that each varied by less than two ten-millionths of an inch from being a truly flat plane at all points. There was no method for testing the surfaces beyond this point because, so far as could be determined, the interference lines were straight at all times, no matter how the surfaces of the three clear fused quartz discs were placed one on another. In this manner three surfaces that may be regarded as being absolutely flat were produced by a miracle of skilful polishing.

Our Daily Bread—(*continued from page* 641)

of wheat stones and the flour-dressing implements, cleaned the wheat and actuated the sack-tackle, etc. The output of this mill averaged 50 sacks of flour per week.

With spring tides a run of six hours' work was possible. The outgoing tide had usually to run some three hours before the difference in level between the pond and the river was sufficient to give the necessary power or "head" to work the mill. With neap tides there was frequently insufficient water to enable the mill to work. Windstorms also influenced the tides considerably, at times making work impossible.

It is by no means a rare occurrence to have an almost empty river, the gales having so influenced the tides that almost the whole river bed was visible. This was notably the case on 9th September, 1908. On this day it should have been low water at about 6 p.m. but owing to the heavy south-west gale of the preceding 24 hours the river was practically empty at 4.30 p.m., and this state continued until nearly 6 p.m. This was one of the lowest tides on record, being eleven feet below Ordnance datum, or three feet below the Harbour Master's zero mark.

The suspended matter, clay, etc., in the water added to the difficulties experienced with this class of mill, each tide precipitating its quantum of mud in the pond, silting it up and thus reducing its water capacity, and necessitating frequent clearances. Thus tide mills have been no more successful than ordinary water mills in meeting the competition of steam power.

ARE YOU IN DOUBT ?

If so, write to the Editor and he will do his best to solve your problem, and to help you with advice. Mark your letter "*Special.*"

Air News

Sir Alan Cobham's African Flight

Sir Alan Cobham's 20,000-mile flight to and round Africa was made in a Short "Singapore" flying boat fitted with two Rolls-Royce "Condor" engines. Sir Alan was accompanied by Lady Cobham, Captain H. V. Waral, second pilot, C. S. Conway and F. Green, engineers. The importance of this flight to commercial aviation is very great for it has proved conclusively that there are great possibilities for flying boat services up the Nile and over the Great Lakes.

As a result of this survey flight, plans for the Cairo-Cape Town air service are being expedited, and it is probable that when the service is commenced the first section from Alexandria and Cairo to Kisumu will be operated by flying boats. An experimental seaplane service has already been operated over this section by a British company. From Kisumu aeroplanes will be commissioned to connect Nairobi, Arasha, Iringa, Mzimbu, Fort Jackson, Blantyre and Salisbury, as the route will not be direct, but will link up most of the white settlements on the way.

* * * *

New African Air Route

A new air route between Johannesburg and Durban in Africa is soon to commence operation. It is to be worked by a new company known as "African Airways Limited," and the Union Government have voted the company a subsidy of £8,000 per annum. It is estimated that the aeroplanes will take from three to four hours to complete the journey, and they will stop, if requested, at Newcastle, Dundee, Ladysmith, Pietermaritzburg, Standerton and Volksrust. The company will possess a fleet consisting of three D.H. 61 eight-seater biplanes, and three D.H. Moths.

* * * *

Last of the "*Richard Penhoët*" Flying Boat

French aviation, notoriously weak on the seaplane side, was dealt a severe blow when the flying boat "*Richard Penhoët*" was lost in the sea at St. Nazaire.

This machine, the largest flying boat ever constructed, was intended for regular trans-Atlantic passenger services and as may of our readers will remember from the full description given in the August, 1927, issue of the "*M.M.*," was so constructed that if a forced landing were necessary the boat could stand the buffeting of any ordinary sea. The machine was a monoplane with a wing spread of 130 ft., and was fitted with five Gnome-Rhone-Jupiter engines.

The disaster occurred just after the machine had left St. Nazaire for a series of official trials. It was flying at a fairly low altitude when suddenly a loud explosion was heard and the machine dived into the sea. A passenger was drowned, but the pilot and two mechanics were saved. The mystery of the flying boat's sudden dive is not yet solved.

* * * *

Giant Zeppelin for Atlantic Crossing

The giant Zeppelin "LZ 127," to which reference was made on this page in our issue of March last, is rapidly approaching completion. This dirigible is intended for a trans-Atlantic mail and passenger service to be operated between Spain and South America, and Dr. Eckenen, the director of the Zeppelin Works responsible for the ship's construction, is confident it will prove the ability of airships to maintain an ocean service with regularity and safety.

"LZ 127" will have a volume of 3,707,500 cu. ft., and will be 771 ft. in length, with a maximum diameter of 100 ft. and a height of 100 ft. Five 530 h.p. Maybach engines are to be installed, and will enable the ship to maintain a commercial cruising speed of 72 miles per hour and a maximum speed of 80 miles per hour.

In normal atmospheric conditions "LZ 127" will be able to carry a load of 129 tons with a crew of 26. There will be 10 double sleeping berths, a dining saloon measuring 20 ft. by 16 ft., and an electric kitchen.

The most noteworthy feature will be the substitution of a new gaseous fuel for the usual liquid fuel, in order to counteract the gradual lightening effect resulting from the combustion of ordinary fuel, such as petrol. Gaseous fuel will also do away with the necessity of releasing gas by the valves, always a dangerous business in times of storm owing to the risk of ignition by an electrical discharge, the gas, as is well known, being highly inflammable.

The new fuel has a superior calorific value to, and will yield 30 per cent. more power than, an equal weight of petrol. It will be stored in ballonets, easy to accommodate on an airship of such a size, and as the fuel is used up it will simply be replaced by air, the densities of the two substances being practically identical. It is said that the new mixture will be composed of hydrogen and carbonic acid gas, a mixture that is not readily inflammable. This naturally will necessitate some alterations to the carburetter in order to achieve satisfactory results, but the alteration will not create difficulty. R. D. G.

Prospecting by Aeroplane

The investment of the Whitneys of New York in the rich Flin Flon copper-zinc mining field has drawn a rush of prospectors to the north of the American continent. To cope with this boom, the Western Canada Airways Company have instituted a regular flying service between Winnipeg, the Pas, and the Flin Flon mines. Machines fly daily over a vast amount of land that is practically unexplored except along the rivers and waterways where canoes are able to penetrate.

To facilitate the exploration of these regions a company has been floated under the name of the "Northern Aerial Minerals Exploration Limited." This company intends to make use of high-powered airplanes, specially constructed for long-range work, as a means of prospecting farther north. The headquarters of the company appear to be at Winnipeg, which is fast becoming an aviation centre and which undoubtedly will open a municipal airport before long. Winnipeg is the centre of the vast Canadian wheat belt, and the establishment of air routes serving Winnipeg naturally will assist the development of the wheat growing industry.

* * * *

Air Mail Records

Some mails recently despatched from Southampton reached Toronto in the record time of six days, six hours, and 42 minutes. This was accomplished by transferring the mails to an aeroplane directly upon the arrival of the mail ship at Rimouski.

Another air mail record has been set up on the Franco-South American mail service. The mails left Toulouse at 6 a.m. one day and the 2,927 miles between Toulouse and Dakar (West Africa), the last eastern calling point of the French mail boat, were covered in 36 hours, the mails being delivered to the mail boat at 6 p.m. the following day. A record has also been set up between Rio de Janeiro and Pernambuco. An aeroplane bearing mails between these two towns accomplished the flight in 16 hours, and the mails reached Pernambuco in the evening of the same day on which they left Rio de Janeiro.

* * * *

A Rhodesian correspondent of the "*D.H. Gazette*" writes as follows:—"A farmer flies his Moth 'plane to Salisbury every Saturday from Bromley (about 50 miles north of Umtali). His name is Wynne-Eaton but he is generally called 'Moth-Eaton' now, of course."

The Handley-Page Automatic Slot

During the past few weeks many of our readers have shown a keen interest in what is known as the Handley-Page Automatic Slot, and for their benefit we give a brief description of the usefulness and functions of this invention.

It is well known to most of our readers that if an aeroplane loses flying speed it ceases to be under the full control of the pilot and commences to fall to earth. The fall may take the form of a nose-dive or a spin and, unless the pilot is able to regain control immediately, the probabilities are that a bad crash will ensue. All the skill of an experienced pilot is called for to correct an uncontrolled spin, but it is the function of the Handley-Page Automatic Slot to overcome such trouble in any circumstances.

The slot itself consists of a hinged flap placed on the leading edge of the plane, the upper ones in the case of a bi-plane. When the machine is in ordinary flight the slots are closed, but as the speed of the aeroplane decreases the slots are forced forward by the action of air suction on the top of the wing. The slot diverts a continuous flow of air over the outer portion of the wings when the unslotted inner portion is not receiving any air. The result is to leave the machine in full lateral control by the ailerons.

It is the opinion of experts that 90% of the serious accidents that occur in aviation may be proved to have been caused by the loss of flying speed, or "stalling," and that 70% of these accidents could be eliminated by the use of the slot. The British Air Ministry are evidently fully convinced of the value of the invention as they have ordered that all new military aircraft, with the exception of single-seater fighters, must be fitted with it. The first French machine to be so fitted is the "Villiers XXIV" which has two slots along the whole of the front of the top of the wing in order to reduce the landing and taking-off speeds.

In order to familiarise pilots on the continent with the auto slot, Squadron-leader T. H. England is to fly an "X" type Cirrus-engined "Moth" fitted with the device to all the principle air ports. In the course of his tour he will cover France, Spain, Switzerland, Italy, Yugo-Slavia, Rumania, Hungary, Austria, Czecho-slavakia, Germany, Poland, Holland and Belgium. He will give demonstrations to the leading airmen of all these countries and probably will take them for a trial flight, during which they will be allowed to take control for a short time if they so desire, and therefore will be enabled to do their utmost to stall the machine. During tests in England, a 'plane fitted with slots was deliberately flown into the ground by Captain Broad without any serious damage resulting.

Flight Endurance Records

Captain Ferrani of Italy recently set up new figures for the endurance flight record by remaining in the air for 58½ hours. The following day, however, two Belgian airmen surpassed this feat and were flying for 60 hours and 7 minutes. The weight and bulk of the petrol required to maintain the machine while they were making their attempt would have greatly handicapped its performing abilities, and in order to give the aviators every chance of beating the record, their aeroplane was refuelled from another machine several times during the course of the flight.

* * * *

Central Heating in Aircraft

A new aeroplane that has been built specially for the purpose of sealing operations in Newfoundland is fitted with central heating apparatus. The machine spots the seals and communicates their whereabouts by wireless to the parent sealer. Extreme cold is, of course, experienced while flying in these parts but when the central heating apparatus is installed it is possible for the pilot to dispense with gloves while he is flying.

* * * *

Britain's Youngest Certified Air Pilot

Robin H. E. Sanders-Clark, whose photograph was published in the "*M.M.*" for April, 1927, is now a qualified air pilot, having just received his Royal Aero Club certificate. This certificate can only be issued to qualified applicants aged 17 and by receiving the certificate on his 17th birthday, Robin has an indisputable claim to be England's youngest certified air pilot. He proposes to take up flying as a career, and he intends to take his "B" certificate as soon as he is old enough to comply with the regulations.

Brakes for Aeroplanes

For some considerable time aeronautical engineers have been experimenting with various methods of braking aeroplanes. As the subject is still only in the experimental stage no definite conclusions are yet available, but many engineers believe that a new system known as the Lockheed Hydraulic System has great possibilities.

When an unbraked aeroplane lands, there are two factors that tend to exert a braking force and eventually to stop the machine completely. These factors are air resistance and ground friction. The retardation due to air resistance varies directly as the speed of the machine, and the retardation due to ground friction varies inversely as the speed. That is to say, when an aeroplane is just landing the retardation due to ground friction is zero, but when the machine has almost stopped the retardation due to air resistance is zero.

If any ordinary type of motor car brake were fitted to the landing wheels of an aeroplane, the machine would skid and overturn immediately the brakes were applied. The Lockheed system of braking overcomes this obstacle by making the load on the tail-skid operate the brakes. Before the pilot of an aeroplane fitted with this device lands, he applies the brake lever, which is then automatically kept in place. When the machine has landed and the tail-skid is just touching the ground the brakes are applied slightly without any attention by the pilot. As the machine slows down the tail-skid presses more heavily on the ground and the hydraulic brakes are applied still more until eventually the machine comes to a standstill. If the machine commences to skid before finally coming to rest the tail lifts and the brakes are then automatically released. In other words, the weight of the tail governs the brake.

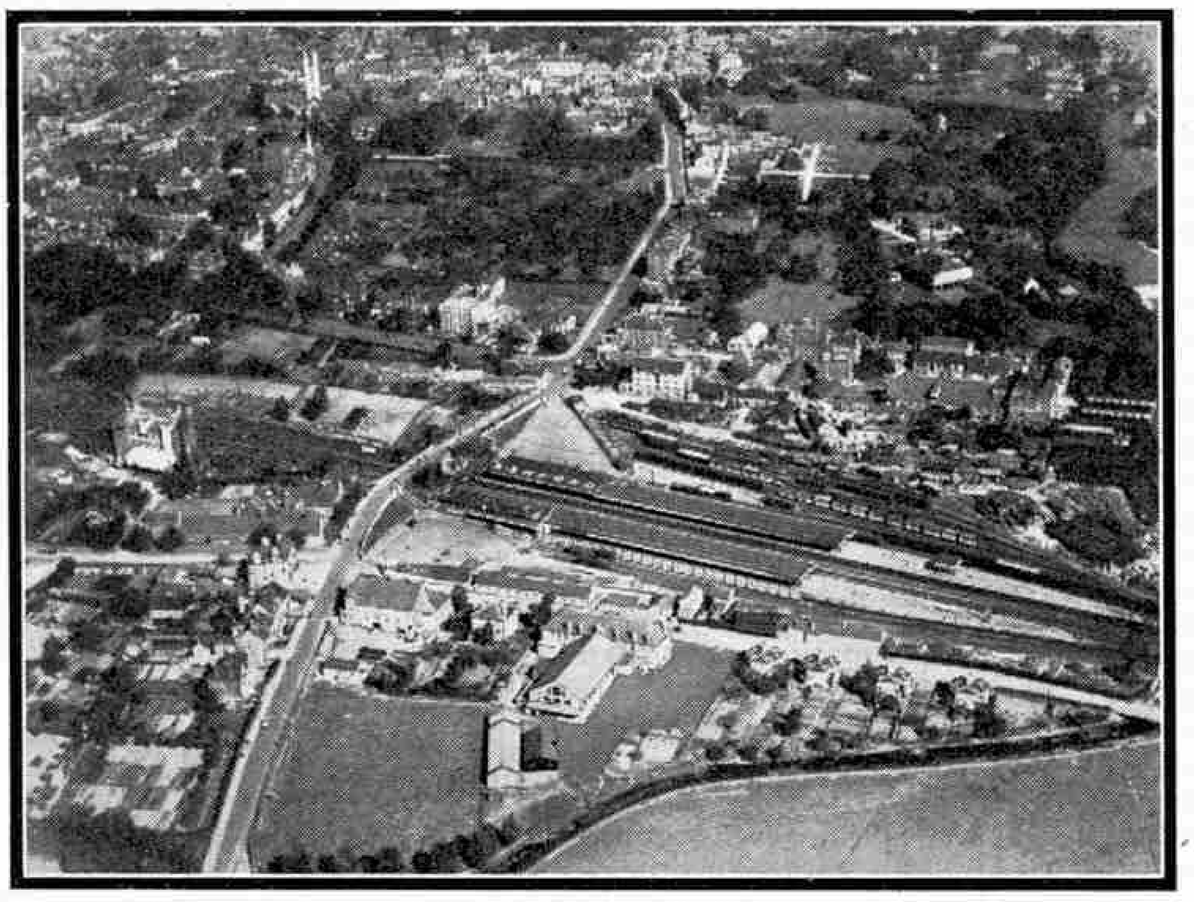
* * * *

The Britannia Trophy Winner

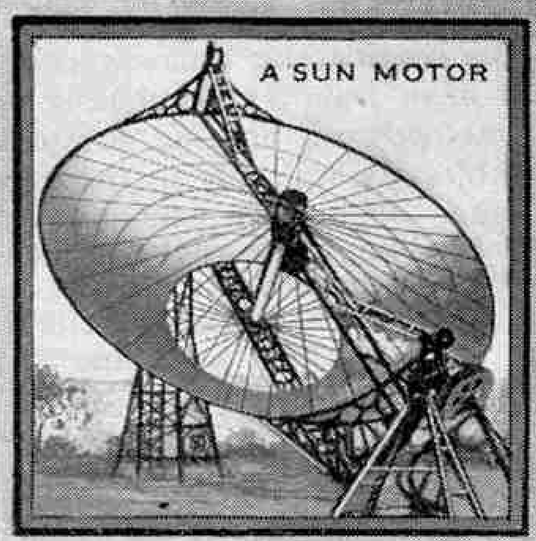
The 1927 Britannia Trophy award has been granted to Lieut. Richard R. Bentley, A.F.C., in respect of his solo flight on a Moth from London to Cape Town in September last.

The Britannia Trophy is granted each year to the British pilot who, in the opinion of the Royal Aero Club Committee, has performed the most distinguished air feat during the year. It is the "blue riband" of the aeronautical world and has been awarded to Sir Alan Cobham three times. In 1923 it was awarded to him for his flight round Europe and Northern Africa in a D.H. 9C; in 1925 he received it for his flight to Rangoon and back; and in 1926 he again secured the award with his flight to Australia. Both of the last two flights were made in the same D.H. 50.

Stations from the Air



An interesting aerial view of Ashford Station on the S.E. & C. section of the Southern Railway. Note particularly the name of the station painted on its roof to serve as a guide to aircraft passing to and from the Continent



Of General Interest

American Ice Exported to India

In the year 1805 an enterprising youth of Massachusetts evolved the bright idea of sending ice to the tropics. This youth was named Frederick Tudor and he was then 22 years of age. His friends laughed at him, but he set to work to cut the ice of a pond on his father's land and shipped 130 tons of it to Martinique. This trial trip was a complete failure, but he persisted in the idea that ice was more valuable in the tropics than in the neighbourhood of Boston where he lived, and by 1812 he had succeeded in building up a small trade in the ice that he found ready to hand on the surface of the numerous lakes in his native State.

The war between Great Britain and the United States then intervened, but when that was settled Tudor extended his old business in all directions and very soon ice from Massachusetts was being shipped to every large port in Central and South America, and even to Calcutta, and the far East. It is recorded that when a certain Persian Ambassador in London met the American Ambassador in that city, his first words were in appreciation of the American ice that was used in his country.

Transporting ice in those early days of the trade was by no means an easy task. The vessels used had to be double sheathed, and it was only after many experiments that a suitable insulator from heat was discovered in pine sawdust. The distances to which ice could be carried by the aid of this sawdust, even in the comparatively slow sailing ships of the period, were quite surprising. Calcutta, for instance, is 11,500 miles from Boston by sea, and the ice that was carried to the former city actually crossed the Equator twice during the voyage.

Another difficulty that Tudor had to overcome was that the natives of the countries with which he began to trade did not know what to do with the ice. It was necessary, therefore, to educate them and at times ice was actually given away in order to popularise ice drinks and ice cream. When the first cargo of the mysterious white solid was landed at Calcutta the natives were greatly bewildered by its coldness, and made excited enquiries with regard to the manner in which it grew! Many of them bought small quantities, and then indignantly demanded their money back when the heat of the sun caused their purchases to disappear!

The trade in natural ice disappeared when modern methods of refrigeration were introduced. Ice can now be made all the year round comparatively cheaply. In America the cost of fuel oil required to make a ton of ice in plant driven by a Diesel engine is only about a shilling, and in consequence ice is used as a food preservative in something like 12 million homes. On the average, each individual in the United States uses more than half a ton of ice annually, and doctors attribute the improvement in health of recent years in great part to the better condition of food stored in ice-boxes.

Over a Hundred Years Ago!

Before the Forth Bridge was Built!

"It is supposed that there are upwards of 300 bridges of different descriptions in England and Wales."—"THE TIMES," 20th Mar., 1828.

10 Miles an Hour, a Century Ago!

"Mr. Gurney's Steam Coach.—This ingenious vehicle continually approaches nearer perfection, under the care and skill of Mr. Gurney. It has been running every day last week in the Regent's Park and the New-road. On Wednesday it preserved the rate of ten miles per hour, although loaded with fifteen persons outside and two inside. On Thursday it was running for a considerable time in the Square of the Cavalry Barracks, in Regent's Park, when it was viewed by a number of distinguished persons, among these was His Royal Highness, Don Miguel, who was accompanied by Lord Mountcharles, and several foreigners of distinction."—"LIVERPOOL MERCURY," 18th Jan., 1828.

No "Free Trips" Now!

"Last summer, a female convict in New South Wales wrote to her lover in England, passionately beseeching him to commit a felony, as the means of transporting him to her arms. The fellow accordingly stole a pair of breeches."—"THE YORK CHRONICLE," 24th May, 1828.

Wheat Growing in Canada

The growth of wheat production in the western provinces of Canada in recent years is very extraordinary and the Dominion is rapidly becoming known as the granary of the British Empire. In 1871 the region that was destined to become the greatest wheat growing area in the world produced a mere 16,000,000 bushels. The coming of the railway increased the flow of immigrants and improved the resources of the country generally, with the result that 30 years later the annual crop had become 55,000,000 bushels.

Wheat production had thus increased by over 230 per cent. which seemed very satisfactory. In the following years, however, the production increased at an absolutely astounding rate, and when the figures for 1927 are available it is expected that even the record yield of 474,000,000 bushels obtained in 1923 will be surpassed.

The vast expansion shown by these figures is not solely due to the increase in the area devoted to wheat-growing. Science has kept in close touch with agricultural practice for many years and, by careful breeding and selection of promising varieties of wheat, new kinds of grain with heavy cropping and early ripening characteristics have been produced. The most famous of these is a variety known as "Marquis," which has been the mainstay of wheat production in Canada and a standard for the whole world since its introduction. Still better varieties are now promised. In 1926 a new wheat named "Garnet" was grown for the first time, and trials during two summers have justified the claim made for it that it ripens 10 days earlier than any other variety, besides giving a satisfactory yield. In addition a slightly higher percentage of flour may be extracted from it than from "Marquis."

The production of varieties of wheat that ripen early is a matter of great importance to Canada. The earlier the crop ripens the less is the danger incurred from the early frosts of autumn, and the introduction of "Garnet" will make it possible to grow wheat with perfect safety much further north than is done to-day. One famous wheat grower claims to have produced a variety that will be still more suitable for the colder regions to the north of the present wheat belt, for, he says, it can be sown later and yet ripen 18 days earlier than the present varieties.

A development that is in some ways even more surprising is the introduction of wheat with a double chaff! Grain of this kind is able to withstand early frosts much better than ordinary wheat, and the Canadian Minister of Agriculture is quite convinced of the possibility of bringing such a wheat into common use. If this is the case, such a wide extension of the grain-growing area is possible that the production of wheat in Canada may be said to be still in its infancy, and in future years the annual yield of wheat will far exceed the 500,000,000 bushels that seems to be the measure of Canada's capacity to-day.

Tracking the Wandering Magnetic Poles

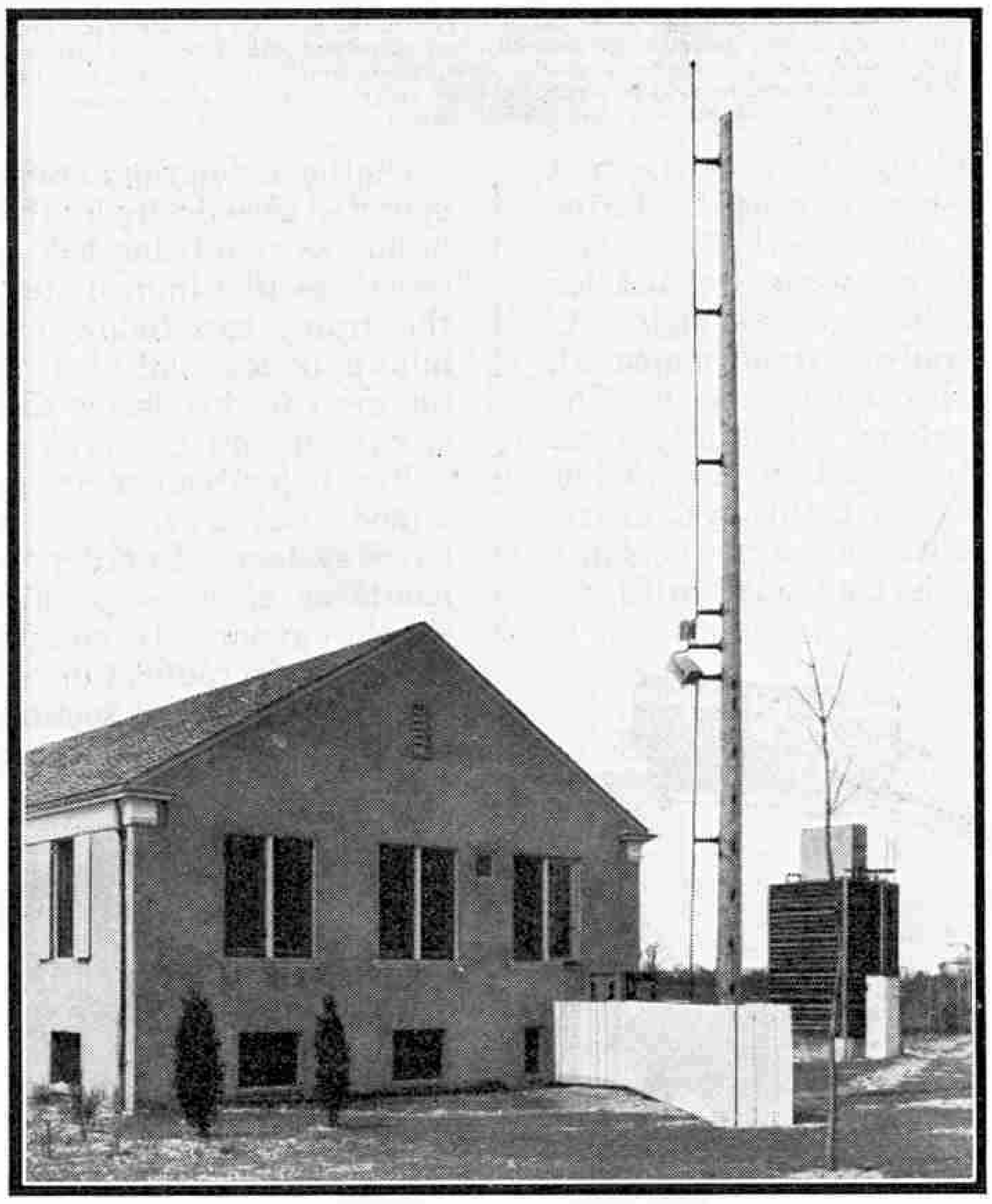
The famous non-magnetic ship "*Carnegie*" has already made six voyages totalling more than a quarter of a million miles, and is shortly leaving for another cruise of more than 1,000 miles. Primarily her existence is due to the somewhat annoying habit that the magnetic poles have of wandering.

At London in 1580 the compass pointed 11° to the east of true north, and this angle slowly decreased until 1659, when it became zero and the compass pointed due north. After that date the north magnetic pole moved to the west of true north until in 1819 the angle between magnetic north and geographical north was a little more than 24°. The declination, as this angle is called, then began to diminish once more, and at Abinger, Surrey, where measurements are now made instead of at the Royal Observatory at Greenwich, it is now a little less than 13°.

As a knowledge of this angle is essential to safe navigation, the scientific staff on board the "*Carnegie*" make periodical measurements at as many places as possible in order that mariners' charts may show accurately the correction to be made to compass readings. One curious feature revealed by accurate measurements is that the compass needle wobbles daily, making a little excursion every morning from east to west and returning to its average position about 6.0 o'clock in the evening. The range of this variation is very small and can only be detected with delicate instruments.

The "*Carnegie*" has been specially built for magnetic work and not more than one ton of iron or steel has been used in its construction. The 100 h.p. oil engine is made of bronze, with the exception of the piston rings and valves. The cooking stoves are of bronze and the pans of aluminium or copper; while even the cutlery is not steel but is made of Mexican silver. No steel wire is used in the rigging and all metal fittings throughout the ship, nails and bolts included, are made of non-magnetic materials. Even the buttons and belt buckles worn by the sailors are of bone or brass.

In addition to determining the angle of declination, the work carried on includes complete measurements of the intensity of the earth's magnetic field. It is absolutely essential to prevent the slightest variation in magnetic conditions near the delicate instruments used, and the small amount of iron and steel on the ship is fixed as far away from them as possible.



The short-wave transmitting aerial at WJ2

Two Million Sheets of Iron in Pile less than One Inch in Height

Metal sheets so thin that it is possible to see through them have been made by a German scientist. The method by which these extraordinary sheets are prepared is to electro-plate the metal on the surface of a material that can afterwards be dissolved away. A smooth surface of rock salt has been used as a temporary support of this kind, as it is easily soluble in water. A thicker ring of metal is used to support the films.

Among the metals from which thin sheets of this kind have been made are iron, nickel, copper, silver and platinum. It is not surprising that they are transparent, for they are so thin that more than 2½ millions of them would be required to form a stack 1 in. in height. Small print may be read through the sheets, with the exception of those made of nickel, but in compensation it has been found that these transmit ultra-violet rays with great ease.

The films are excellent conductors of electricity, a strip that contains no more metal than an ordinary wire one hundredth of a millimetre in diameter being capable of carrying enough current to supply several lamps. An ordinary wire of the diameter indicated would be scarcely visible and would be melted almost instantly by such a current. Probably the large surface presented by the metallic film is responsible for its remarkable conductivity. Another interesting feature is that the films are very elastic. Those of a circular form may be made to bulge to the extent of 1/10th of their diameter before breaking. This discovery opens up possibilities of solving the problem of making flexible "glass" on entirely new lines!

The Lost Continent of Atlantis

A new and reasonable suggestion regarding the position of the famous lost land of Atlantis has been made. The legend of the catastrophe in which Atlantis disappeared beneath the waves was still very much alive among the people of Greece 2,500 years ago, and it seems likely that the event happened a reasonable length of time before this. It is now known that the present North Sea was the site of a land connection between Britain and Europe as late as the Bronze Age, about 3,000 B.C. and a Swedish geologist has given reasons for supposing that the sinking of this land connection and the resulting influx of the sea is the catastrophe referred to.

Traces of the lost land can be seen to-day at the Dogger Bank, formerly one of its highest ridges, while there is ample evidence of communication between Britain and Sweden in the prehistoric times of the Bronze Age. In all probability the Thames then united with the Rhine, the combined streams entering the ocean on a coastline that stretched between the north of Scotland and Norway.

The engulfing of this ancient land by the sea would undoubtedly make a great impression in north-western Europe, and the story would almost certainly be passed on to the merchants and traders from Mediterranean countries who came to Britain for tin and other natural products. The legend says that the lost land lay beyond the Pillars of Hercules, or through the Straits of Gibraltar, as we should now say. For this reason it has usually been supposed that the lost continent lay in the Atlantic Ocean, but we now know that there was a close connection between Spain and Britain on the one hand, and between Spain and eastern Mediterranean countries on the other, so that the natural route to Britain would be through the straits and along the shores of Spain and France. In other words, to the ancient peoples of the eastern Mediterranean, Britain lay beyond the Pillars of Hercules, and the suggestion now made for the position of Atlantis is in complete accord with tradition.

A Growing Island

A remote island in the Bering Sea has again drawn attention to itself of recent years by increasing very largely in size. It is called Bogoslaf Island, and it came into existence 130 years ago during a volcanic disturbance at the bottom of the shallow sea, the somewhat terrifying accompaniment of earthquake, fire and steam being well attested by a Russian who chanced to witness the spectacle from a neighbouring island.

Since then the island has grown and diminished in a mysterious and baffling manner. Expeditions have visited it and compiled maps that have become inaccurate and misleading almost before they have been printed and distributed. A new peak was thrown up in 1927, photographs of which showed clouds of steam issuing from crevices in the mountain side, thus indicating that volcanic disturbances at the bottom of the sea still continue. There is every possibility of further changes, for Bogoslaf Island lies on the earthquake line stretching from Japan to California.

Electricity Applied to Meccano

X.—Automatic Block System Control for Electric Railway

These articles are intended to draw every Meccano boy's attention to the numerous fascinating uses to which the Meccano Electrical parts may be put. The first two articles of the series dealt with the elementary principles of electricity, and subsequent articles described various Meccano switches, a coil winding machine, a Meccano electric telegraph system, electro magnets, a galvanometer, motors, an electric locomotive, bells, lamps, an ammeter, an electric sign, etc. Below we describe a simple method by which two locomotives on a model railway may be controlled simultaneously. The engines stop and start each other automatically and always keep a safe distance apart!

IT is a far cry from the hand signalling of the first railways to the elaborate systems now used. In the early days comparatively crude methods of signalling were relied upon, for trains were few and far between and the speed of the engines was not high. As both the density and rapidity of railway traffic increased, however, more reliable systems became necessary. The signalling was improved or modified constantly until the well-known block system emerged in its present form. Thanks to the care with which this system has been designed and to the skill of its operators, the dense railway traffic of this country is controlled with remarkable speed and safety.

In the block system the track is divided into a number of sections, each section having its own signal cabin. Before a train enters any particular section, the signalman of that section asks the signalman in the next section ahead whether he will accept the train. If the reply is in the affirmative, he allows the train to proceed, and as soon as the train has passed the signals he returns them to the "danger" position. Meanwhile the signalman in the box ahead is ascertaining whether the next signalman along the line will accept the train. If he cannot for any reason, the second signalman holds the train in his section until he receives the information that the next section ahead is clear. From this it will be seen that two trains cannot be in the same section at the same time. Hence the possibility of accidents is reduced to a minimum.

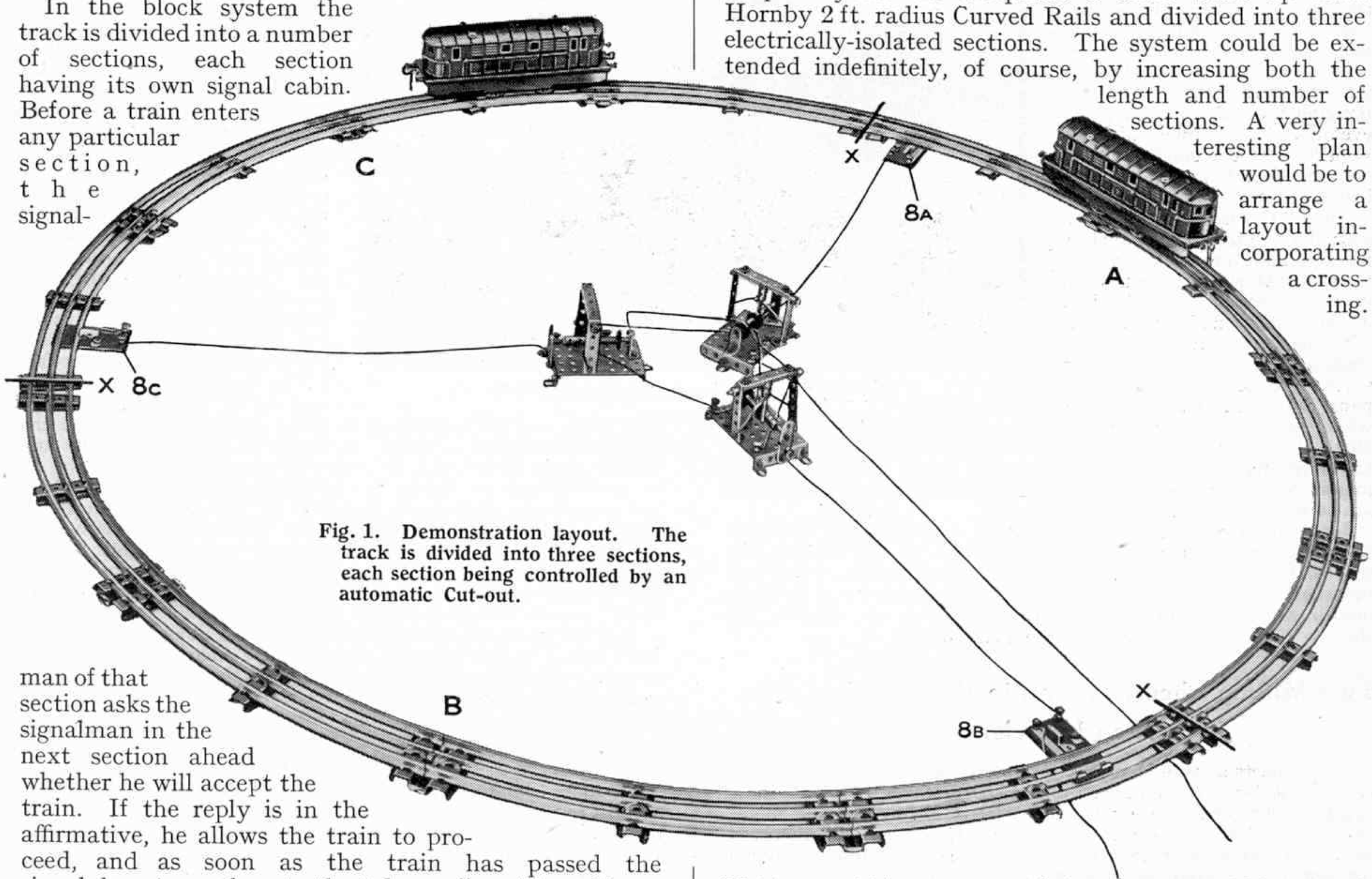


Fig. 1. Demonstration layout. The track is divided into three sections, each section being controlled by an automatic Cut-out.

On the underground railways of London the signals are operated electrically by the trains themselves, the signals in any section being held at danger so long as a train is on the section immediately in front. With this system the trains can follow one another at intervals of a minute or less and at a high speed with perfect safety, for even if the driver disregards a signal, the current is cut off and the brakes applied automatically.

Fig. 1 shows a simple arrangement by means of which a model railway may be controlled automatically by the block system. In order to make the necessary arrangements as clear as possible we have designed a very simple layout. It comprises a circle built up from Hornby 2 ft. radius Curved Rails and divided into three electrically-isolated sections. The system could be extended indefinitely, of course, by increasing both the length and number of sections. A very interesting plan would be to arrange a layout incorporating a crossing. Matters could be so arranged that power would be cut off from one train whilst the other passes over the crossing, the first train remaining immovable, of course, until the second is quite clear of the crossing. This is only one suggestion; no doubt the fertile brains of Meccano boys will produce innumerable others, resulting in some extremely interesting layouts.

An automatically-controlled model railway forms an ideal demonstration for Meccano Club purposes, etc., for

it will continue to function for long periods without any attention whatever. It is very fascinating to watch the trains stopping and starting without human intervention.

The current supply for the layout should be obtained from a Meccano 4-volt Accumulator, and not from the main through a transformer, for the alternating current so obtained rapidly makes the contacts of the cut-outs sooty, thereby impairing their efficiency.

Construction of the Meccano Cut-outs

As the most important features of the model are the electro-magnetic cut-outs, or switches, their construction will be described first. The number of cut-outs required depends upon the number of sections in which the layout is divided, for a separate cut-out is required for each section. Three cut-outs are necessary for the layout illustrated in Fig. 1. One of them is shown more clearly in Fig. 2.

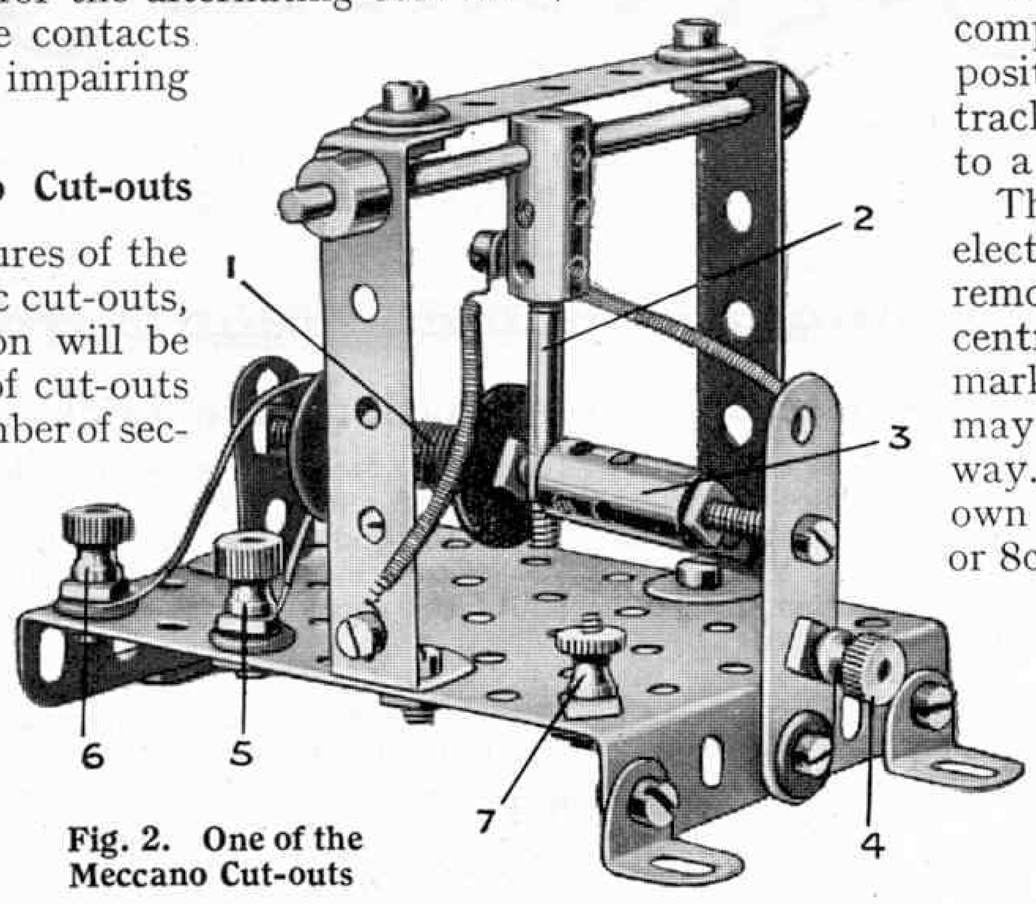


Fig. 2. One of the Meccano Cut-outs

The magnet coil 1 consists of two layers of No. 23 S.W.G. Wire wound on a Meccano Bobbin. The Bobbin is mounted on a Pole Piece that is secured to a 1″ × ½″ Angle Bracket, which, in turn, is bolted to the 3½″ × 2½″ Flanged Plate forming the base of the apparatus. Two 2½″ × ½″ Double Angle Strips are bolted to the base and their top ends are connected together by a 2½″ Strip.

The armature 2 consists of a Pole Piece (part No. 308) held in the bore of a Coupling that is secured to a 3″ Rod journalled in the 2½″ × ½″ Double Angle Strips. Two short lengths of Spring Cord are attached to a set-screw, which is inserted in one of the tapped holes of the Coupling, and also, by means of nuts and bolts, to the 2½″ Double Angle Strips.

The contact 3 consists of a Threaded Coupling mounted on the end of a ¾″ Bolt and secured in place by a nut. The bolt is fastened, by means of a second nut, to a 2″ Strip. This Strip is secured to and insulated from the 3½″ × 2½″ Flanged Plate by a 6 B.A. Nut and Bolt, with an insulating Bush and Washer on the shank of the Bolt.

The tension exerted by the Spring Cord should be very light, but sufficient to hold the armature against the contact 3 when no current is flowing through the magnet.

The distance between the armature 2 and the pole face of the magnet must be adjusted very carefully by altering the position of the Threaded Coupling 3 on the ¾″ Bolt. The correct gap is the thickness of a visiting card. In order to prevent the armature sticking to the magnet pole face on account of residual magnetism after the current is switched off, it is advisable to stick a small piece of paper over the pole face.

Each of the terminals 5 and 6 is insulated from the base plate by Insulating Bushes and Washers placed on the 6 B.A. Bolts that form the shanks of the terminals. The third terminal 7 is in direct metallic contact with the base plate, and therefore it is in electrical contact with the armature 2. Another terminal 4 is secured to the 2″ Strip that carries the contact 3.

When the three cut-outs have been completed they may be secured in position in the centre of the circle of track, which should be screwed down to a suitable base board.

The track is divided into three electrically-isolated sections A, B, C, by removing the connecting pegs of the centre collecting rails at the points marked X in Fig. 1. The running rails may be continuous as in the ordinary way. Each section is provided with its own Terminal Collecting Plate 8a, 8b, or 8c, which is connected to its respective cut-out.

Wiring up the Model

The theoretical wiring diagram is shown in Fig. 3. The terminals on the cut-outs are numbered in the diagram as in Fig. 2, but the numbers are followed by letters, which refer to the rail section (A, B, or C) controlled by each cut-out. The terminals on the Terminal Collecting Plates 8a, 8b, 8c, which communicate with the centre rails, are connected to the terminals 4a, 4b, and 4c, on the cut-outs. Terminals 6a, 6b, 6c, are all connected together by a length of wire, an extension of which forms one of the wires or leads to the Meccano 4-volt Accumulator. This lead is marked + in the wiring diagram. Lastly, 5a is connected to 7b, 5b to 7c, and 5c to 7a. The other wire from the Accumulator is attached to the terminal of one of the Collecting Plates, as indicated in Fig. 1. (The terminal to be used is the one communicating with the outside, or running rails).

On referring to Fig. 3 it will be seen that, supposing a train is running on section A, the current passes from the Accumulator through the electro magnet of the cut-out the contact and armature of which form part of the circuit supplying section C. After leaving the magnet of this cut-out the current passes along the armature and contact of a second cut-out to the centre rail of section A. The electro magnet of the first cut-out, thus energised, attracts the armature, and the movement of the latter breaks the circuit in section C (since the armature and contact of this cut-out form part of C's circuit). Therefore any train on this section would be unable to move.

As soon as the train has passed out of section A into B, the armature of the first cut-out flies back to its original position—because current is no longer flowing through the magnet—and thus allows the current to flow again through section C. Hence the train in section C can move into section A. The process is then repeated.

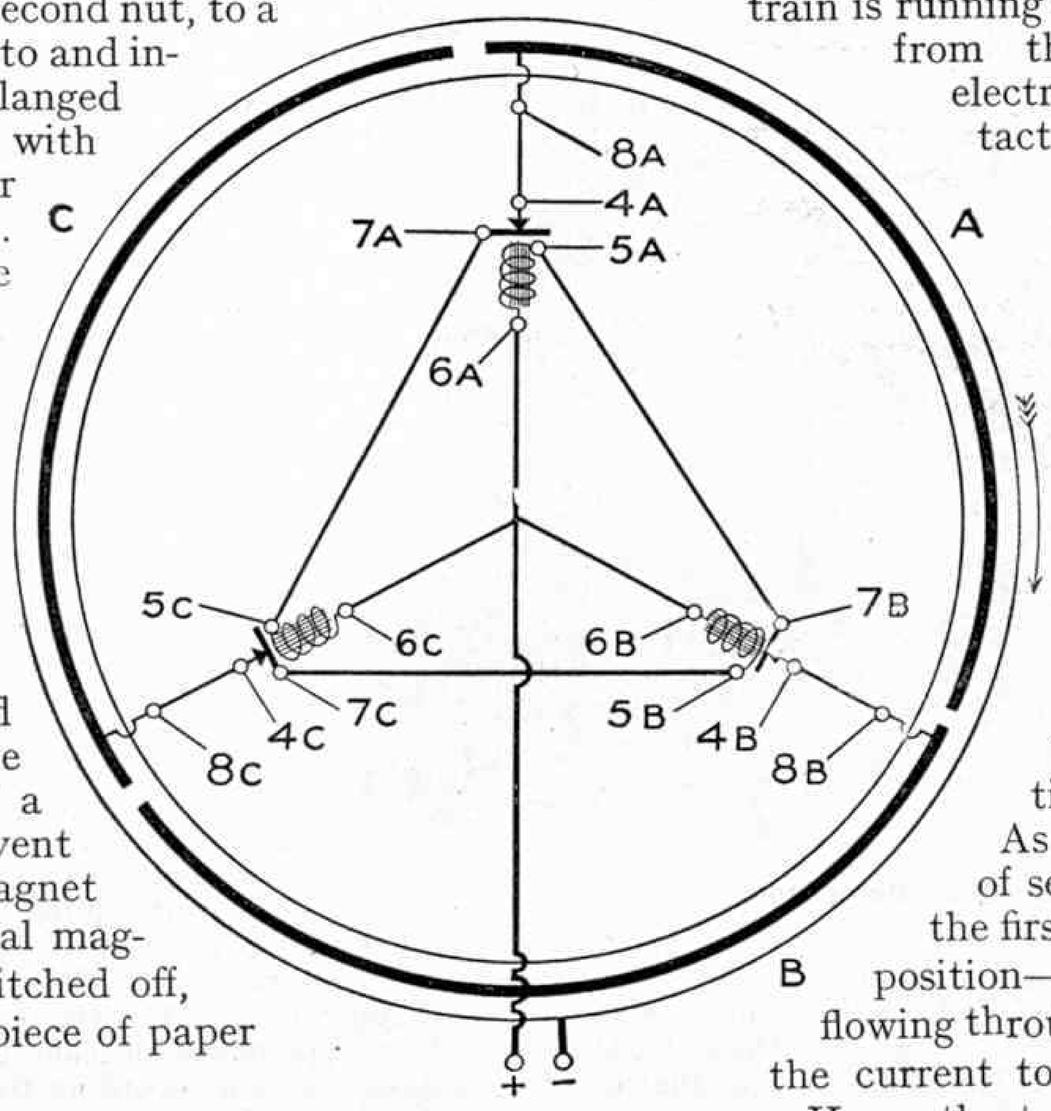
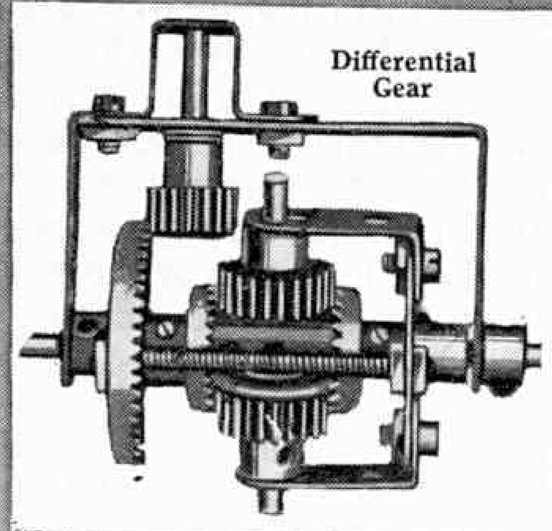


Fig. 3. Diagram showing Connections



Suggestions Section

Edited by "Spanner"

(129)—Meccano Combination Safe Lock

NO comparison can be made between the crude locks of primeval man, who sought by means of a wedge or piece of wood to bar the door of his hut against both human and animal foes, and the ingenious time lock of the modern safe. Yet it may be said that the one is the direct ancestor of the other, for both are locks, in a sense, although at the very extremes of their class.

Modern safes, or strong rooms, as the larger variety should more correctly be called, are certainly marvels of the engineer's art. For example, an improved type of strong room recently introduced by a well-known British firm of safe makers is claimed to be burglar-, fire-, and even earthquake-proof! It has a door 24″ thick that is secured in position by twenty-four bolts. The bolts are so controlled by a complicated system of time locks that they cannot be moved until a certain set time has elapsed. The time may be anything from a few hours to a few weeks, but it is practically impossible to open the door until the allotted period has elapsed.

All safes are not quite so big as this, of course, but the smallest and most innocent-looking safe may have unpleasant surprises in store for those who attempt a little amateur safe-breaking! For instance, some safes resent being touched and if so treated they promptly ring a gong and thus spread the alarm. Electric shocks, too, may come the way of those who attempt without authority to investigate the interior of a safe. On the whole, safe-breaking is not a profession we advise any of our readers to go in for!

The Meccano combination safe lock illustrated in Figs. 129 and 129a is intended to demonstrate the principles underlying the working of a typical combination lock.

The safe door consists of four $5\frac{1}{2}''$ Angle Girders to which are bolted two $5\frac{1}{2}'' \times 3\frac{1}{2}''$ Flat Plates. Collars forming the movable portions of the hinges are secured to one of the $5\frac{1}{2}''$ Angle Girders as indicated.

The two combination dials 1 and 2 (Fig. 129) consist of circular cardboard discs pasted to Bush Wheels. They are graduated round their peripheries by equally-spaced markings, which should be numbered or lettered. The $1\frac{1}{2}''$ Rods on which the Bush Wheels are mounted are journalled in Double Arm Cranks bolted to the front of the $5\frac{1}{2}'' \times 3\frac{1}{2}''$ Flanged Plates and Worms 4 and 5 secured on their inner ends engage with $\frac{1}{2}''$ Pinions on the $3\frac{1}{2}''$ Rods 6 and 7. These Rods are free to slide in $1'' \times 1''$ Angle Brackets bolted to the Flat Plates, and Strip Couplings 8, 9 are secured on their ends.

A connecting piece, consisting of two $3\frac{1}{2}''$ Strips placed together face to face and bolted to a Double Arm Crank, is placed on the Rods 6 and 7 behind the Strip Couplings 8 and 9, and is secured to the end of the Rod 12 by the Double Arm Crank. A Worm secured to the latter Rod engages with a $\frac{1}{2}''$ Pinion on the end of the short Rod to which the handle 3 (Fig. 129) is attached.

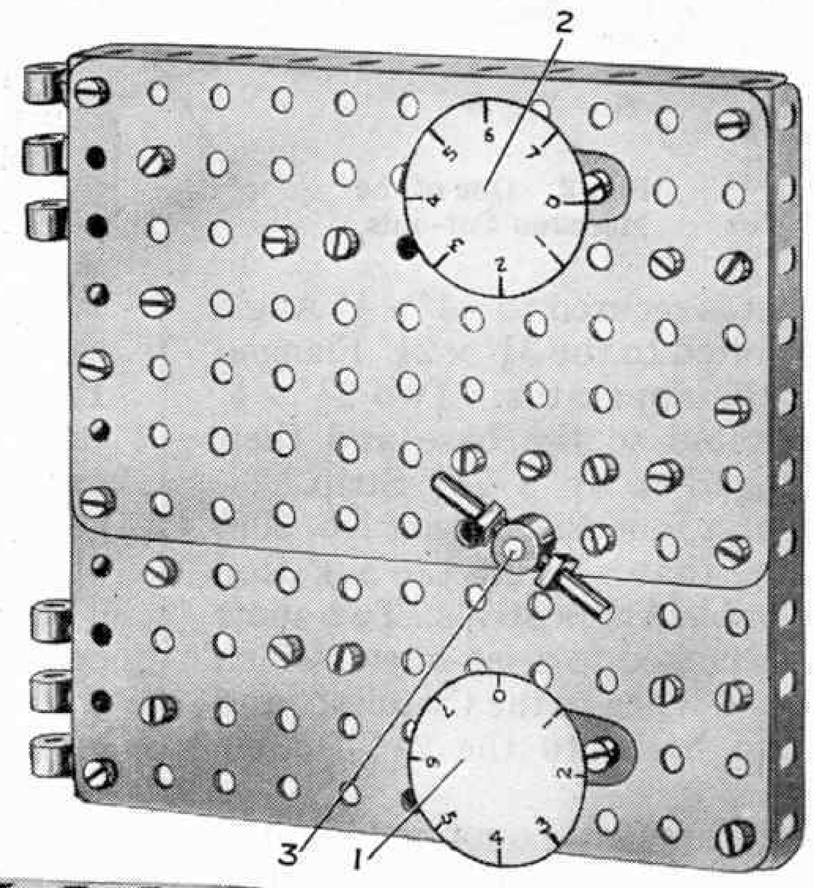


Fig. 129
Front of Safe Door

As will be seen, the handle consists of a new style Collar, or the "spider" from a Universal Coupling, with two Threaded Pins inserted in its set-screw holes. On turning the handle the Worm on the Rod 12 functions as a rack and Rods 6, 7 and 12, which represent the three bolts, will be moved to the right—provided, of course, that the slots in the ends of the Strip Couplings 8 and 9 coincide with the edges of the $1\frac{1}{2}''$ Angle Girders 13.

The $\frac{3}{8}''$ Bolts inserted in the Strip Couplings limit the amount the latter may turn by striking against the stops 10 and 11. The stop 10 takes the form of a $\frac{1}{2}''$ Reversed Angle Bracket, while stop 11 is the shank of a Bolt. When the safe door is locked the $\frac{3}{8}''$ Bolts should butt against their respective stops, but by turning each dial a pre-determined number of complete turns and fractions of a turn, as denoted by the numbers on the circumference of the dial, the slots in the ends of the Strip Couplings are brought opposite the edges of the Angle Girders 13. The bolts may then be shot back by means of the handle 3 and the door may be opened.

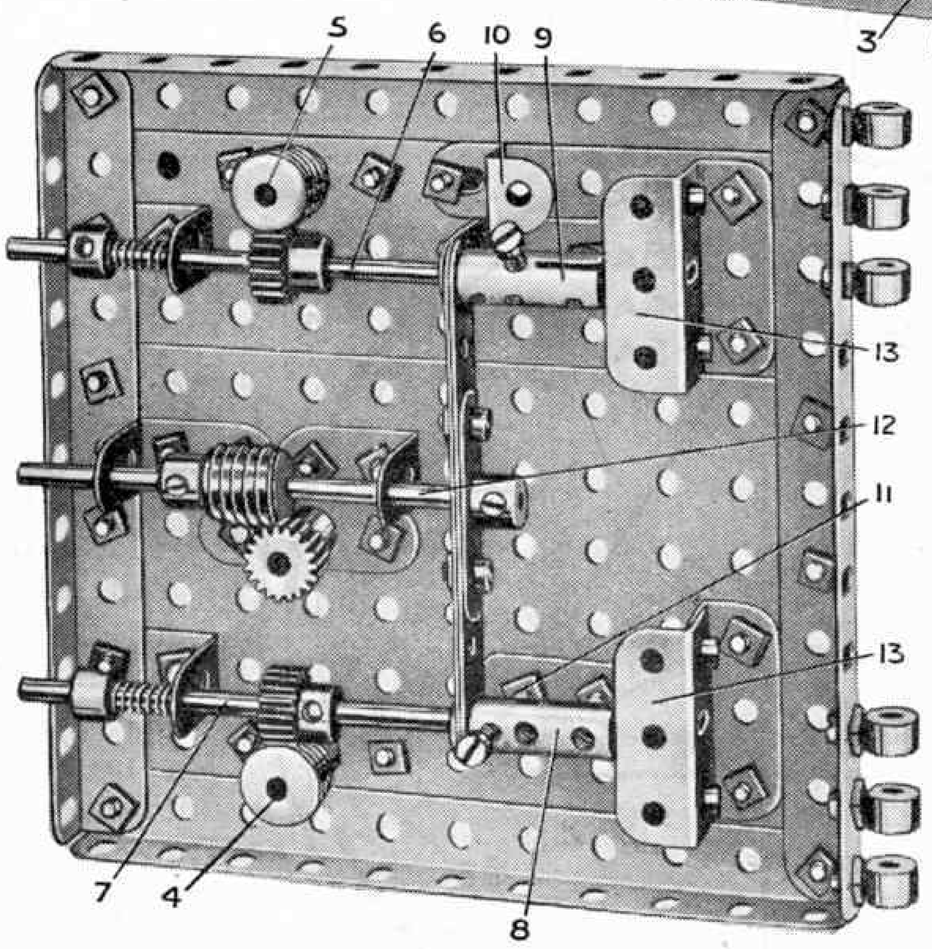


Fig. 129a. Reverse Side of Door

In order to bring the Strip Couplings to the required positions it might be necessary, for example, to revolve the dial 1 ten complete turns and a fraction of a turn, say to the third division, while the dial 2 might have to be rotated only a fraction of a turn.

When the door is closed again and the handle 3 released, the bolts 6, 7 and 12 are shot back into the bolt holes in the jamb of the safe by means of the Compression Springs placed on each of the bolts 6 and 7. The positions of these Compression Springs are indicated clearly in Fig. 129a.

It should be an easy matter to build a very interesting and efficient model safe incorporating this lock mechanism. The two sets of Collars shown attached to one side of the door form sections of the hinges, and corresponding sets of Collars should be secured to the safe. A built-up hinge of this type was illustrated and described under Suggestion No. 107 (see December, 1927, "*M.M.*").

The construction of Meccano lock mechanism provides endless opportunities for the exercise of one's inventive abilities, and we hope many Meccano boys will be prompted by this model to design a lock according to their own ideas. It should not be impossible to build a Meccano safe that would be practically burglar proof.

(130)—Model of Dual Control for Aeroplanes

(M. & S. Falkof, Johannesburg)

The model illustrated in Fig. 130 demonstrates the principles of aeroplane "dual control" gear. The mechanism may be fitted—perhaps with slight alterations—into any Meccano aeroplane of fair size. The purpose of dual control is, of course, to enable two people to control an aeroplane simultaneously or independently from different driving positions. Obviously such an arrangement is invaluable in teaching beginners how to fly.

The joysticks 1 are held in the bosses of Fork Pieces, which are bolted to pairs of 2½″ Strips 2. Each pair of the latter is free to pivot on two Bolts 3 inserted in opposite sides of a Collar (new style) secured on the Rod 5. This Rod 5 is journalled in upright 3″ Strips secured to the frame of the model, and the lower ends of the two joysticks are connected pivotally together by the 5½″ Strip 4, the connections being made by lock-nutted bolts (see Standard Mechanism No. 263). Hence a movement in any direction imparted to one of the joysticks must be reproduced exactly in the other.

The two wires from the elevators are secured to the rearmost joystick, one on each side of its fulcrum. Therefore, by moving the joysticks forward or backward the elevators, which are small hinged planes on the tail of the machine, are actuated, and thereby the aeroplane is caused to dip or rise according to the direction in which the joystick is moved.

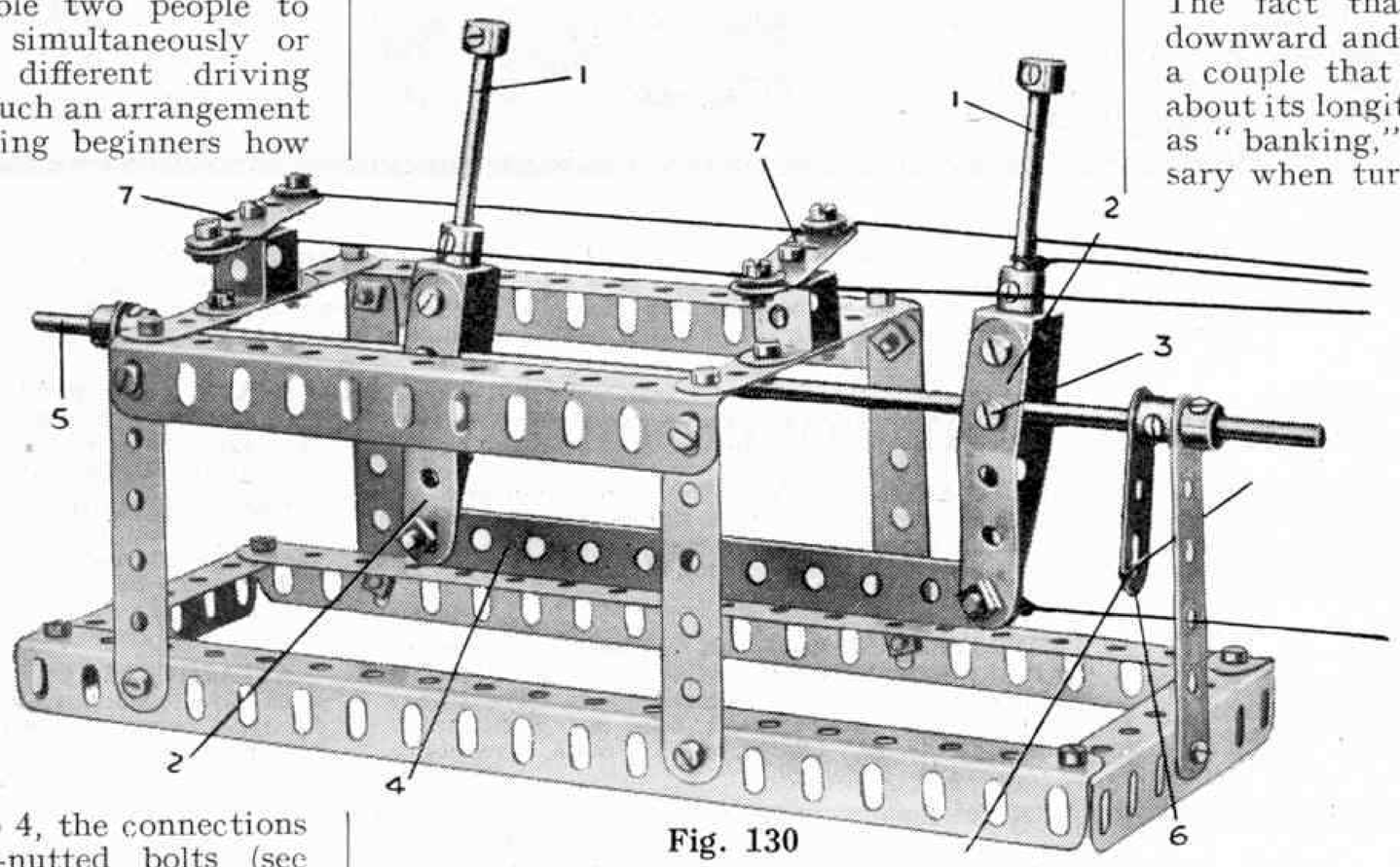


Fig. 130

The wires from the ailerons are attached to the Crank 6. The ailerons are small planes pivoted to the trailing edges of the outer ends of the main planes, each aileron extending about one third of the length of each main plane. Each wire is attached to the underside of its respective aileron, and a third wire, not included in the illustration, is connected between the top sides of the ailerons, so that when one of the latter is pulled down by the wire from the Crank 6, the other is pulled upward by the action of the wire that is attached to the upper surfaces of both ailerons. The fact that one aileron is inclined downward and the other upward produces a couple that tends to roll the machine about its longitudinal axis. This is known as "banking," a manœuvre that is necessary when turning the machine in either direction. It is also necessary to operate the ailerons frequently while the machine is in flight, in order to maintain equilibrium.

In a biplane, which has a double set of main planes, there are four ailerons, of course. In this case each of the ailerons on the top wings is connected to its corresponding aileron on the bottom wing by tension wires, so that each pair of ailerons work in unison.

The rudder bars 7, which the pilot operates with his feet, are connected to the rudder by two wires. The bars are represented by 2½″ Strips mounted pivotally by means of bolts and nuts (S.M. No. 262) on Double Bent Strips. They are connected by wires so that each must follow the movement of the other.

Miscellaneous Suggestions

Under this heading "Spanner" replies to readers who submit interesting suggestions regarding new Meccano models or movements that he is unable to deal with more fully elsewhere. On occasion he offers comments and technical criticisms that, he trusts, will be accepted in the same spirit of mutual help in which they are advanced.

(M.21). Measuring Meccano Parts.—Richard Manchée (West Molesey) points out that a paper foot rule pasted along an edge of a Meccano Outfit carton will prove a great convenience to all model-builders who are not yet thoroughly familiar with the various lengths and sizes of the Meccano parts. A paper rule suitable for the purpose will be found on the back of each issue of "Tit-bits" or "Answers."

(M.22). Automatic Gear Change.—P. Kent (Bridgford) sends in an ingenious idea for changing gear automatically. The pivoted gear lever is thrown over at pre-arranged intervals by means of a series of Dredger Buckets mounted on an endless Sprocket Chain that is actuated by the driving mechanism of the model. The Buckets are reversed—that is, they are secured with their open sides against the chain. Hence in moving round with the chain they act as cams in raising the lever. The idea is good but somewhat cumbrous. Much the same result could be obtained by using a built-up cam on the lines of that described under Standard Mechanism No. 266.

(131)—Novel Square-Hole Drill

(S. Boothby, Stoke-on-Trent)

The model shown in Fig. 131 represents a tool specially designed for drilling square holes. A tool of this description was illustrated in the "*M.M.*" for October 1926 (see "Our Busy Inventors" section).

Each side of the body of the drill is composed of two 7½″ and two 5½″ Angle Girders overlapped one hole and spaced apart at one end by a 1½″ Angle Girder which, in turn, is secured to two 5½″ Flat Girders laid face to face. The Angle Girders are braced at the centre by means of 1½″ Flat Girders, one of which forms, together with a Double Bent Strip bolted to it, the bearing for the 1½″ Rod that carries the 3″ Pulley 5. A 3″ Strip bolted to this Pulley 5 has a Crank secured to its outer extremity, and a 1½″ Rod, which is held in the boss of the Crank, carries five ½″ loose Pulleys that form a convenient handle by means of which the four circular saws may be operated.

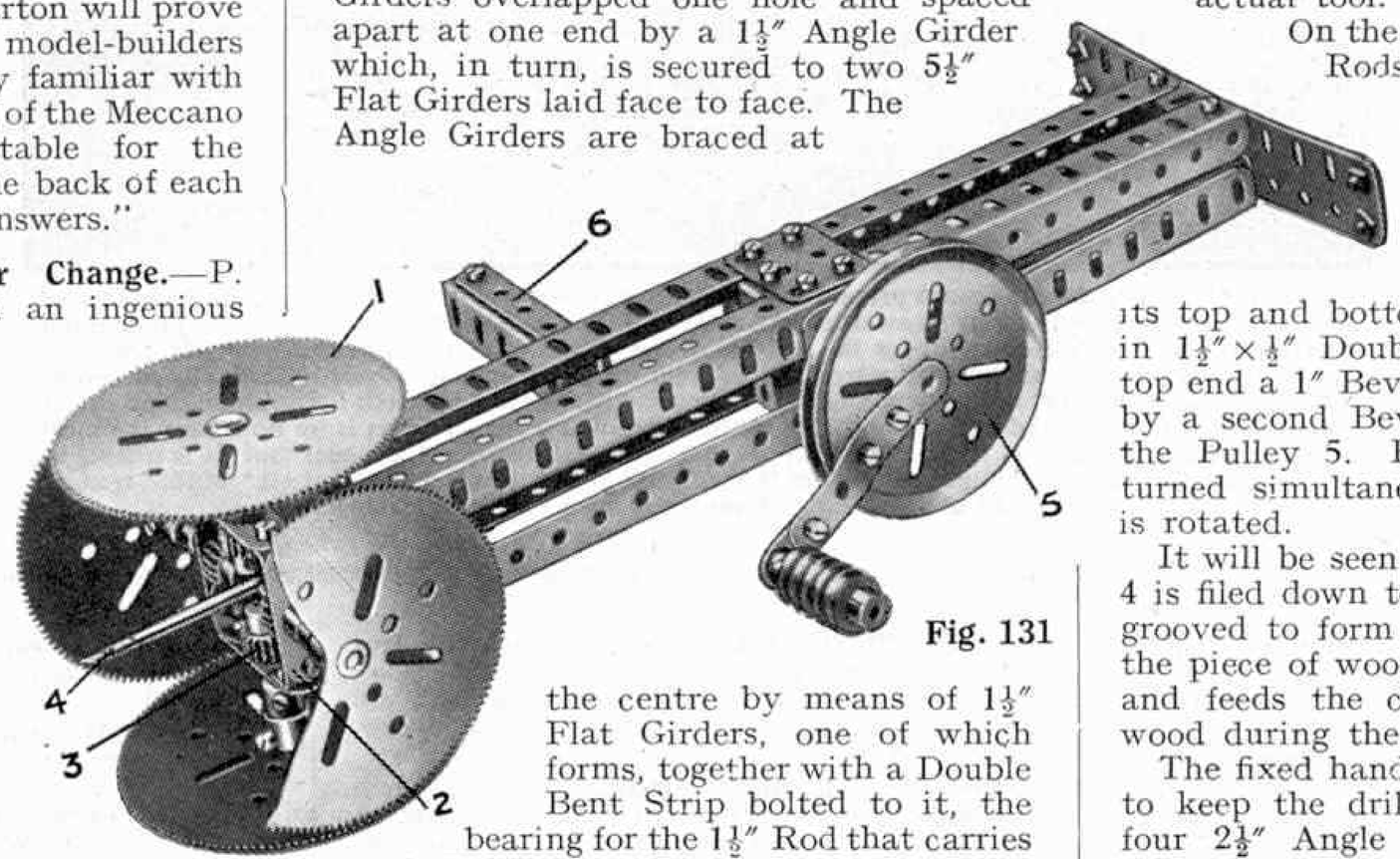


Fig. 131

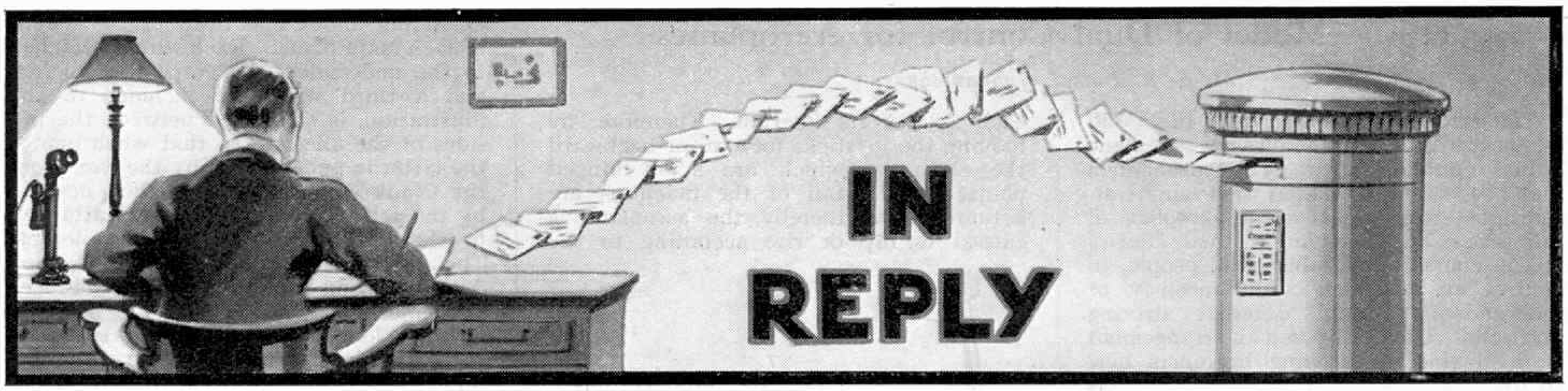
Four 1½″ Strips are bolted in the form of a square between the bottom ends of the 7½″ Angle Girders, each Strip having a Double Arm Crank secured to it. The latter form the bearings for the 1½″ Rods to which are secured the 3½″ Gear Wheels 1, which represent the circular saws of the actual tool.

On the inner end of each of these Rods a ½″ Pinion is secured, and all four Pinions engage with a 1½″ Contrate Wheel on the 11½″ Rod 4. The latter is journalled in the centre of the model, its top and bottom ends being supported in 1½″ × ½″ Double Angle Strips. At its top end a 1″ Bevel is secured and engaged by a second Bevel on the Rod carrying the Pulley 5. Hence all four saws are turned simultaneously when the handle is rotated.

It will be seen that the end of the Rod 4 is filed down to a gimlet-like point and grooved to form a drill. This bores into the piece of wood that is to be cut away and feeds the circular saws 1 into the wood during the process of cutting.

The fixed handle 6 enables the operator to keep the drill steady. It consists of four 2½″ Angle Girders bolted together to form a post of square section and is secured to the sides of the 7½″ Angle Girders by ½″ × ½″ Angle Brackets.

The operator holds the tool against his chest and steadies it with his left hand by holding the post 6, while turning the handle 5 with his right hand.



In these columns we reply to suggestions regarding improvements or additions to the Meccano and Hornby Train systems. We receive many hundreds of such suggestions every week, and consequently we are able to publish only ideas that show particular interest or ingenuity. Suggestions submitted for consideration in this section must be written on separate sheets of paper and the name and address of the sender must appear on each sheet used. Envelopes should be addressed to "Suggestions," Meccano Ltd., Binns Road, Liverpool.

Suggested Meccano Improvements

CATERPILLAR TRACK.—A small plate having a clip attached to its under surface, when used in conjunction with the Sprocket Chain, would certainly enable caterpillar track to be built up. Your idea will receive consideration. (*Reply to J. Moon, Stonehouse, Glos.*)

NEW SPRING CLIP.—An extra long Spring Clip could no doubt be used as a coupling for two Rods. Your idea is interesting and will receive attention in due course. (*Reply to N. Campey, Liverpool*).

SPECIAL SAWS—Special steel saws perforated with standard Meccano holes would be useful in such models as the Stone Sawing Machine, Vertical Log Saw, etc. Their introduction is hardly necessary, however, as ordinary hack saw blades can be used quite effectively, and are easily obtainable. (*Reply to A. Godfrey, Nairobi, Kenya Colony*).

IMPROVED WINDING KEY.—The usefulness of the winding key might be increased considerably if the keyed portion were enlarged for a short distance so that it might fit over a standard nut. Your idea will receive attention. (*Reply to S. D. Barton, Wolverhampton*).

INTEGRAL FRONT AXLE.—A special front axle for incorporation in the Meccano Motor Chassis is not a suitable addition, as this article can quite easily be built up from existing parts. (*Reply to E. N. Gooch, Hove*).

WASHERS FOR 6 B.A. BOLTS.—Metal washers would no doubt find many uses in electrical models and your idea will be given further thought. (*Reply to R. D. Simonds, St. Leonards-on-Sea*).

24½" STRIP.—It would be impracticable for us to introduce this article as it would be very unwieldy. (*Reply to A. Helliwell, Bradford*).

LARGER RATCHET WHEELS.—Your suggestion regarding a larger edition of the Ratchet Wheel (part No. 148), is receiving consideration and a further announcement will appear later. (*Reply to R. D. Eyles, Wellingborough*).

NEW CRANK.—To substitute a circular hole in place of the elongated one already stamped in the Crank, Part No. 62, would no doubt increase its efficiency in certain models. The existing Crank is however, more adaptable. (*Reply to C. J. Jamison, Sydney, Australia*).

FRICTION GEAR.—There is no necessity for us to introduce special accessories for frictional gearing, as by using Pulley Wheels fitted with Rubber Rings, many gear ratios can be obtained. Incidentally, a Friction Gear Mechanism was described in the Suggestions Section of the July, 1926 "*M.M.*" (*Reply to J. E. Kennett, Peterborough*).

BACK AXLE CASING.—We were interested in your suggestion, but do not think its manufacture advisable, as apart from its application to motor chassis, few uses would be found for it. (*Reply to O. Gilmore, Auckland, N.Z.*)

IMPROVED BOLT.—If an additional slot were cut in the head of the standard bolt it would no doubt simplify model-building in certain cases. The slight advantage that would result does not justify this addition, however. (*Reply to P. French, Brighton*).

IMPROVED PIVOT BOLT.—Your suggestion that the enlarged portion of the Pivot Bolt (part No. 147b), should be increased in length, is interesting and will receive careful attention. (*Reply to E. Worthington, S. Vancouver, B.C.*)

NEW DOUBLE BENT STRIP.—A Double Bent Strip somewhat larger than part No. 45, would no doubt find several uses in the system. It should be quite possible, however, to build up this article from existing parts. (*Reply to H. L. Edwards, Cheltenham*).

IMPROVED RACK STRIP.—We are unable to see any advantage that would result from shortening the Rack Strip. The majority of suggestions received regarding improvements to this part have favoured lengthening it! The cutting of slots in the existing article would no doubt improve its adaptability. (*Reply to H. H. Miles, Southampton*).

SMALL SAND ROLLERS.—Very few uses could be found for a small Sand Roller such as you suggest. We cannot therefore consider its introduction. (*Reply to E. Ginns, Desborough*).

NEW COUPLINGS.—We were interested in your suggestion that the ends of the standard Axle Rods should be alternately fitted with a plug and socket. This would form a particularly neat coupling for two Rods, but its strength would not be very great. (*Reply to D. Harris, Northfield, Birmingham*).

ATTACHMENT FOR WINDING KEY.—A standard Rod terminating in a box portion which could be fitted over the winding spindle of the Clockwork Motor would find very few uses if incorporated in the system. Its manufacture is not therefore advisable. (*Reply to P. Pottier, Purley*).

MECCANO DYNAMO.—We find it impossible to give consideration to the manufacture of a Meccano dynamo for some time yet. (*Reply to S. W. Hardisty, Cockermouth*).

2" ARTILLERY WHEEL.—We consider that the present range of wheels is quite comprehensive and we do not therefore think that your suggested 2" wheel is a necessary addition. (*Reply to F. Marquand, Woodville, N.Z.*)

PETROL TANKS.—You will find that the new Meccano Boiler forms a most effective petrol tank when fitted to motor tank lorries. (*Reply to Tony Denton and S. Swanson, Barnsley*).

IMPROVED CRANK.—We note that you have experienced difficulty in fastening the Double Arm Crank to a Plate as a portion of the boss prevents the Crank from lying flat. This difficulty can be overcome by "bolstering-up" each end of the Crank by means of a Washer. (*Reply to D. Garnett, Bournemouth*).

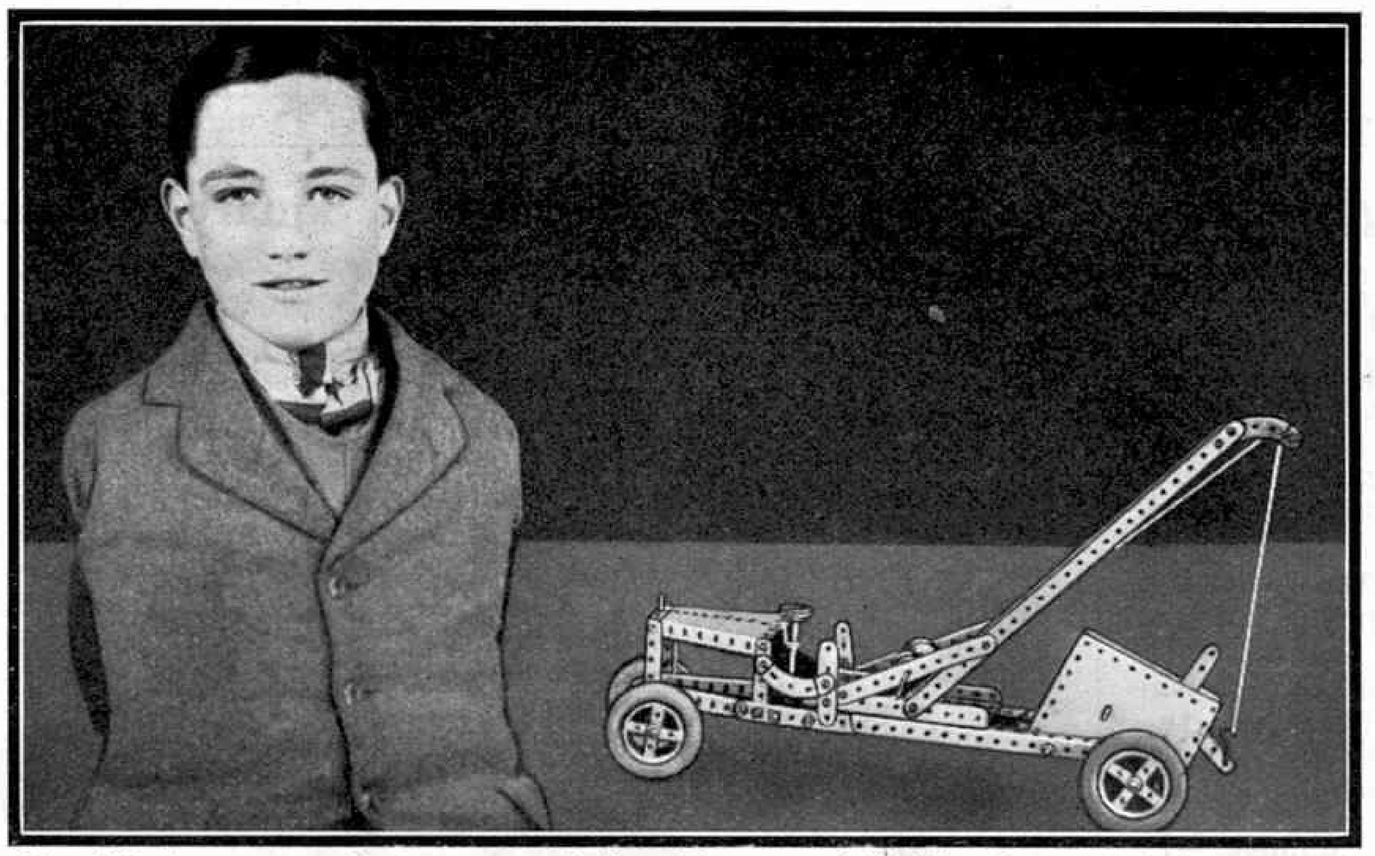
WIND SCREENS.—Apart from their application to model motor cars, few uses can be found for these articles. With a little ingenuity it should be quite possible to devise model windscreens from standard Meccano parts and small pieces of celluloid, mica, etc. (*Reply to N. Campey, Liverpool*).

IMPROVED SAW.—We note that you consider that the teeth of the Circular Saw (part No. 159) should be "set." We doubt whether it will be possible to do this but we shall consider your suggestion carefully. (*Reply to D. Garnett, Bournemouth*).

MECCANO PENCILS.—Pencils having the word Meccano stamped upon them would be popular among Meccano boys. Your idea is receiving attention. (*Reply to F. Marquand, Woodville, New Zealand*).

CIRCULAR CUTTER.—A circular cutter is hardly a suitable part for inclusion in the system. The Circular Saw should fulfil nearly all the uses of your proposed accessory. (*Reply to J. Jones, Victoria, Australia*).

A MODEL BUILDER WITHOUT ARMS!



The spirit of perseverance is always present in keen Meccano model-builders, but we think the honour of being the pluckiest should surely be awarded to A. Myers of the Lichfield Meccano Club, whose photograph appears above. Myers labours under the terrible disadvantage of being armless. Probably few boys with such a handicap would think of attempting to build with Meccano, but Myers has actually succeeded in building a large number of excellent models, by means of his feet and his teeth! The photograph shows a model of a Motor Breakdown Crane that is entirely his own work, and this is by no means the most elaborate model that he has built. The only stage in the construction of a model that he is unable to carry out unaided is the final tightening up of the nuts and bolts. We feel sure that all "M.M." readers will join us in wishing Myers every success with his hobby.

Suggested Hornby Train Improvements

LOOSE LINK COUPLINGS.—Your suggestion that we should introduce loose link couplings to all Hornby goods rolling stock is interesting, though unfortunately, not practicable. We considered a similar idea previously and carried out experiments with wagons fitted with such couplings. We found that they very easily became derailed at the curves, owing to the buffers interlocking, whereas when the same operations were carried out with other wagons fitted with our present standard couplings, no accidents of this kind occurred at all. (*Reply to P. B. Hunt, Crowborough, Sussex*).

OUTSIDE THIRD RAIL.—We have received letters from several readers asking us to introduce the outside third rail electric feed system. This system is certainly interesting but we do not see that it has any practical advantages over the present system and therefore we do not propose to make the change. (*Reply to D. H. Heaps, Hastings*).

NEW TENDER.—Although the "Flying Scotsman" has always had an eight-wheeled tender, we do not consider it advisable to manufacture one of this kind for our models. It will be remembered that the tender of the "Scotsman" has a rigid wheelbase, and therefore we very much doubt whether a model of it would give satisfactory running on curves. (*Reply to G. Hardwick, Sydney, N.S.W.*)

SLEEPER WAGONS.—Our No. 1 Timber and Lumber Wagons are both well adapted to the transport of sawn wood, such as sleepers. We know of no particular type of goods vehicle termed a "Sleeper Wagon." (*Reply to G. T. Dane, Winchester*).

CAST WHEELS.—Enthusiasts desiring to fit their rolling stock with cast wheels can now purchase Hornby "Mansell" wheels for 4d. per pair. It is hardly necessary to say that the superior smooth running of coaches fitted with cast wheels is very noticeable. (*Reply to H. Hopkins, London, N.W.6*).

DETONATORS. — It would be practically impossible to manufacture detonators that would explode when the leading wheels of a locomotive ran over them. A method that used to be adopted by some manufacturers was that of fitting to the side of the rail a lever which when tripped by a passing locomotive liberated a spring and thus brought about the explosion of a small gunpowder cap. The mechanism in fact was very similar to that found in a cheap toy pistol. The apparatus was very unrealistic in appearance and we are sure that it would not appeal to Hornby enthusiasts. (*Reply to G. T. Dane, Winchester*).

YELLOW DISTANT SIGNALS.—We do not propose to introduce yellow distant signal arms at present. The idea will not be lost sight of, however, and if it is decided to adopt it an announcement will be made in the "*M.M.*" (*Reply to A. J. Bournheim, London, E.7, and B. Graves, Taunton*).

CONTAINERS.—This is a good idea. The 'container' is certainly becoming very popular in the transport of big consignments of goods from consignor to consignee in actual railway practice, and we feel that it would make a very interesting model. We will give this matter serious consideration. (*Reply to H. Parcell, Newcastle-on-Tyne*).

COLOURED DOMES.—You will be pleased to hear that in future Hornby locomotive domes and smoke-boxes are to be coloured in correct accordance with actual railway practice. (*Reply to C. M. Fidler, Yarmouth, Yorks., and P. Lyth, Newcastle, Staffs.*)

CATTLE PENS.—We are examining the possibilities of introducing model cattle pens at some later date. (*Reply to J. H. Holmes, Birkenhead, and P. Carr, West Hartlepool*).

ELECTRIC SIGNALS.—Very realistic electrically-operated signals can be made from Meccano. Full instructions for constructing one of these were given in the March 1927 issue of the "*M.M.*," on page 245. (*Reply to A. A. Clarke, London, E.6*).

GROUND DISC SIGNALS.—We are experimenting with a model of a ground disc signal of the latest type used on actual railways. We hope to make an interesting announcement in this respect soon. (*Reply to E. E. Lambert, Birmingham*).

CONTROL PARALLEL POINTS.—We hope before long to be able to supply parallel points fitted for control. (*Reply to O. Macnamara, Oxford*).

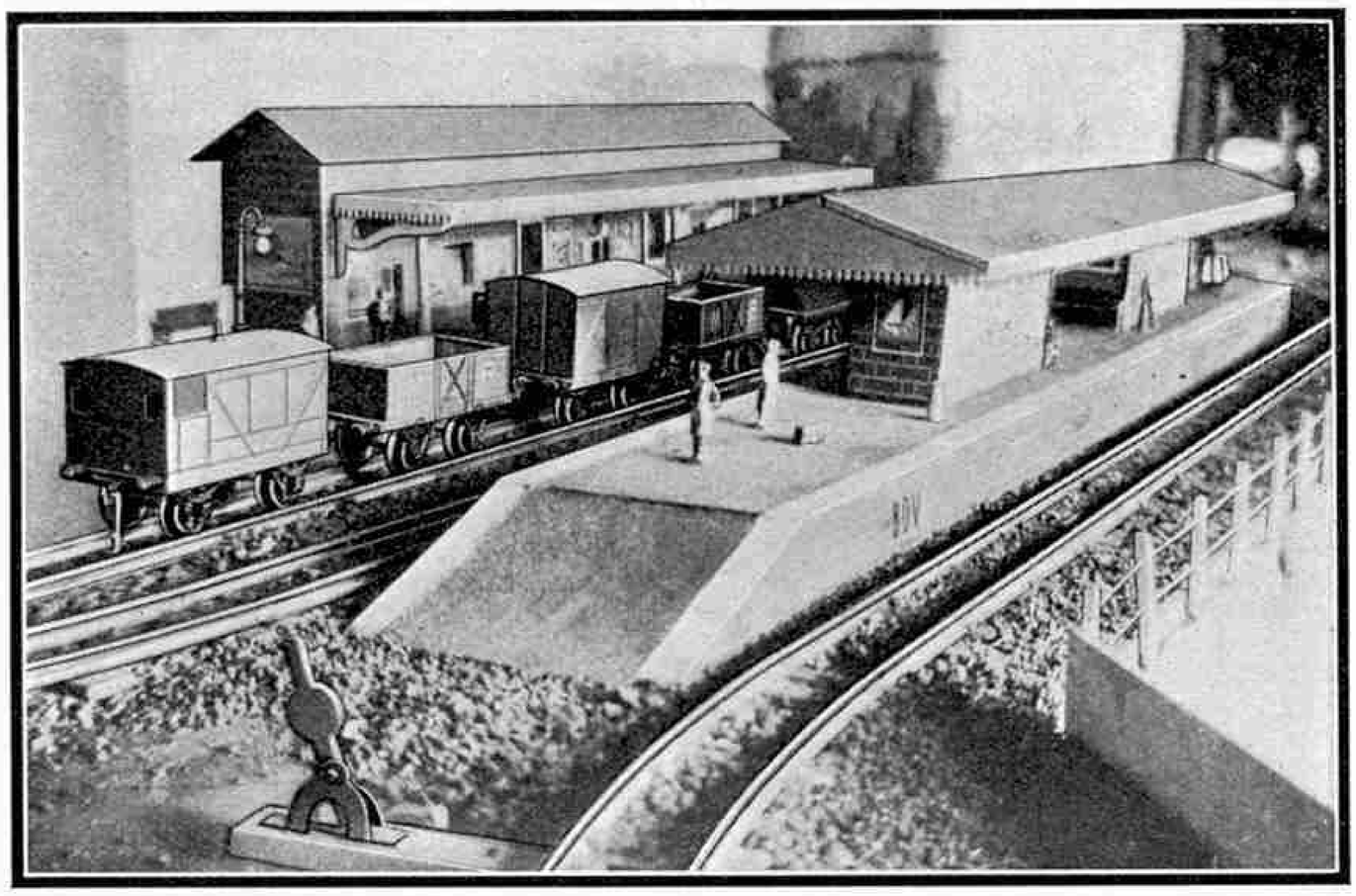
EMPIRE TRAINS.—Our correspondence shows that comparatively few Hornby Train enthusiasts are anxious for the introduction of "Empire" trains. For the time being we do not propose to introduce C.P.R. models. (*Reply to R. Boden and R. Keay, Richmond*).

COACH LIGHTING.—Your idea regarding the lighting of coaches by means of lamps covered with luminous paint is certainly interesting but we are afraid impracticable. Luminous paint would not give anything like sufficient light to be satisfactory and in any case this would only be seen in the dark. (*Reply to M. H. S. Baker, Tetbury*).

DOUBLE ROAD STATION.—Such a station is, of course, a very desirable feature in a layout but it would be a very expensive item to manufacture specially. If you have two standard platforms it is a simple matter to make a two-way station by placing one on each side of the track. (*Reply to C. Abbey, Swansea*).

EIGHT-COUPLED LOCOMOTIVES.—Locomotives with eight-coupled wheels would be quite unsuitable for the majority of gauge "0" layouts owing to their extremely long rigid wheelbase. We are afraid, therefore, that the idea is impracticable. (*Reply to C. Machine, Johannesburg*).

REALISM IN MODEL RAILWAYS



Hornby railway enthusiasts will agree that the portion of a model railway layout shown in our photograph is a fine example of realism. The railway belongs to Cyril Vincent of Ipswich, who has modelled his line on the Great Eastern section of the L.N.E.R.

Many details contribute towards the realistic effect, and of these, four are particularly important. In the first place the track is ballasted. All those who have tried ballasting their track know that this is an effective remedy for the locomotive malady known as "wheel slip," and it is beyond dispute that a ballasted track is ideal for displaying to the best the smooth running qualities of Hornby locomotives. The second point is that the station platforms are given a certain amount of life by the introduction of the figures. Thirdly, the advertisements add greatly to the appearance of the platforms, giving them something of the distinctive look of real railway stations. It is interesting to note that these advertisements were cut from old magazines and therefore cost nothing. The last item to be mentioned is the railings on the right, which give a very tidy and finished appearance to the layout and add considerably to its attractiveness.

MINIATURE STATION STAFF.—We agree that miniature figures of railway officials add greatly to the realism of a model station. We have considered the introduction of such figures and it is possible that we may introduce them at a later stage. (*Reply to N. Campey, Liverpool*).

BOGIE PASSENGER COACHES.—Your suggestion that we should manufacture bogie passenger coaches is interesting. At the same time we consider that our Metropolitan coach is quite a realistic model of the standard type four-wheeled bogie coach as used by real railways. We suggest that a train of these coaches would satisfy your requirements. (*Reply to E. H. Williamson, Birmingham*).

CORRIDOR CONNECTIONS FOR "M" COACHES.—We quite appreciate your desire to have corridor connections but we do not think it would be possible to fit these to the "M" coaches with any approach to realistic effect. (*Reply to T. Simpson, Belfast*).

ENTRANCE HALL TO STATION.—The cost of the Windsor Station would be considerably increased if we were to make an open entrance hall such as you suggest. For this reason, although we agree with what you say regarding appearance, we cannot make a change, at any rate at present. (*Reply to J. Dowland, Hastings*).

LONGER PASSENGER COACHES.—By 'passenger coaches' we presume you are referring to the No. 1 Coaches. See our reply to "Bogie Passenger Coaches" on this page. (*Reply to R. Kirkby, Sutton, Surrey*).

BANANA VANS.—We agree that vans of this type would prove very popular. We are filing your idea for further consideration. (*Reply to R. D. Johnson, Bournemouth*).

SINGLE DRIVERS.—Locomotives of the 2-2-2 and 4-2-2 wheel arrangements are now almost obsolete on actual railways owing to the limited weight they have available for adhesion. For the same reason a model of this type of locomotive would not be very successful. (*Reply to J. Holt, Huddersfield*).

TWO-SPEED GEAR FOR LOCOMOTIVES.—It is impossible to embody a two-speed gear in the present type of Hornby mechanism and therefore we are afraid that we cannot consider your suggestion. (*Reply to A. Davies, Northampton*).

STEEL RAILS.—There is a very small demand for scale model steel chaired track. In any case the present type of Hornby tin-plate track is very serviceable, and our correspondence with Hornby enthusiasts tells us that it gives very realistic and satisfactory results, especially when ballasted. (*Reply to R. Bowden, and R. Keay, Richmond*).

MODEL AMBULANCE COACHES.—We sincerely hope that the need for models of this kind is not very often felt among Hornby enthusiasts! Accidents will happen, however, even on the best organised model railways, and where a bad one occurs we suggest that the nearest passenger coaches should be brought into use without delay. (*Reply to H. B. Harrison, Birmingham*).

PRIVATELY OWNED WAGONS.—We thank you for suggesting a way out of the difficulty of introducing well-known privately-owned wagons. We agree that wagons marked Meccano Ltd. would be popular, and at the same time universally known. We are filing the matter for further consideration. (*Reply to T. Edwards, Huddersfield*).

INTERLOCKING LEVER FRAME.—We are afraid that a lever frame of this kind would be far too expensive to be popular. It should be possible for keen Hornby railway owners to devise interlocking systems for themselves. (*Reply to D. Slade, Redhill, Surrey*).

WHEEL FLANGES.—The new die cast 'Mansell' wheels include flanges of very much more realistic proportions than those of the ordinary pressed metal wheels. It will be readily realised that it is necessary to include larger flanges on the lighter types of wheels. (*Reply to C. Fox, Wavertree, Liverpool*).

Results of Meccano Model-Building Contests

By Frank Hornby

"February" Competition, Home Sections

THE following list gives the names of the principal prize-winners in Sections A and B of the special "February" Model-building Competition. The results in the Overseas Section will be announced later.

Section A (for competitors over 14 years of age).

FIRST PRIZE (cheque to value £3-3s.): S. Riley, Stowmarket, Suffolk. SECOND PRIZE (cheque to value £2-2s.): Leslie Hope, Weston-super-Mare, Somerset. THIRD PRIZE (cheque to value £1-1s.): W. D. Cripps, The Grange, Kensworth.

SIX PRIZES, each consisting of Meccano products to value 10/6: A. E. F. Spence, Levenshulme, Manchester; B. Unné, Harrogate, Yorks.; W. L. Almond, Harrogate; W. Haggar, East Ham, E.6; Stanley Batchelor, Crofton Park, S.E.4; Ian Jamieson, Langside, Glasgow, S.1.

TWELVE PRIZES, each consisting of Meccano products to value 5/-: P. W. Clempson, Hayes; C. Johnson, Tunbridge Wells; J. Hopper, Harrogate; George Wood, Upper Holloway, N.19; John Bliss and Victor Millar, Brixton, S.W.9; C. Jenkins, Fulham, S.W.6; C. P. J. Crawley, Peterborough; T. Pope, Rochester; E. Whatley, Manchester; James Wilson, Aberdeen; J. Redfern, Salford, near Manchester; H. A. Davies, Abergele.

SPECIAL COMMENDATION (Certificate of Merit and Standard Mechanisms Manual): W. H. Williams, Treharris, S. Wales; J. Guy, London, S.E.14; N. Lishman, Burneside, Westmorland; R. Wardle, Coxhoe, Durham; V. B. Harris, Hastings; J. Thompson, Glasgow; Jack Senior, Cleckheaton, Yorks.

Section B (for competitors under 14 years of age):

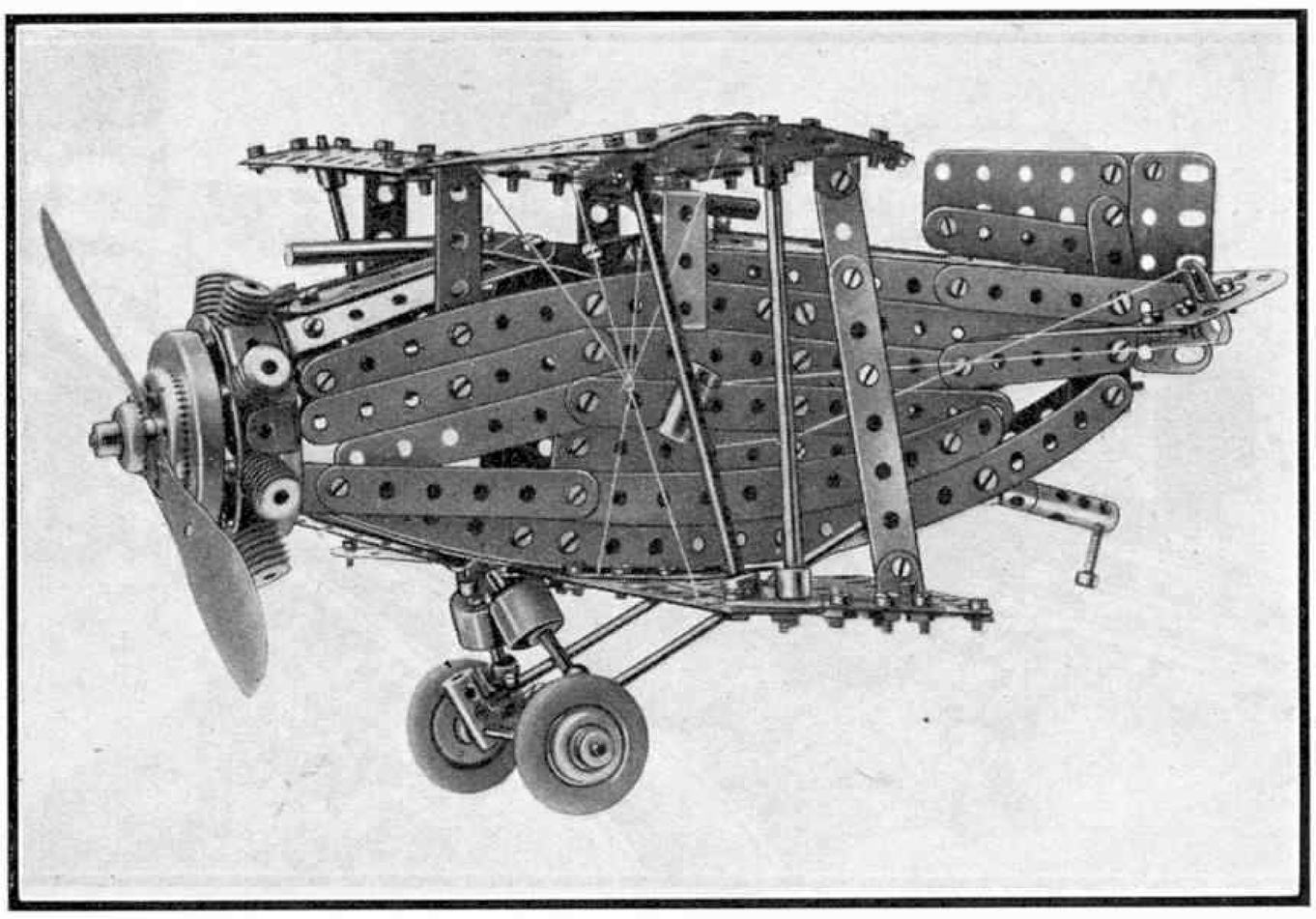
FIRST PRIZE (cheque to value £2-2s.): R. L. Houlding, Esher, Surrey. SECOND PRIZE (cheque to value £1-1s.): M. Berry, Wanstead, London, E.11. THIRD PRIZE (cheque to value 10/6): Alan D. Horton, Birchfield, Birmingham.

SIX PRIZES, each consisting of Meccano products to value 5/-: B. A. Bowles, Southall, Middlesex; Brian Way, Colchester; M. Jones, Barking, Essex; E. Oakes, Winchester, Hants; George Chambers, Peterborough; Peter Ray, Alton, Hants.

SPECIALLY COMMENDED (Certificate of Merit and Standard Mechanisms Manual): E. Birch, Northampton; J. Durwin, Finchley, N.3; J. G. Yates, Belfast; R. Horton, Ashford; J. Knowles, Wallasey; E. J. Harris, Richmond; R. M. Latter, Wallingford; Lionel Mackenzie Horne, Whitby; G. Kenneth Holland, Liverpool; W. Riddell, Rowlands Gill, Co. Durham; H. D. Hosegood, South Norwood; E. A Crooks, West Kensington, W.14; W. H. Barber, St. Leonards-on-Sea; Frank Sweetnam, Mallow, Co. Cork; John S. Came, Bridgwater; F. A. Smith, Sheffield; G. F. Clark, Great Missenden, Bucks.; R. Gore, Dingle, Liverpool; L. A. White, Glasgow; J. W. Drinkwater, London, N.21; J. Broadhurst, Prenton, Birkenhead; N. T. Sandbrook, Handsworth; Birmingham; G. Tucker, Laugharne, Carm.

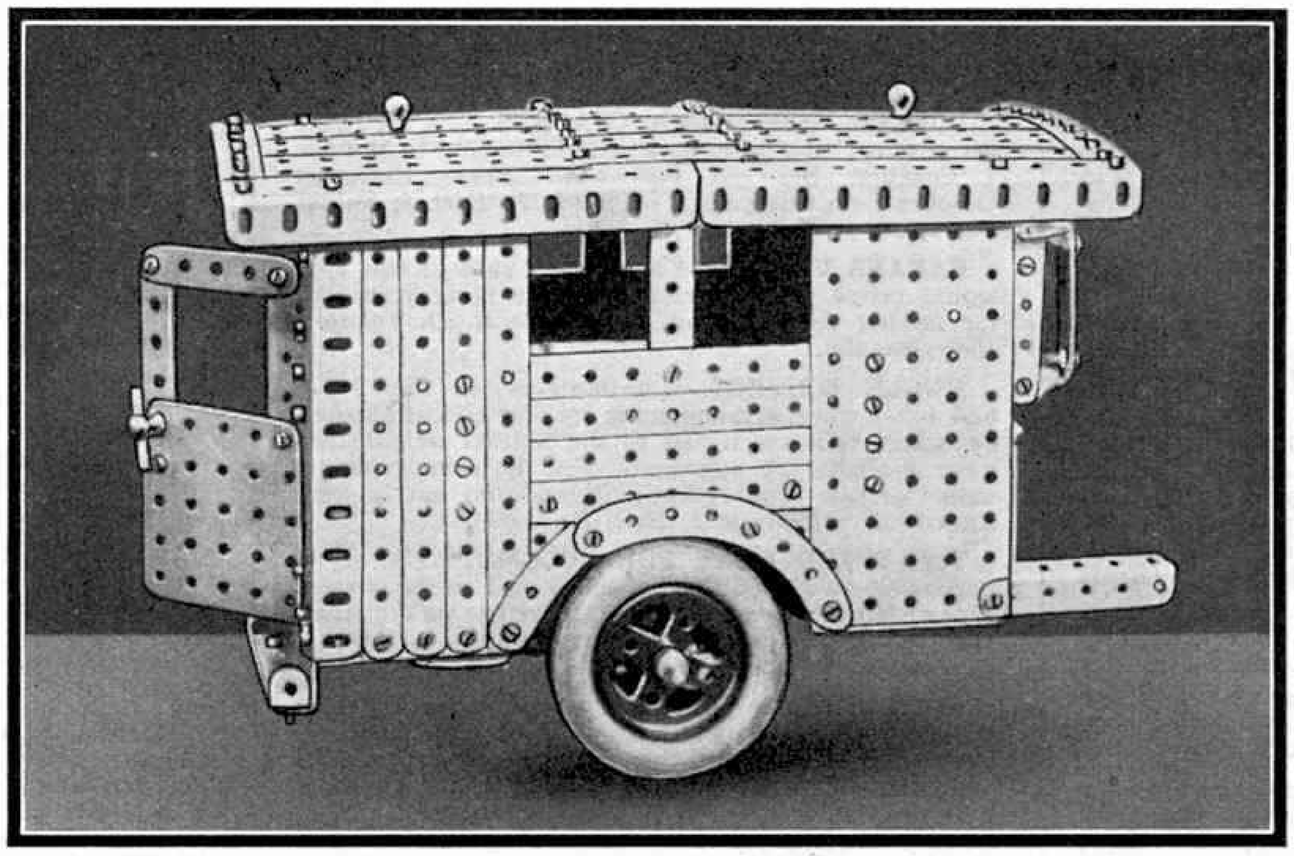
The judges have awarded a number of Certificates of Merit in addition to those listed.

A model of particular merit is the high-speed mixing machine constructed by S. Riley. The model is representative of the latest type of mixer and embodies a circular drum, mounted in a horizontal position, in which spiral blades are rotated rapidly. These "blades" are really Strips, twisted to shape. A belt pulley consisting of two Flanged Wheels butted together takes the external drive to the mixer blades shaft and a belt clutch is fitted so that the mixer mechanism may be thrown in or out of gear. When the material has been completely mixed the motion of the spiral blades is reversed and the "mix" is thus expelled from the container. The model is cleverly designed and well built.



R. L. Houlding's prize-winning model of a "Gloster Gamecock" biplane

Aeroplanes will always prove fascinating to model-builders and the fighting biplane illustrated on this page is a realistic little example of Meccano aircraft. It is the work of R. H. Houlding. The prototype of the model is the well-known "Gloster Gamecock" machine that was fully described in the "*M.M.*" for October, 1926. Those of our readers who have the opportunity to do so, should turn to page 628 of that issue, and the similarity of the model to the original will at once be noted. The construction of the model is by no means perfect, but it represents a very creditable attempt on the part of its builder. The mounting of the engine and propeller and the construction of the undercarriage (complete with shock absorbers) are points of special merit, but the appearance of the aeroplane is spoilt by the assembly of the fuselage. The ends of several Strips in this are left unattached and are placed irregularly.



Meccano Motor Caravan Trailer, by N. J. Berry

Leslie Hope's model, which is illustrated on the opposite page, represents an interesting device installed recently at Plymouth to facilitate the removal of mail bags from the liners to the mail trains on the quayside. The apparatus was fully described on page 1034 of the December, 1927, issue of the Magazine. The model consists of a conveyor frame or gangway built up from Strips and Girders and carrying a conveyor belt that is driven by means of the Clockwork Motor attached to one end of the frame.

One end of the conveyor rests on the ship while the other rests on the dock side. The conveyor is lowered

or raised into position by means of a winch located at the base of the tower, the cord being passed over a 3″ Pulley Wheel at the top of the tower and thence to the "bridle" attached to the conveyor framework. The weight of the conveyor and its Motor, etc., is counteracted by the cage that can be seen on the right in the photograph. This cage should be filled with a quantity of Meccano parts or any other suitable load. When set in motion the model carries Meccano Loaded Sacks, or other miniature merchandise, along the belt in a most realistic manner.

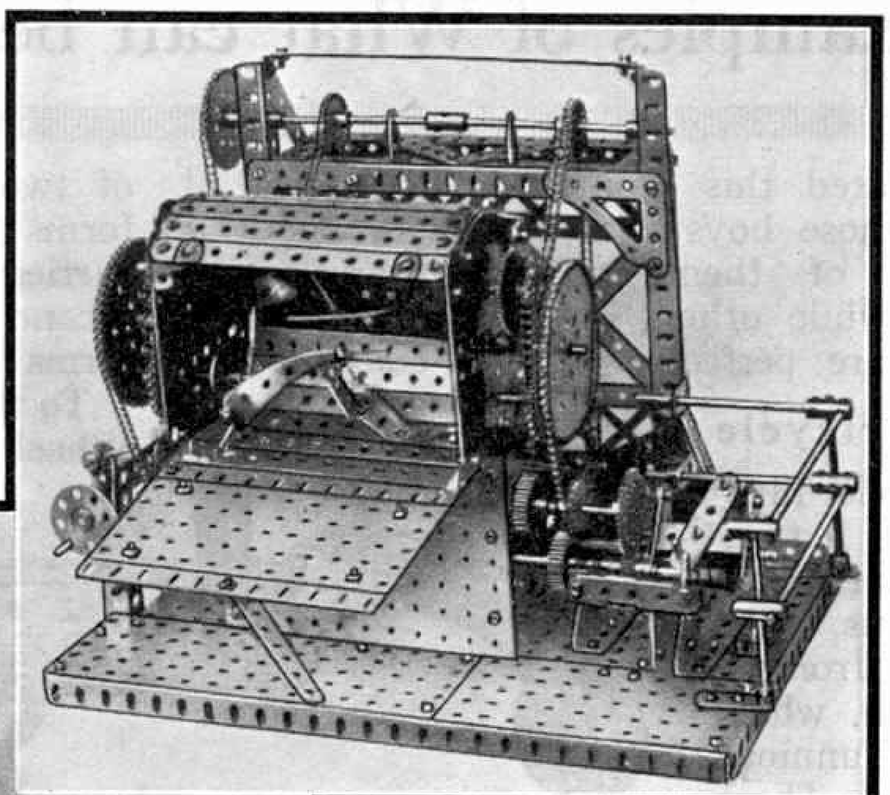
N. J. Berry's interesting entry is also illustrated. It will be seen that it represents a motor caravan trailer. Doubtless readers will have seen many of these caravans drawn by motor cars along the high-roads and by-roads of our countryside. The model includes Dunlop-tyred road wheels, a door and step at the rear, and a bay-window in the front. Attached to the new Meccano Motor Chassis the caravan would form an almost ideal "outfit" for Mr. Meccano and his family when on tour!

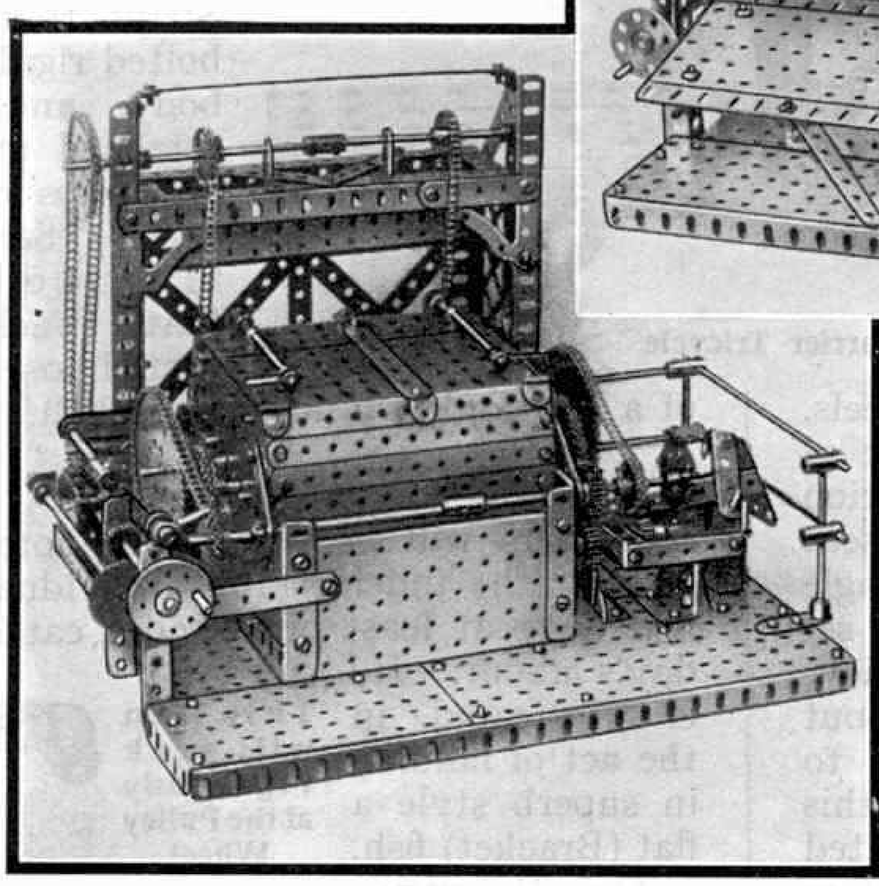
A railway break-down crane formed D. W. Cripp's entry. The crane is pivoted on a base frame that runs on four flanged wheels, and an operator's cab is attached to the rear of the swivelling base of the crane. The model is complete with "match" truck, upon which the jib of the crane rests when the apparatus is transported. In this manner the crane may be passed under bridges or through tunnels, etc., like any other piece of rolling stock.

A model of a "teagle" was sent in by A. E. F. Spence. A teagle is a type of hoist that often can be seen in warehouses and similar places where large packing cases, sacks, etc., have to be transported from the delivery lorries into various parts of the building. The model consists of an upright framework that contains the hoisting winch and the necessary gears. To this is attached an overhead runway which projects over one side of the framework, and in the actual teagle would run the complete length of the building. On the runway a four-wheeled trolley travels backward and forward, and this trolley supports the pulley block and cord. A model of this type should prove most interesting to build and operate.

Amongst other prize-winning entries I noticed another fine model of a biplane—this time of the Handley Page military type. Bertram Unné, its builder, has evidently studied the design of the actual machine most carefully and the resulting production is very realistic. An interesting feature of the model is the navigation lights placed on the extremity of each lower plane. These consist of standard Meccano bulbs and bulb holders held in place by means of Double Bent Strips on the ends of the Angle Girders forming the framework of the lower planes. The aeroplane is fitted with four engines. Two tractor propellers are placed one on each side of the fuselage, at the leading edges of the planes, while two pusher propellers are situated at the rear of the planes, directly behind the first pair.

The model is equipped also with four landing wheels that are connected by means of a Sprocket drive to the Electric Motor placed in the fuselage of the aeroplane. Current for the Motor is supplied by a Meccano 8 amp. Accumulator ingeniously concealed in the centre of the fuselage. Hence the model will run along under its own power even if it will not actually rise in the air! Unné apparently has had some difficulty in building up the fuselage of the machine and the design of this portion of the model could certainly be improved upon. Perfection in model-building (as in every other occupation) is very difficult to obtain, but it is a goal well worth striving for.





Two views of S. Riley's high-speed Mixing Machine

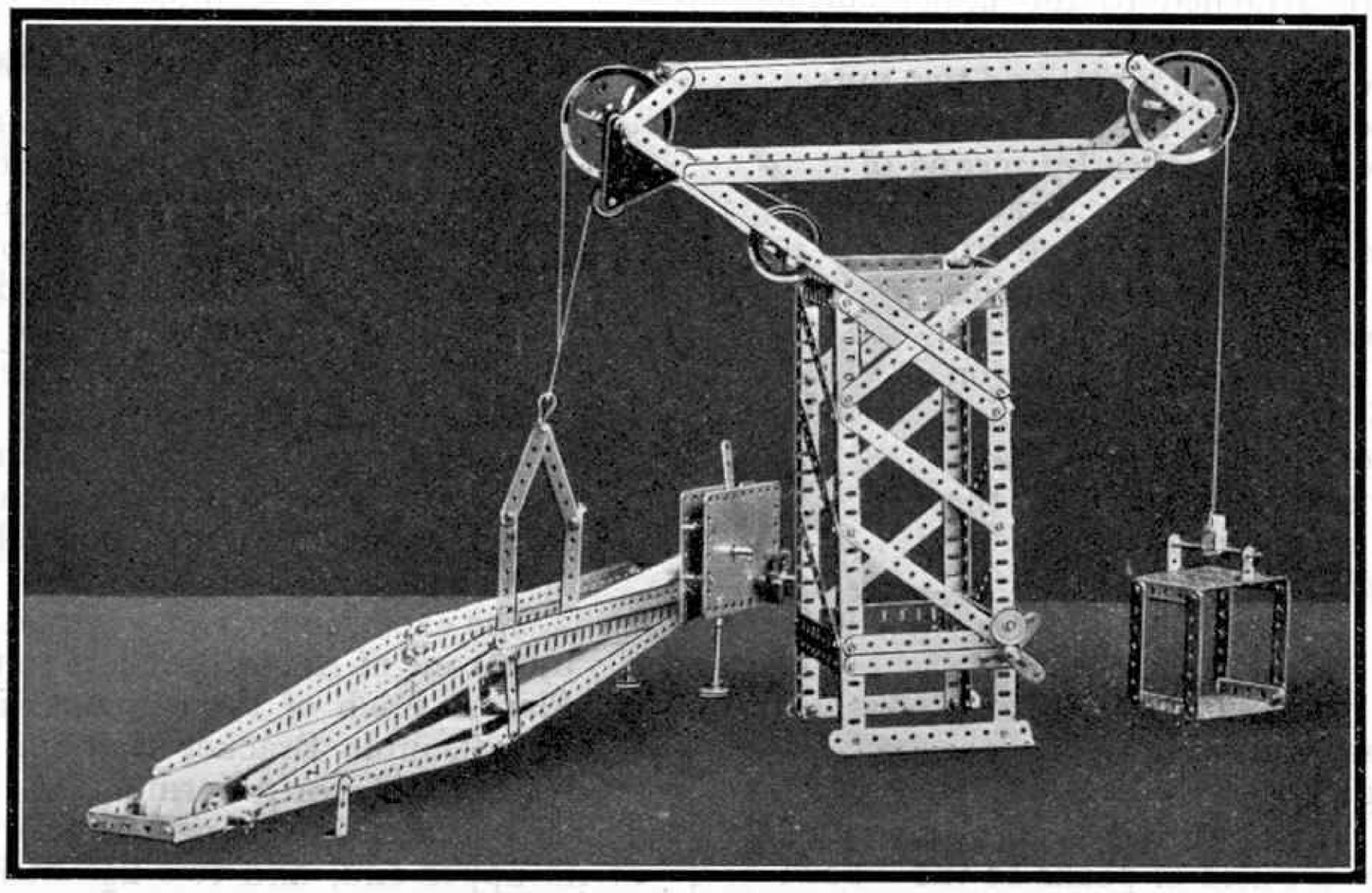
It would be difficult to say whether Capt. Malcolm Campbell's racing car or Major Segrave's is the most popular subject with model builders. In this competition, however, the latter car was the more prominent of the two amongst the entries. Of the prize-winning models of this famous car, those built by W. Haggar, Ian Jamieson, and Stanley Batchelor are worthy of special mention, for they are all built on sound lines and their external appearance closely conforms with that of the original car.

I also noticed a particularly neat model of Capt. Malcolm Campbell's car. Its builder, W. L. Almond, must have expended much time and patience in its construction, for although the complete model measures less than 20″ in length, it contains quite a lot of detail. It is equipped with an ingeniously constructed duplicate steering mechanism. Readers will remember that duplicate steering was fitted to the actual car in order to obtain greater safety when travelling at such enormous speeds as 200 m.p.h. and over!

A model of the "King George V" locomotive, perhaps the most famous of all G.W. engines, was submitted by George Chambers. It is a praiseworthy piece of model-building, and its external appearance conforms very closely with the original.

Fire escapes lend themselves readily to reproduction in Meccano, for all the essential features, such as the sectional ladder and mechanism whereby the escape is raised or lowered as required, can be faithfully reproduced with standard parts. E. Oakes submitted a fire escape attached to an automobile of pleasing design.

Yet another creditable piece of miniature aeronautical engineering was a large model of the famous British seaplane, the winner of the Schnieder Trophy. This model was constructed by M. Jones, of Barking.



Prize-winning model of the continuous-belt Mail Conveyor used at Plymouth. By Leslie Hope

New Meccano Models

Further Examples of What can be Done with a few Parts

THE models illustrated this month should appeal particularly to those boys who own very small Outfits. Several of them include interesting working movements, while others are really amusing when built up. All are perfectly easy to construct.

A Useful Carrier Tricycle

The simple little model illustrated in Fig. 1 depicts a type of pedal delivery van that should be well known to all of us. The tricycle is built up from a $5\frac{1}{2}'' \times 2\frac{1}{2}''$ Flanged Plate, which carries two Flat Trunnions bolted one on each side. These Trunnions form bearings for the $3\frac{1}{2}''$ Axle Rod carrying two 1″ fast Pulley Wheels.

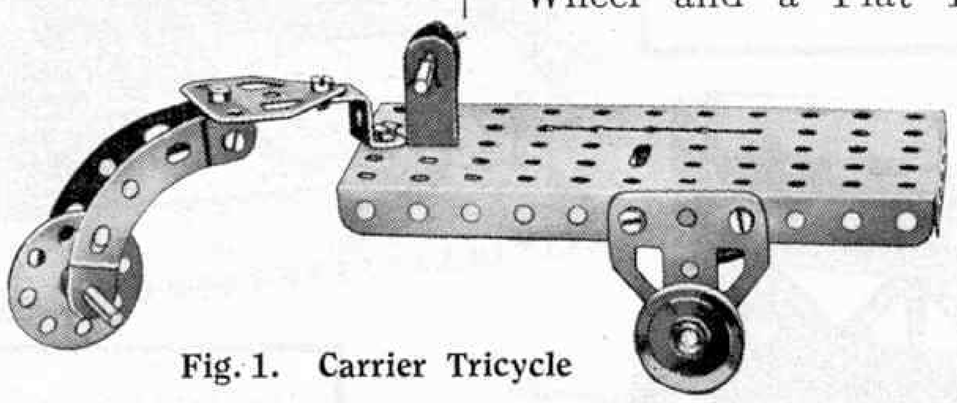


Fig. 1. Carrier Tricycle

The handle bars and handle bar support consist of a Cranked Bent Strip and a 2″ Axle Rod. Connection is made between the Flat Trunnion that forms the seat and the Flanged Plate by means of a Reversed Angle Bracket firmly secured to the Trunnion, but free to pivot about a bolt attached to the Flanged Plate, this bolt being lock-nutted in the usual way (see Standard Mechanism No. 263).

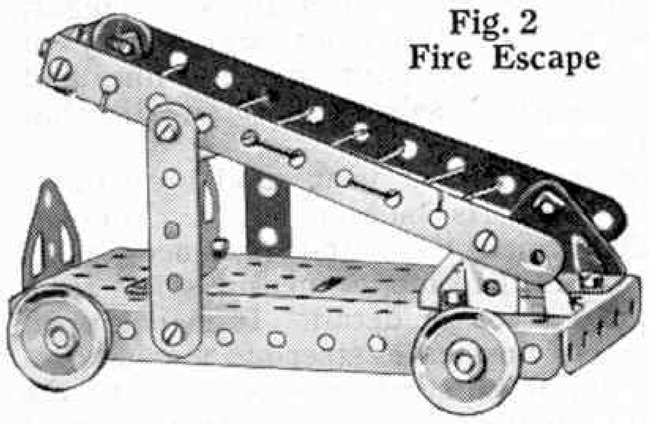


Fig. 2 Fire Escape

Fire Escape

The base of this model consists of a $5\frac{1}{2}'' \times 2\frac{1}{2}''$ Flanged Plate, in which are journalled the $3\frac{1}{2}''$ Rods carrying four 1″ fast Pulley Wheels. To one end of the Flanged Plate a Flat Trunnion is bolted, while near the other end two Trunnions are attached to the upper surface of the Plate. To each of the latter Trunnions is pivoted a $5\frac{1}{2}''$ Strip, the pivot consisting of a bolt and two nuts, as in Standard Mechanism No. 262. The ends of these $5\frac{1}{2}''$ Strips are joined together by means of two Angle Brackets and two Flat Brackets.

The "rungs" of the ladder are formed from a length of cord interlaced between the holes of the $5\frac{1}{2}''$ Strips. The ladder rests on a $2\frac{1}{2}''$ Double Angle Strip that is held in position by means of two $2\frac{1}{2}''$ Strips, the ends of which are bolted to the flanges of the Flanged Plate. A second Flat Trunnion is secured to the Flanged Plate in the position shown by means of Angle Brackets.

Pecking Hen

This model is particularly amusing, for by alternately pushing forward and drawing back the lower of the two $5\frac{1}{2}''$ Strips at the base of the model (Fig. 3), the hen makes a series of pecks at the "bowl" (a 1″ fast Pulley Wheel). The hen's body consists of two Flat Trunnions and a $2\frac{1}{2}''$ Curved Strip that forms its breast. The apex of one of the Flat Trunnions carries a Flat Bracket (representing the tail!) and a second $2\frac{1}{2}''$ Curved Strip bolted to the Flat Trunnion forms the bird's neck.

To the extremity of the Curved Strip a $\frac{1}{2}''$ loose Pulley Wheel and a Flat Bracket are fastened. The $2\frac{1}{2}''$ Strips that form its legs are bolted rigidly at the top to the body, and one leg only is attached pivotally to the two $5\frac{1}{2}''$ Strips in the position shown. The $5\frac{1}{2}''$ Strips are kept parallel to each other by means of a Flat Bracket pivotally connected to each Strip by means of a bolt and two nuts (S.M. 262).

The Meccano Angler

Readers will be pleased to note that the Meccano Angler (the indefatigable individual shown in Fig. 4) will have at least one good "catch" to show for his day's labour. He is illustrated in the act of landing in superb style a flat (Bracket) fish.

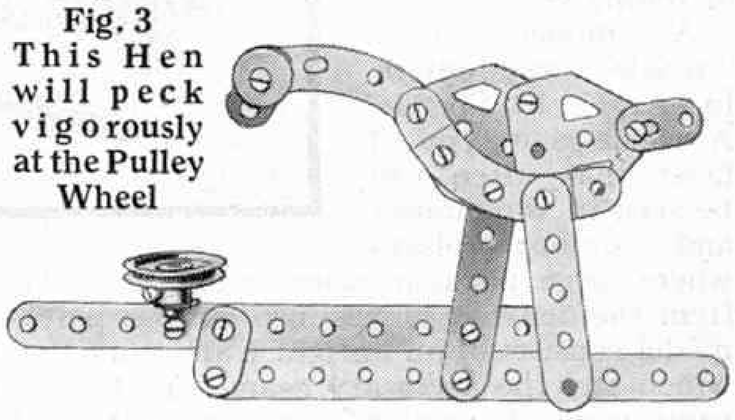


Fig. 3 This Hen will peck vigorously at the Pulley Wheel

The $2\frac{1}{2}''$ Strips forming the angler's body are attached each by a bolt and two lock-nuts to Angle Brackets that are fastened rigidly to the $2\frac{1}{2}''$ Strip forming the body. Hence the Strips may be moved into various positions and the angler can be made to go through the complete procedure of landing his catch.

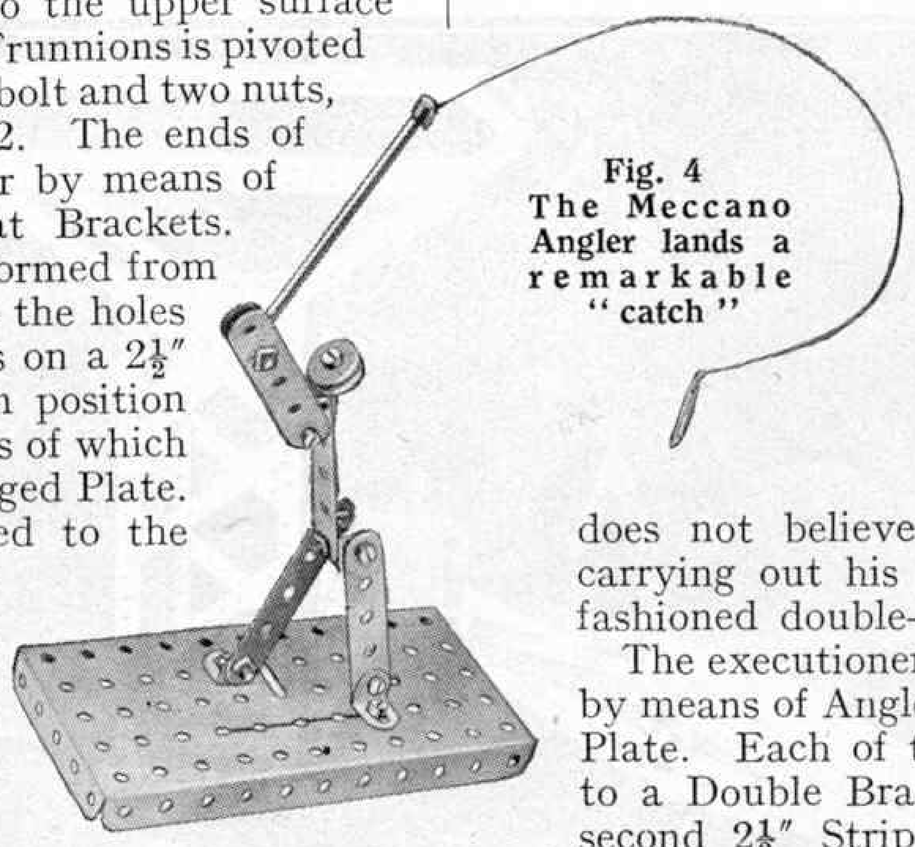


Fig. 4 The Meccano Angler lands a remarkable "catch"

The Execution

Our first glance at the photograph reproduced at Fig. 5 gave us quite a nasty turn. It appears that a worthy inhabitant of Meccanoland has met an untimely, and surely undeserved, death! We gather from the model that the "state executioner" in that wonderful country does not believe in "new fangled" methods of carrying out his work, but relies on the good old fashioned double-edged axe!

The executioner's legs consist of $2\frac{1}{2}''$ Strips secured by means of Angle Brackets to the $5\frac{1}{2}'' \times 2\frac{1}{2}''$ Flanged Plate. Each of these Strips is connected pivotally to a Double Bracket that, in turn, is bolted to a second $2\frac{1}{2}''$ Strip forming the executioner's body. This Strip carries two Angle Brackets and a Flat Bracket at its upper end, and two $2\frac{1}{2}''$ Strips forming the arms are attached to the Angle Brackets as shown. The

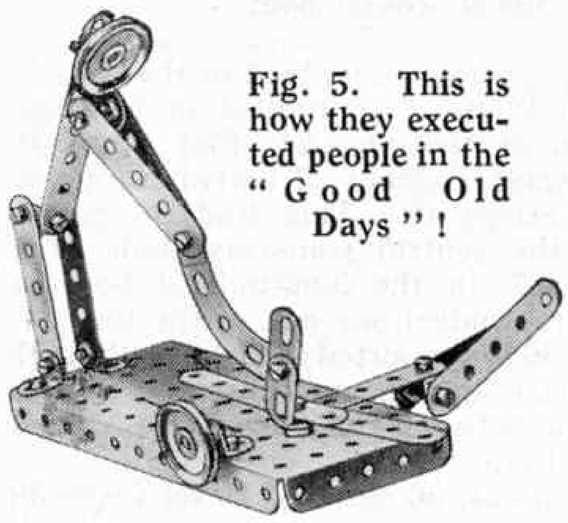


Fig. 5. This is how they executed people in the "Good Old Days"!

extremities of these Strips hold the "axe," which, as can be seen, consists of a 2½" Curved Strip and two Flat Brackets.

The head of the decapitated one is attached quite separately (alas!) to the base plate by an Angle Bracket.

The Strong Man

Another remarkable model is illustrated in Fig. 6. It represents a Meccano "super man" demonstrating to his weaker brethren what a tremendous weight he is capable of lifting. It can be understood that while the lifting of a few 1" Pulley Wheels does not present any very great difficulties to the average Meccano boy, an individual whose total height does not exceed 6" might well consider the achievement as something worth boasting about!

The arms of this miniature Hercules consist of 2½" Strips having Flat Brackets fastened to their outer ends. To each of these, Angle Brackets are bolted, thus forming supports for the 2" Rods that carry the Pulley Wheels. His head consists of a ½" loose Pulley Wheel. One might think that this part of his anatomy is rather out of proportion, but it will be agreed that a possible deficiency of brains is more than compensated for by the size of the muscles in his arms!

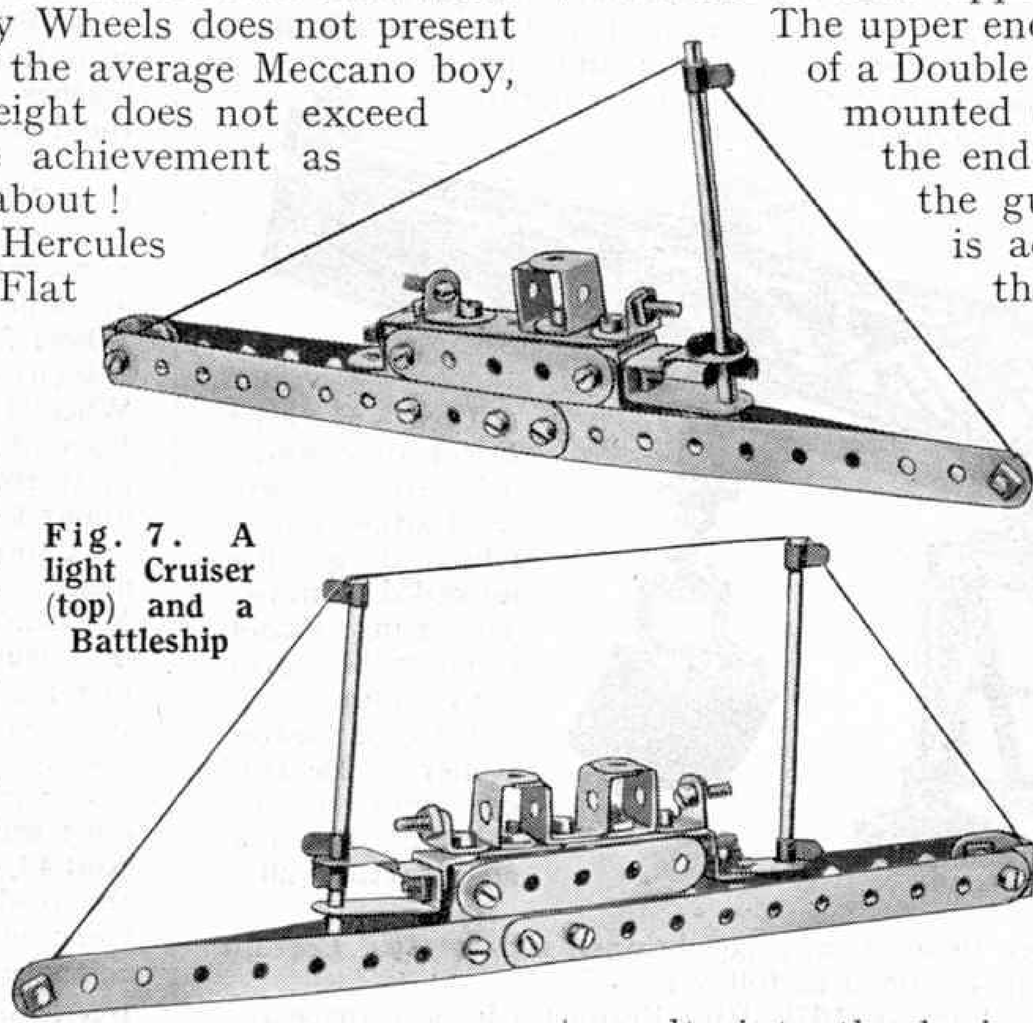


Fig. 7. A light Cruiser (top) and a Battleship

Meccano Warships

Our next illustrations (Fig. 7) depict two interesting little warships, both of which are constructed quite simply and look most effective when completed.

The three 2½" Strips forming the deck superstructure in each boat are held together by means of Angle Brackets, and are fastened to the hull of the vessel by means of Flat Brackets. The funnel in the case of the light cruiser shown in the upper illustration consists of two Double Brackets. The battleship boasts two funnels, each consisting of a Reversed Angle Bracket and a Double Bracket. Great fun may be had by building up a whole fleet of model vessels similar to the two shown.

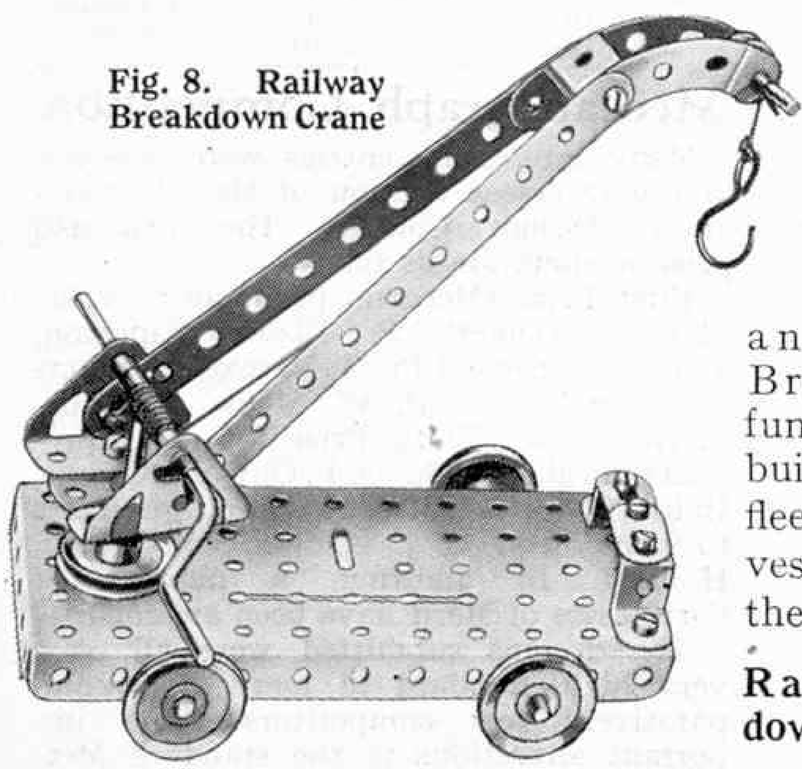


Fig. 8. Railway Breakdown Crane

Railway Breakdown Crane

Fig. 8 illustrates a railway breakdown crane. Few Meccano boys would associate a model of this type with the very small outfits but, nevertheless, this breakdown crane is of quite authentic design and uses a minimum of parts.

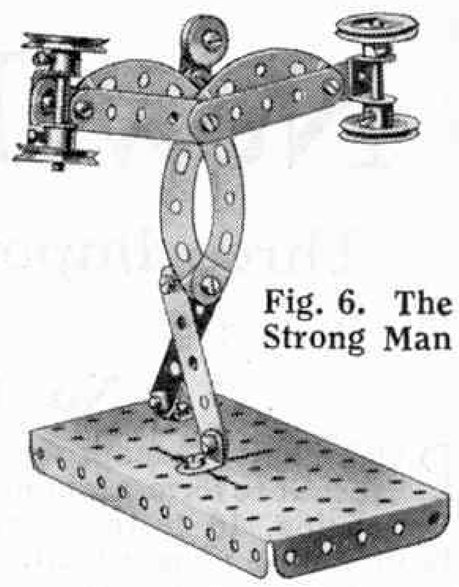


Fig. 6. The Strong Man

The swivelling base of the crane consists of a Bush Wheel having two Trunnions bolted to it in the positions shown. This Bush Wheel pivots about a 2" Rod that is kept in place by means of two 1" fast Pulley Wheels placed on either side of the Flanged Plate. The jib of the crane is composed of two 5½" Strips extended at their upper ends by two 2½" Curved Strips. The upper end of the jib is kept apart by means of a Double Bracket. A ½" loose Pulley Wheel mounted on a 2" Rod that is journalled in the end holes of the Curved Strips forms the guide for the hoisting cord, which is actuated by the Crank Handle at the base of the jib.

A Very Efficient Catapult

The catapult shown in Fig. 9 completes our example of models for this month. As many of our readers will know, giant catapults of similar design to our model formed very formidable engines of war in the days before the invention of gunpowder. They were used principally for storming castles, etc. Large lumps of stone, scrap iron, or anything else that happened to be at hand, were hurled by the catapults into the besieged castle, with unpleasant results to any one who happened to be in the way!

The arm of the Meccano catapult consists of two 5½" Strips held together at their ends by means of Double Brackets. It is pivoted on a 3½" Rod journalled in a framework consisting of two vertical 2½" Double Angle Strips having a 2½" Strip bolted across their upper ends. At one end of the arm is attached a cup-like receptacle formed from five Angle Brackets. A small piece of elastic is secured between the other end of the arm and the base of the model.

After placing a pellet in the cup, the arm should be drawn back and released suddenly. The pellet will then be thrown quite a distance.

A great deal of fun may be obtained by constructing several of these "engines of war" and arranging a contest with one's friends. When indulging in this form of warfare, however, strict rules should be laid down forbidding the use of Meccano parts as missiles, for however inviting may be the temptation to fill the cup of the catapult with nuts and bolts it should be overcome, else windows, etc., will suffer.

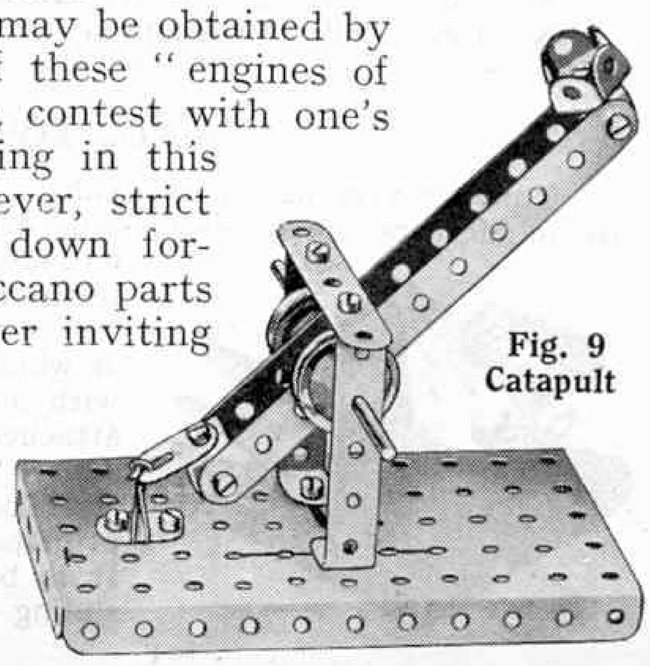


Fig. 9 Catapult

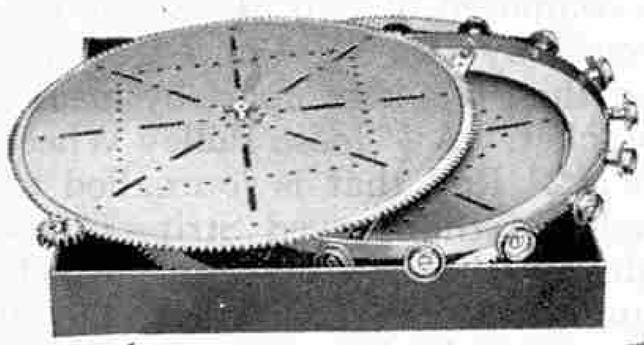
New Meccano Parts

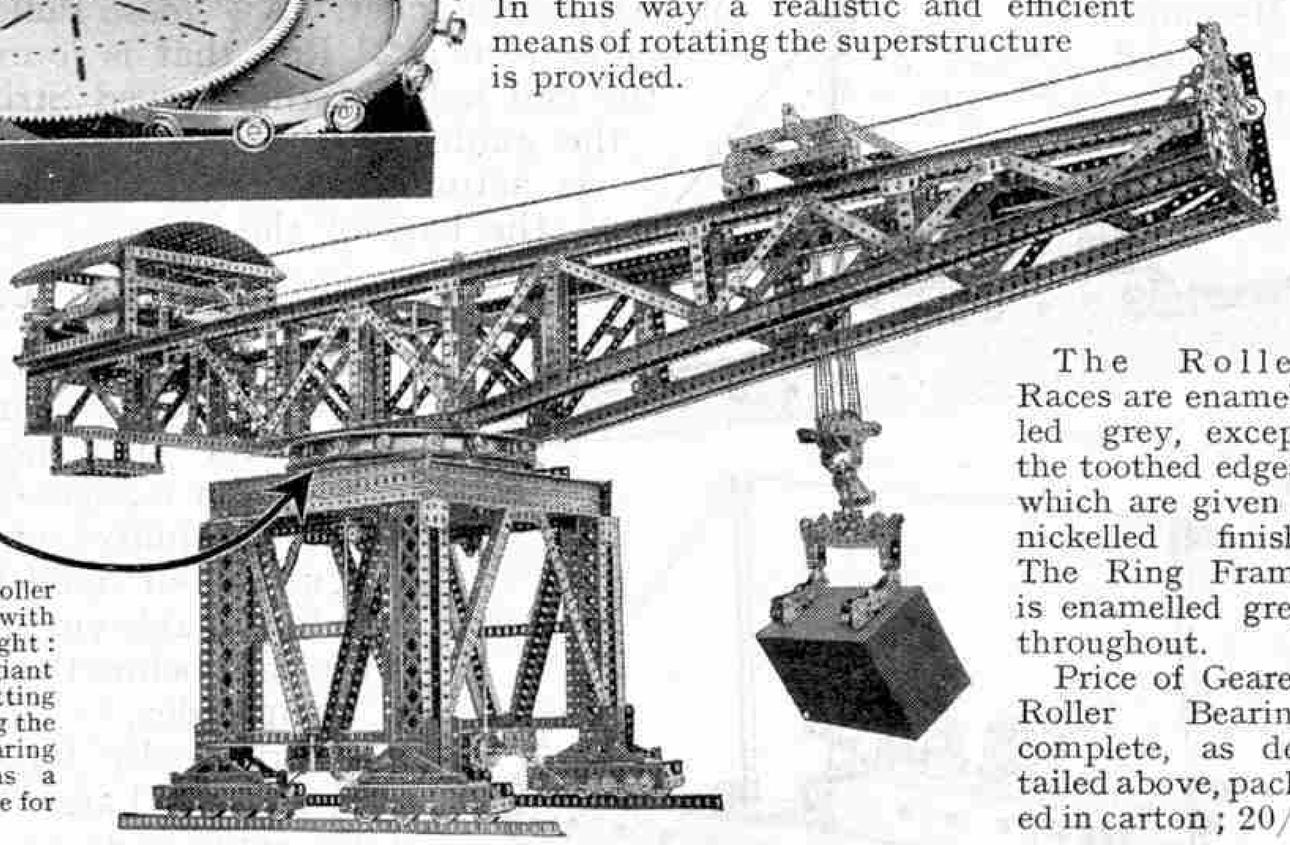
Three Important Additions to the System

No. 167, Geared Roller Bearing

PART No. 167 comprises the following units: two Roller Races, each 12″ diam. and dished to form a rim near their peripheries; one Ring Frame, 10″ diam.; one special Pinion, 16 teeth; sixteen ¾″ Flanged Wheels; sixteen Pivot Bolts and Nuts; two Bush Wheels; one 9½″ Strip; one 1½″ Rod; ten nuts and bolts. When assembled these parts form a complete Roller Bearing.

The Meccano Roller Bearing is designed to facilitate the building of large models of swivelling structures, such as giant Hammerhead Cranes, Rolling Bridges, etc. The Roller Races are provided with teeth around their peripheries, so that they may be engaged by the special Pinion. In this way a realistic and efficient means of rotating the superstructure is provided.





Above: The complete Roller Bearing unit, with box. On Right: A Meccano giant Block - setting Crane, showing the Roller Bearing Unit used as a swivelling base for the boom.

The Roller Races are enamelled grey, except the toothed edges, which are given a nickelled finish. The Ring Frame is enamelled grey throughout.

Price of Geared Roller Bearing complete, as detailed above, packed in carton; 20/-

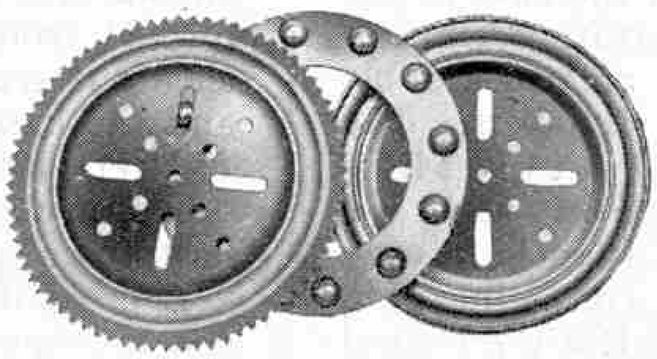
The components of the Geared Roller Bearing may be obtained separately. Certain of them are entirely new parts; these will be listed as follows:—

Part No. 167a, Roller Race, price 4/6. Part No. 167b, Ring Frame for Rollers, price 3/-. Part No. 167c, Pinion for Roller Bearing, price 1/-.

The remaining components are included already in the Meccano Parts List.

No. 168, Ball Bearing

Part No. 168 comprises the following units: one Ball Race Flanged, one Ball Race Geared, and one Ball Casing, complete with Balls. The over-all diameter of the part is 4″. It is designed for use in models of swivelling structures where the Roller Bearing (part No. 167) would be too large. Its use reduces friction to a minimum and enables the moving part to be turned easily and smoothly about its pivot. The Flanged and Geared Ball Races are enamelled green, and the Ball Casing is nickel-plated throughout. Price, complete, 3/-.

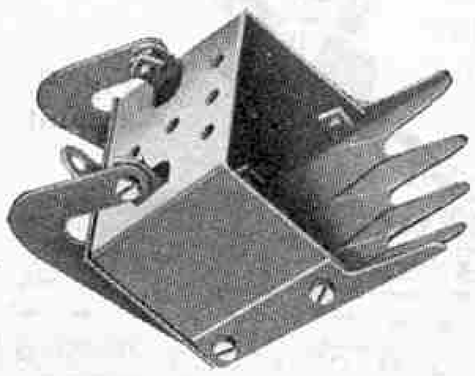


The components of the Ball Bearing will be listed separately, as follows:—

No. 168a, Ball Race, Flanged, price 6d.
No. 168b, Ball Race, Geared, price 9d.
No. 168c, Ball Casing, complete with Balls, price 1/9.

No. 169, Digger Bucket

This is a very useful and realistic accessory. It is designed principally, of course, for use in Meccano steam shovels, or mechanical navvies, etc. The mouth of the Bucket measures about 1⅞″ by 2¼″, while the depth (over cutting teeth) is 2½″. The bottom of the Bucket is mounted on hinged levers and normally is held in place by a sliding lever, the end of which may just be seen in the illustration, that engages with a slot in the front of the Bucket. A cord may be attached to the lever and on pulling this the floor falls open and so discharges the contents of the Bucket.



The Digger Bucket is of very sturdy construction, the principal parts being secured together by nuts and bolts. It is beautifully enamelled in steel blue, except for the sliding lever, which is nickel-plated. Price 2/-.

Meccano Model Roundabout—

(*Continued from page* 667)

An 11½″ Axle Rod 36, held in the boss of the Face Plate, is journalled in bearings consisting of the 5½″×2½″ Flat Plate 31 and an Angle Bracket 27 bolted to one of the 9½″ Strips 18. This Rod 36 passes through the central transverse hole of a Coupling 37, in the longitudinal bore of which is journalled one end of the Rod 24. The Rod 36 is supported in the Coupling 37 by a fixed Collar 38, and carries a second fast Collar between the Face Plate 35 and the Flat Plate 31.

The Rods 24, 36 carry ¾″ Bevel Gears 39 that are in continuous engagement with each other. The 1″ Gear Wheels 23, rolling around the teeth of the Contrate Wheel 22, rotate the Axle Rods 24, and thus set the cars in motion.

Arrangement of the Gearing

A Worm Wheel secured to the armature spindle of the Electric Motor (see Fig. 3) meshes with a 57-teeth Gear Wheel 40 on the Rod 44, to which is also secured a ½″ Pinion 42 that engages a second 57-teeth Gear Wheel on the Rod 43. The drive is then led via a pair of ⅞″ Bevel Gears to a 1″ Sprocket Wheel 41, which is connected by an endless Sprocket Chain to the 1″ Sprocket Wheel 7 (Fig. 5). The special 1″ Pinion 8 is secured to the same Rod as the Sprocket Wheel 7, and by turning the upper Geared Race of the large Roller Bearing causes the platform and superstructure of the roundabout to revolve about the Rods 12, 21.

It should be noted that the gearing just described was designed for use with the Meccano high-voltage Electric Motor, and is unsuitable for the 4-volt type. The latter is, however, quite powerful enough to operate the model at a considerable speed, and if it is desired to make use of the low-voltage Motor it is only necessary to omit the ½″ Pinion 42 and the gears on the Rod 43, adding a ⅞″ Bevel Gear on the end of the Rod 44 to mesh with a similar Bevel Gear on the vertical Rod that carries the Sprocket Wheel 41.

Parts required:—

17	of No.	1A	1	of No.	16B	5	of No.	70
8	" "	2	1	" "	18A	16	" "	90
8	" "	3	2	" "	24	14	" "	90A
8	" "	5	1	" "	26	2′	" "	94
4	" "	6A	2	" "	27A	2	" "	96
2	" "	7	6	" "	30	10	" "	99
7	" "	8	1	" "	30C	2′	" "	100
8	" "	8A	4	" "	31	16	" "	108
8	" "	9E	1	" "	32	4	" "	109
2	" "	10	288	" "	37	2	" "	126
62	" "	12	8	" "	38	4	" "	126A
6	" "	12A	1	" "	48A	2	" "	130
5	" "	13	8	" "	48D	1	" "	160
2	" "	14	2	" "	54	1	" "	167
1	" "	15A	12	" "	59			
2	" "	16	2	" "	62B	1 Electric Motor		
1	" "	16A	3	" "	63			

Meccanograph Competition

Many interesting entries were received in the Overseas Section of the Meccanograph Design Contest. The principal prize-winners are as follows:—

First Prize (Meccano products to value £1-1s.): Kenneth P. Bland, Kingston, Jamaica. Second Prize (Meccano products to value 15/-): B. W. Monk, Adelaide, S. Australia. Third Prize (Meccano products to value 10/6): O. P. Olivant, Madras, India. Fourth Prize (Meccano products to value 5/-): C. J. Boeljon, Amsterdam, Holland. In addition, a number of Certificates of Merit have been awarded.

The designs submitted were all of a very high standard of merit, but comparatively few competitors made important alterations to the standard Meccanograph model.

How Many Errors in this Engine?

Another Test for Sharp-eyed Model-builders

SPECIAL CONTEST FOR THE HOLIDAYS

DURING the summer months the majority of Meccano boys are so fully occupied with the many sports and open air pastimes that the warmer weather affords that they have little time in which to design and complete new models. But even if the Meccano boy spends every minute of his holidays out of doors, he never loses touch with his hobby, for the "*M.M.*" keeps him well informed of all the latest happenings and the newest ideas emanating from Meccanoland. What could be more suitable for a quite hour on the beach or in the garden, when it is too hot to do anything energetic, than a contest dealing with model-building that does not require a Meccano Set with which to compete?

The contest that we are organising this month is of this type. All that you are required to do when entering it, is to criticise the model twin-cylinder horizontal engine illustrated below, and submit a brief description of the way in which you consider the model ought to be built. Your only requirements when entering the contest will be a pen or pencil and a few sheets of paper! There are no entrance fees or forms.

It should clearly be understood that to enter this contest one need not be an expert essayist; any boy who "spots" most of the mistakes and sets down his criticisms in a clear and precise manner stands a very good chance of obtaining one of the principal awards.

THE PRIZES

Prizes in Sections A and C are as follows:—
First Prize: Meccano Products to value £3-3s.
Second Prize: Meccano Products to value £2-2s.
Third Prize: Meccano Products to value £1-1s.
Six Prizes each consisting of a Meccano Crystal Receiving Set or Meccano Products to value 10/6.

Prizes in Section B:—
First Prize: Meccano Products to value £2-2s.
Second Prize: Meccano Products to value £1-1s.
Third Prize: Meccano Products to value 10/6.
Six Prizes, each consisting of a complete Meccano Manual.

How every "*M.M.*" Reader may Enter

A glance at the illustration of the engine will show that a number of mistakes have been made both in designing and constructing the model. It is these mistakes that we wish "*M.M.*" readers to set down on paper. Most of the mistakes are obvious and any Meccano boy who has only a slight knowledge of model-building should be able to point them out without difficulty.

The best plan is to write out your list of errors in column form and then, against each item on the list, state clearly and briefly the best way in which you think the fault may be rectified.

In preparing your list you will probably find the complete Meccano Instructions Manual of considerable use, for in it are illustrated several models of reciprocating engines that are built on correct engineering lines. Equally helpful will be the Standard Mechanisms Manual, for many of the mechanical movements described therein are directly applicable to models of steam engines.

There is no doubt that many boys will be able to discover all the mistakes readily if they build up the actual model for themselves, but we may say that it is possible to discover every mistake quite easily from the illustration. If no competitor succeeds in pointing out every mistake, the First Prize will of course be awarded to the competitor or competitors who submit the largest list of errors.

Should a number of competitors succeed in pointing out all the mistakes included in the model, the judges will give precedence to those entries that put forward the simplest and most practicable alternative methods of construction.

Hints to Competitors

In compiling your list it may be noted that two distinct types of error were made when the model was constructed. The first type relates to the manner in which the parts have been assembled, which, to say the least, is certainly not in accordance with good Meccano practice! Of course, it is assumed that the builder had the proper parts available when he constructed the engine illustrated. The second type of error concerns the design of the model. Any boy who is familiar with the elementary principles of the steam engine will soon "spot" mistakes of this type.

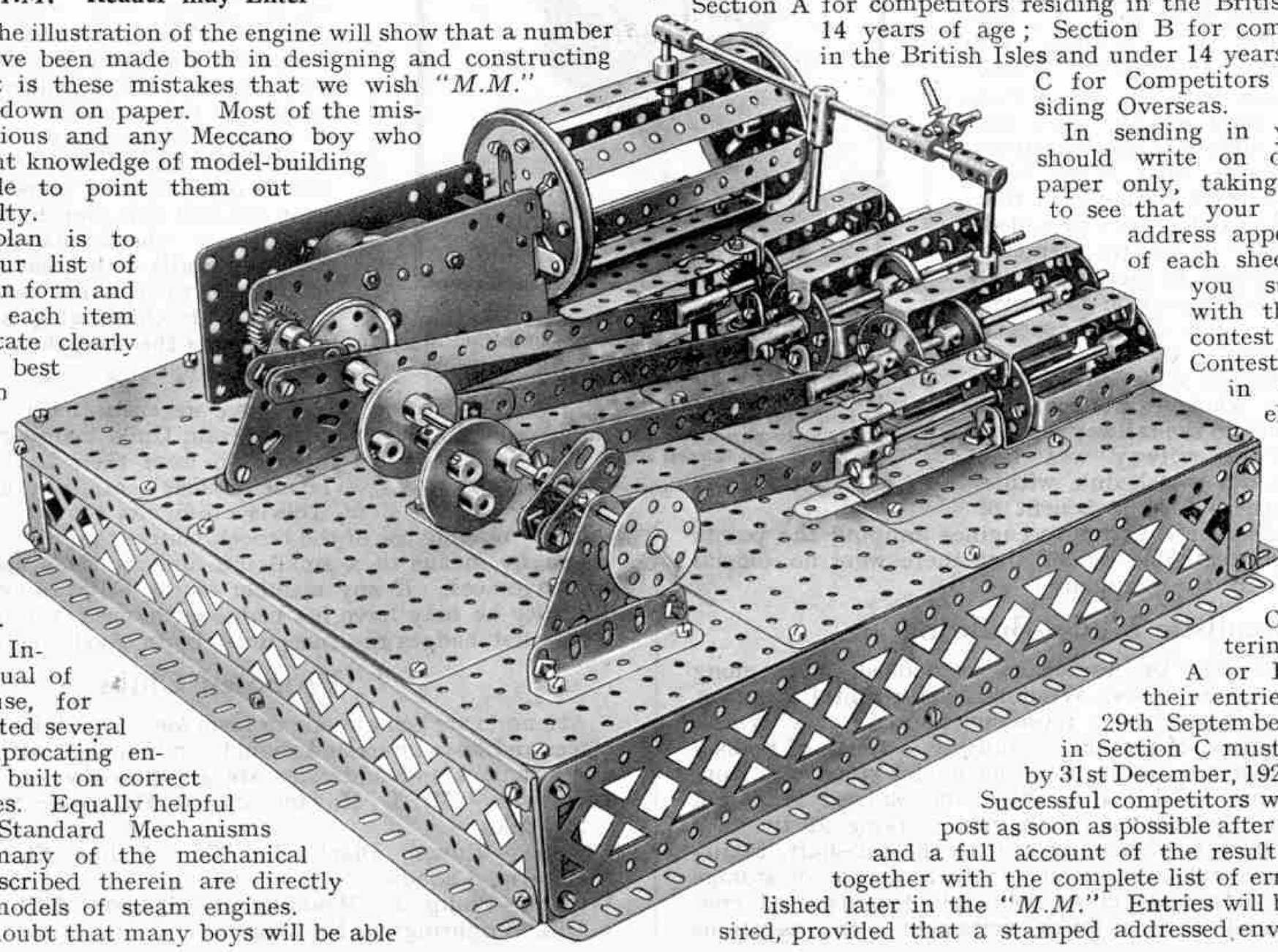
Follow these Instructions Carefully

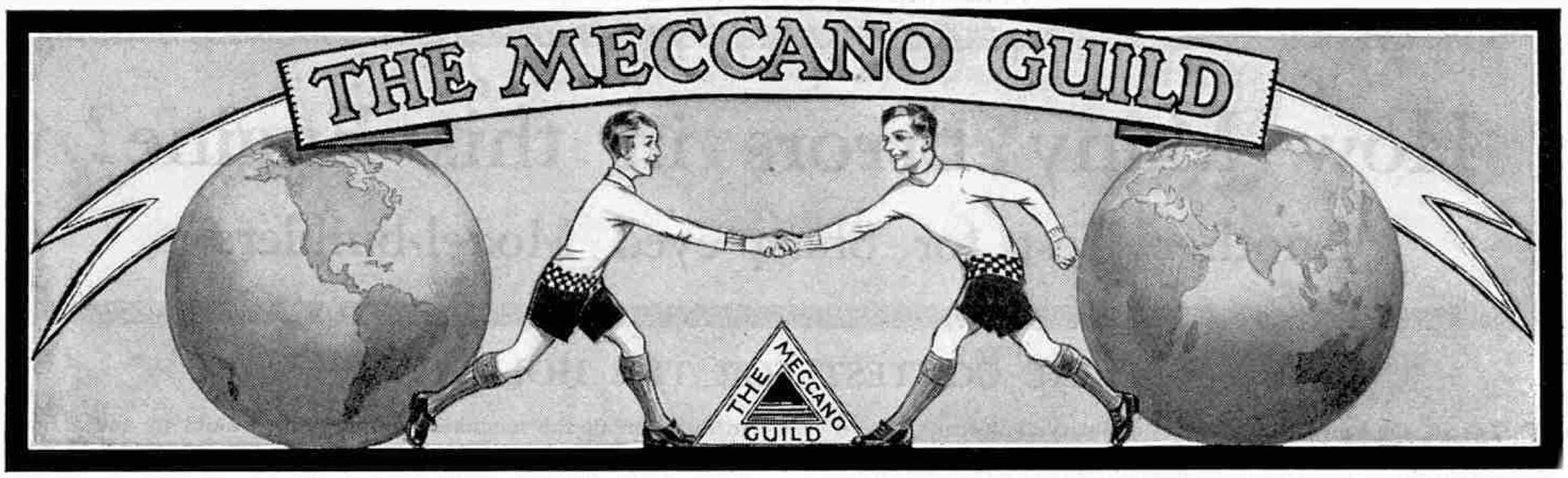
Entries will be divided into three separate Sections, as follows: Section A for competitors residing in the British Isles and over 14 years of age; Section B for competitors residing in the British Isles and under 14 years of age; Section C for Competitors of all ages residing Overseas.

In sending in your entry you should write on one side of the paper only, taking particular care to see that your name, age, and address appear on the back of each sheet of paper that you submit, together with the name of the contest ("Second Errors Contest") and the Section in which you are eligible. Address your entry to "Second Errors Contest," Meccano Ltd., Binns Road, Liverpool.

Competitors entering either Sections A or B must forward their entries not later than 29th September, 1928. Entries in Section C must reach Liverpool by 31st December, 1928.

Successful competitors will be advised by post as soon as possible after the closing dates, and a full account of the results of the contest, together with the complete list of errors, will be published later in the "*M.M.*" Entries will be returned if desired, provided that a stamped addressed envelope is enclosed.





With the Secretary

Model Railways for Exhibitions

In arranging the details of a club exhibition it is wise to attempt to provide some especially striking feature for the benefit of those visitors to whom the activities of a Meccano club are not familiar. A large model of a well-known building, bridge or other local object is very useful in this respect, but nothing appears to attract the attention of visitors more than a well-planned Model Railway. The members of the Northwood Meccano Club evidently realise this, and as a part of their second Annual Exhibition introduced a display that proved irresistible to every visitor, young and old.

Four tracks were laid down along the length of the hall in which the Exhibition was held. These represented the main line between London and Carlisle, and a constant service of non-stop Pullman express trains was maintained in both directions between the termini. This service was supplemented by goods trains that traversed the whole route and by local trains for suburban districts.

The officials of the railway company maintained the service in professional style, operations being quite realistic. But perhaps the greatest surprise to visitors was that the trains ran according to a time-table. The latter was closely followed throughout, with the result that onlookers always knew exactly what was being done. Their interest in the operations was retained far better than would have been the case if a track with trains that merely ran up and down had been provided. Several visitors were so greatly attracted by the excellent service, in fact, that they decided to make an inspection trip over the whole system, and ordered special trains to enable them to do so!

The local newspaper commented very favourably on the whole exhibition, and in a special reference to the railway portion remarked that "the railway was well staffed, the trains ran to schedule with a few specials thrown in for the benefit of the onlookers, while accidents due to engines jumping the points were negligible, so negligible indeed that there were no official statements issued by the Company!"

Realistic Model-Building

Meccano models were by no means overlooked, and among those shown were Aeroplanes, Windmills, Horizontal Engines, a Motorcycle and Sidecar, and a representation of Laxey Wheel. But here, as in the case of the Model Railway, a touch of realism was introduced with the result that one model stood out from the rest. This represented a Coal Mine and showed the main haulage road correctly propped, with men working at the coal face. The whole process of hauling coal to the pit-shaft, taking it to the surface and unloading it on to railway trucks or storage dumps by means of a huge crane, were all demonstrated continuously, and created nearly as much excitement as the operations of the Northwood Railway Company.

The club is to be congratulated on its enterprise, and on the co-operative spirit shown by its members. As a result of careful organisation and preparation, the exhibition gave great pleasure to a surprising number of adult visitors and was a great success from a financial point of view. The money raised amounted to more than £5, and will be devoted to the purchase of further equipment that will no doubt be used by the members in such a manner that they will strengthen the excellent impression already formed of their club.

Meccano Club Secretaries

No. 13. Mr. Chia Boon Hoe

Mr. Chia Boon Hoe has been the Secretary of the Singapore Chinese M.C. since the formation of the club. He has proved a very capable assistant to the Leader in bringing the club to its present prosperous condition. He has been compelled to resign his appointment as he is proceeding to England to pursue his law studies, but retains his interest in the club.

Meccano Challenges

An interesting method of stirring up the competitive spirit is productive of very lively meetings of the Sittingbourne Pioneer M.C. One member asserts that he will build a certain model that will work better than any similar production of other members, whereupon the latter make determined efforts to prove him to be boasting unduly. The secretary of the club led the way by challenging members to produce a racing car, incorporating the Meccano clockwork motor, that would be speedier than one that he proposed to build. Races over two courses, one circular and the second a veritable Tourist Trophy course, were to provide the necessary tests. The challenger was well beaten on this occasion. His car required 1 minute 15 seconds to complete the three circuits of the circular course, while one member produced a model that reduced the time to 50 seconds.

This is a scheme that may be adopted by other clubs with great advantage as it lends itself to sectional as well as personal rivalry, the challenging attitude of one side making the struggle much keener.

* * * *

I have recently received many complaints from Guild members that they are unable to wear their badges because the lapels of their coats have no button-holes. This is a difficulty that may easily be overcome by making use of the brooch badges that are available. These fasten by means of a small pin and are thus useful under any circumstances. If any member of the Guild is experiencing this difficulty he may have his badge exchanged, the only stipulation being that badges returned must be in good condition.

Proposed Clubs

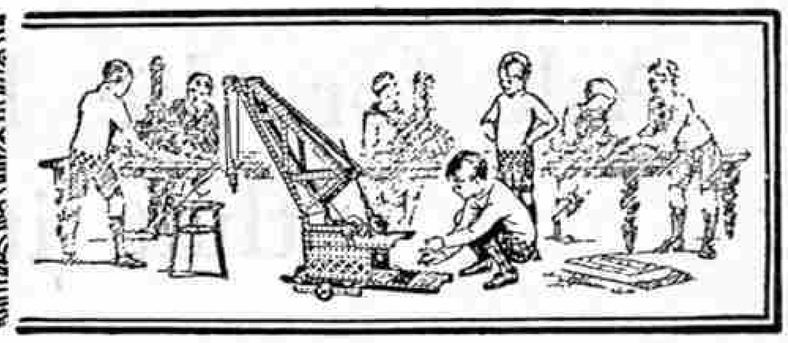
Attempts are being made to form Meccano Clubs in the following places and boys interested should communicate with the promoters whose names and addresses are given below:—

ABERDARE.—Mr. D. H. Smedley, 60, Pembroke Street, Aberdare, S. Wales.

CANADA.—Edwin Blackwell, 125, Arthur Street, Brantford, Ontario, Canada.

WIGAN.—Philip L. Waddington, Sparrow Hill Café, Sparrow Hill, Wrightington, Nr. Wigan.

CLUB NOTES



Parkstone M.C.—Competitions arranged from time to time are very keenly contested, interesting models that have been made including an Electric Lathe, Elevated Jib Crane, and a Wire Rope-maker. Hornby Train Nights frequently appear on the syllabus. Club roll: 14. *Secretary*: Eric Bath, 165, Ashley Road, Parkstone, Dorset.

Bailieborough M.C.—The summer programme includes Paper Chases, Outings to various places of interest and Cricket Matches. The members are very keen cricket players, and full equipment has been secured. Attendance at meetings is very satisfactory. Club roll: 8. *Secretary*: R. A. Laven, Bank House, Bailieborough, Co. Cavan.

Blyth M.C.—Meetings are being held monthly during the summer session. A Model-building competition was held and many excellent models were displayed. A Club Bank has been formed and is well supported by members. Interesting Lectures on "*The Story of Oil*" and on "*Famous Bridges*" have been given, the latter by the Leader. Club roll: 12. *Secretary*: R. N. Carr, 135, Hambledon Street, Blyth.

Exeter M.C. — The chief item of interest at present is boating, parties being out every Saturday. The members of the football team have been presented with a set of medals as they were finalists in the Hodder Cup Competition. The Leader has been presented with a gold medal in recognition of his services in connection with the Football League. *Secretary*: F. G. W. Brewer, 8, Cedards Road, St. Leonards, Exeter.

Sittingbourne and Milton Regis M.C.—Great keenness is being shown in all three sections, Senior, Intermediate and Junior. A very interesting Lantern Lecture by the President, entitled "*A Journey across Lake Lucerne*," was very successful, and a representative of the Triumph Motor Co. gave a Demonstration and Lecture on "*The Working of the Petrol Engine*." Cricket matches have been arranged and it is hoped to have a camping holiday later. The Secretary will be glad to hear from any boy who wishes to become a member. Club roll: 45. *Secretary*: A. Golding, 14, Epps Road, Sittingbourne.

Sheffield M.C.—Rambles to various places of interest have been greatly enjoyed, members being allowed the rare privilege of ascending the tower of Beauchief Abbey on one occasion. A cycle run to Grindelford and Hathersage was very successful and one night was devoted to tracking, which proved an attraction. Three members went on ahead to lay the trail, making chalk sketches of the Guild badge at intervals along the road, and the other members followed a few minutes later. Club roll: 46. *Secretary*: Kenneth Stacey, 128, Peveril Road, Sheffield.

Ludlow M.C.—A Contractors' Night provided a keen contest, two excellent bridges being built by the competing gangs in the 1½ hours allowed. A Meccanograph Night proved highly successful, each member making several designs. The interesting programme for the summer session includes Lectures, Hornby Train Nights and Joke Evenings. A novel Competition was arranged in which a prize was awarded for the best humorous Meccano model of a living or extinct animal. Three nights were devoted to the building of a club model of the Big Wheel. Club roll: 12. *Secretary*: A. T. Chester, 8, Castle View, Ludlow, Shropshire.

Northwood M.C.—A display held some time ago was an outstanding success and realised a profit of £3 5s. 0d. An interesting feature of this display was a bureau at one end of the room containing Guild application forms and other leaflets for distribution. A Model Railway attracted much attention and was specially referred to in the local newspaper report, as was a working model of a Coal Mine. The excellent outdoor programme being followed during the present session includes Cricket, Swimming, Games, Rambles, and a Flower Show. Club roll: 14. *Secretary*: A. S. Whiddington, Pencarrow, Northwood.

Lichfield M.C.—An Exhibition organised recently proved highly successful. The many excellent models included Locomotives, Lorries, an Electro-magnetic Crane and a Model Workshop, all constructed by members, and the Derricking Crane on loan from Headquarters. The room was crowded with visitors, who were greatly interested in all the exhibits. A clockwork-driven Breakdown Lorry constructed by an armless member attracted special attention. Leader: Mr. S. P. Hughes, 25, Sturgeons Hill, Lichfield, Staffs.

Woolwich and Plumstead M.C.—A visit was paid to the Woolwich Borough Council's Power Station. Model-building is popular and many excellent models have been built, including a Morgan Runabout. Two interesting Lectures have been given by members, the subjects being respectively "*The Sun, Moon and World*" and "*Photography*." It is hoped that a Photographic Section will be formed shortly. The secretary is hoping to secure permission to visit the London Studios of the B.B.C. and he is also applying for permits to visit several large liners. Meetings are well attended and the club roll is increasing. Those wishing to join are requested to apply to the secretary. Club roll: 39. *Secretary*: S. E. Weller, 22, Woodhurst Road, Plumstead, S.E.18.

Holy Trinity (Barnsbury) M.C.—The prizes for Model-building Competitions, attendance and good work were presented on the occasion of a very successful and well-attended Parents and Friends' Night. The Annual Outing to Ruislip Common proved very enjoyable, the members indulging in football, boating, and rambles in the woods. Plans have been made and preparations have already begun for the tenth Annual Exhibition, to be held on October 25th and 26th at the Holy Trinity Parish Hall. Further details will be given in a later report. Club roll: 51. *Secretary*: Mr. F. W. Johnson, 23, Market Street, Edgware Road, Paddington, London, W.2.

Diss Church M.C.

Our group shows the members of Diss Church M.C. Originally this club possessed the distinction of having a lady as Leader, Mrs. Maling, the mother of the hard-working secretary, occupying that position. The present Leader is Rev. F. P. Law, under whose guidance excellent progress has been made. The activities of the club are very varied and one excellent feature is that its splendid social work has secured for it the strong support of the people of the surrounding district.

Buckhurst Hill M.C.—Outdoor pastimes figure largely on the syllabus, Cycle Runs especially being greatly enjoyed. Billiards is very popular and Games Evenings are frequently held. New members will be made very welcome and should write to the secretary for further particulars. Club roll: 7. *Secretary*: Denis Mason, 17, Palmerston Road, Buckhurst Hill, Essex.

Diss Church M.C.—Recent meetings have been planned with the idea of getting as many members as possible to take an active part, five-minute lectures and games being very useful for this purpose. A most enjoyable and instructive visit was paid to the "East and West" Missionary Exhibition at Norwich. Paper Chases are popular and an excellent summer programme of Cycling and other sports is being followed. Club roll: 34. *Secretary*: J. J. Maling, 6, Mount Pleasant, Diss.

The Mall School M.C.—An amusing form of miniature cricket has been introduced. This is played with a ping-pong ball and a bat made by bolting a 5½″ × 2½″ plate on a 12½″ strip. Three similar strips erected on the edge of a flanged plate serve for wickets. An interesting lecture on "*Butterflies*" was given by one of the members, who illustrated his remarks with specimens caught by himself. Hide and Seek in the dark is a very popular method of closing the meetings. A lecture on "*Fossils*" proved more interesting than the title suggested, and a Mock Trial of an alleged murderer was very amusing. Club roll: 30. *Secretary*: G. O. Mills, Keswick House, 60, Waldegrave Park, Twickenham, Middlesex.

New Zealand

Dunedin M.C.—Competitions are frequently held and many excellent models have been produced. A lecture on "*Electricity Applied to Meccano*" by the secretary proved very interesting, his demonstrations attracting great attention. Another evening was devoted to a demonstration of a Meccano model of a Gyro Compass. Mystery evenings are very popular and are keenly anticipated. Stamp Nights appear on the syllabus at regular intervals, most of the members being keen collectors. Club roll: 8. *Secretary*: Tony MacLachlan, Art Studio, 66, Albany Street, Dunedin, Otago, New Zealand.

Egypt

Cleopatra (Egypt) M.C.—The Library is a great attraction, and many interesting books have been contributed for general use. Members are hoping to pay a visit to the Suez Canal. A photographic section has been formed under the direction of the secretary, and a Club Magazine printed in Arabic is to be published. Meetings are well attended and members usually bring their friends to see how the club is conducted. The formation of a Gymnastic Section has been suggested. Club roll: 34. *Secretary*: Abd-El-Hamid Amin Abd El-Monem, 2, Haret El-Ismailly, Nasria, Cairo, Egypt.

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Then you can be sure that the machine you have bought will give you years of good service and jolly times in the open air.

If you join the Fairycycle Association—free to purchasers of a Fairycycle—you will belong to an association, formed solely for Fairycycle owners, which now has members all over the world. What splendid fun you can have if your friends also own Fairycycles ! Tell Daddy that you would like a Fairycycle, but ask him to see that it has the triangle trademark on the front.

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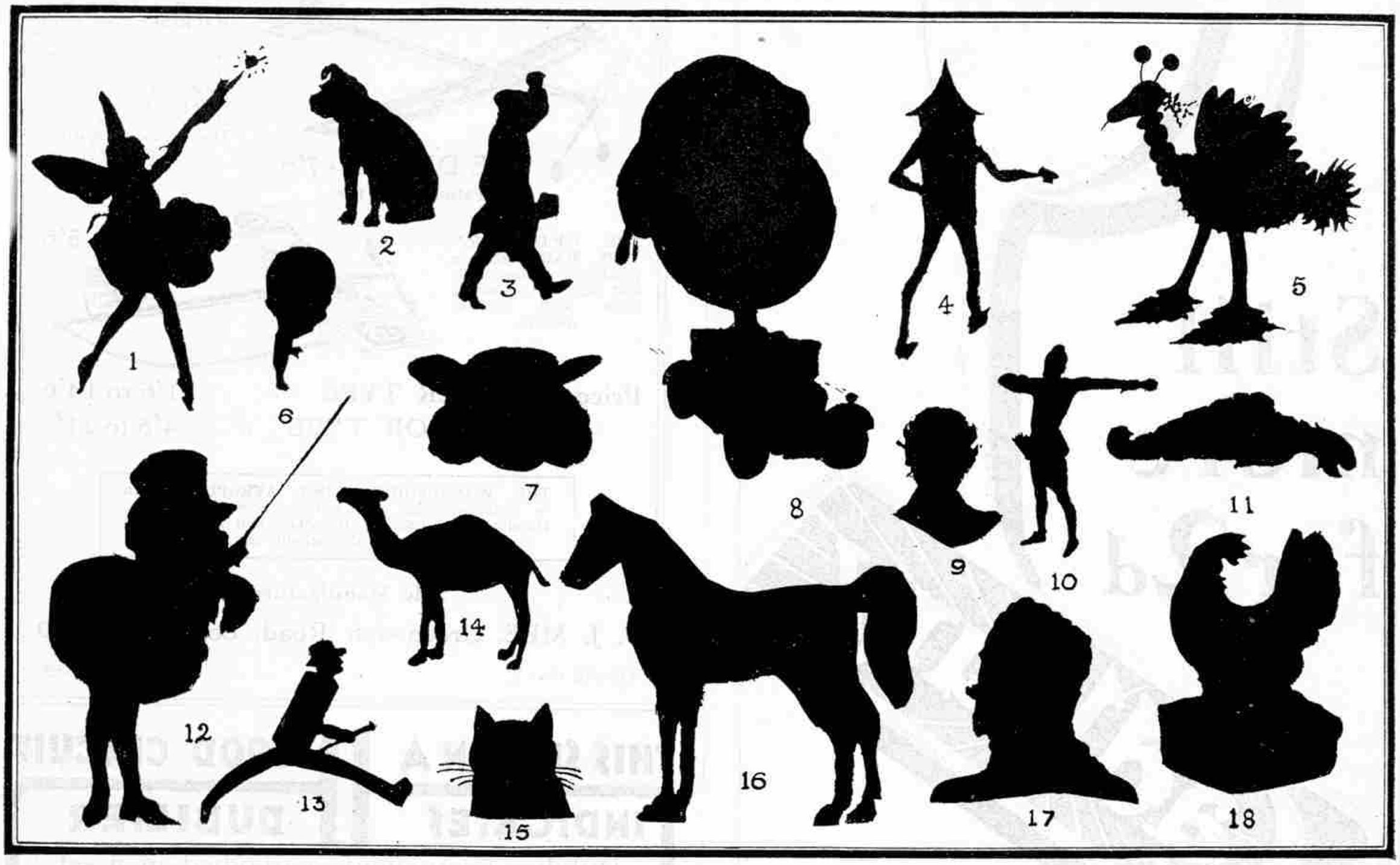
No. 6, Senior Model with 16" wheels, ⅞" ribbed tyres, ball bearings throughout.	70/-
No. 7, as Model 6, but with pneumatic tyres	75/-

Competition Page



What Advertised Products Are Represented Here?

Each of the silhouetted figures shown in the illustration above has been featured recently in the advertisement pages of newspapers and magazines, and readers are asked to identify as many as possible of the products that are advertised. Prizes of Meccano Products, to be chosen by the winners, to the value of £1/1/–, 15/–, 10/6 and 5/– respectively, will be awarded to the four competitors who submit the most accurate list of advertised products and the names of the firms marketing the individual articles. In addition there will be a number of consolation prizes. In the event of two or more competitors tying for any prize the award will be made to the competitor whose entry is the neatest or presented in the most novel way, as is our custom in such circumstances.

The solutions must be submitted in the form of a list, each item being numbered to correspond with the numbers appearing against the silhouettes in the illustration. Every competitor must see that his name and address appears on the back of his entry.

Entries must be addressed to "Silhouettes No. 3, Meccano Magazine, Binns Road, Liverpool," and must be sent to reach this office not later than 31st August. Overseas closing date, 30th November.

36th Photographic Contest

In pursuance of our policy of setting photographic subjects appealing to every one of our readers, our subject this month is "*A Transport Photograph.*" If it is necessary to add any words of explanation to a title of this description, it is sufficient to say that anything that carries passengers, or goods, comes within the definition "transport."

Prizes of Meccano or Photographic goods to be selected by the winners, to the value of 10/6 and 5/– respectively, are offered to the senders of the best and second best photographs in each of the two sections into which the competition is divided, A, those aged 16 and over; B, under 16.

Entries must be addressed to "36th Photographic Competition, Meccano Magazine, Binns Road, Liverpool," and must reach this office not later than 31st August. Overseas closing date, 30th November.

COMPETITION RESULTS

ADVERTISEMENT FRAGMENTS.—1. A. M. Johnston (Dunstable, Beds.); 2. R. Bern (Cosham, Hants.); 3. L. Daymond (Newport, Mon.); 4. G. E. Owen (Bishopston, Bristol). Consolation Prizes: W. D. Chops (Barnard Castle); B. Dennis (Honor Oak Park, S.E.23); R. True (Leicester); H. Smith (Balham, London); J. Shepherd (Eastbourne); R. H. Aldridge (St. Neots, Hunts.); H. S. Brown (Nailsea, Nr. Bristol); P. J. Healy (Cobh, Co. Cork); G. Harris (Thornton Heath); J. Toombs (Twickenham, Middx.); Special Consolation: J. Rodriguez (Maida Vale, W.9).

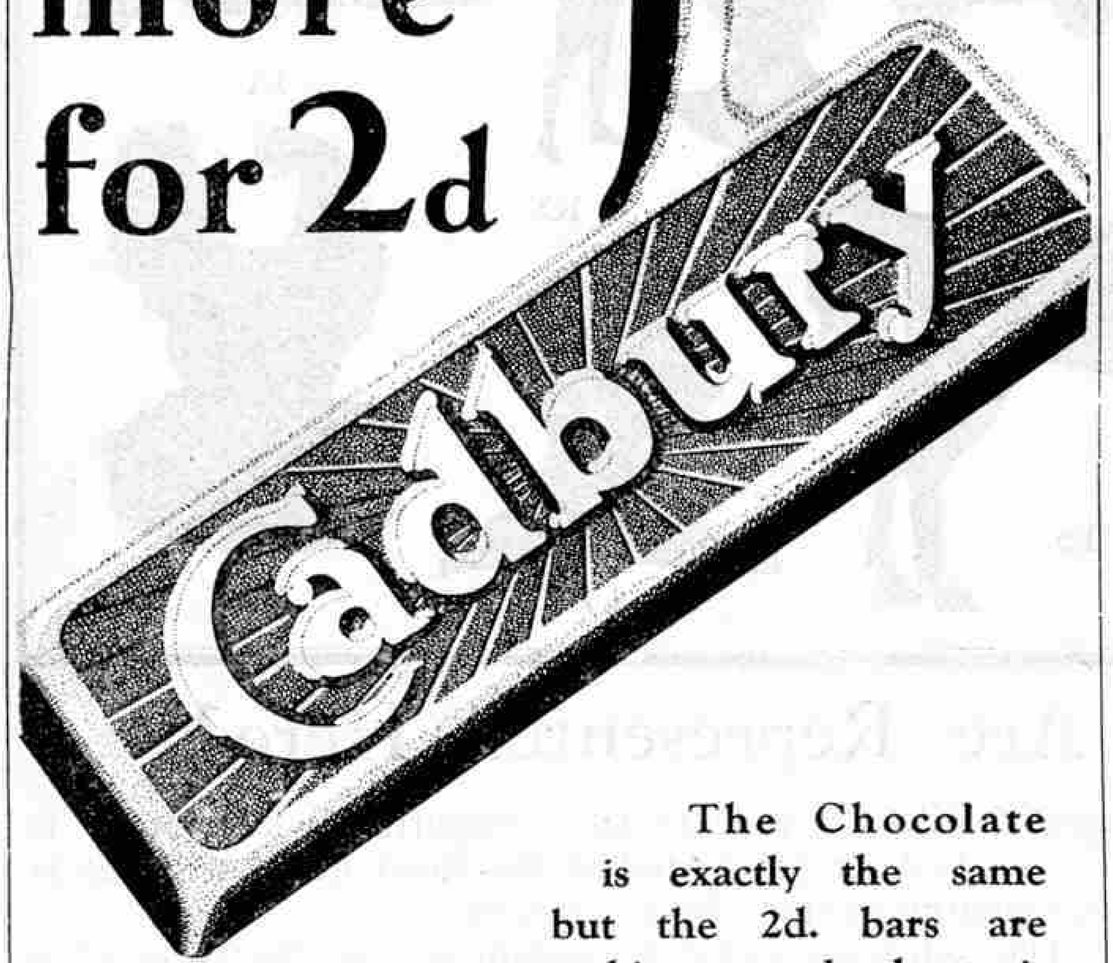
34th PHOTOGRAPHIC CONTEST.—First Prizes: Section A, F. G. Clements (Luton); Section B, H. Lambert (Harrogate). Second Prizes: Section A, J. Atkinson (Manchester); Section B, G. Lane (Wakefield). Consolation Prizes: H. Kite (Birmingham); A. G. Dodsworth (Pendleton).

OVERSEAS RESULTS

COVER VOTING CONTEST.—1. B. Singh (Lahore, India); 2. S. Falkof (Johannesburg, S.A.); 3. W. F. Kaler (Otago, N.Z.); 4. L. M. Noguera (Buenos Aires, Argentine Republic). Consolation Prizes: R. G. Mellsop (Pukekohe, N.Z.); J. Jessen (Dargaville, N.Z.)

CRITICS' LETTER CONTEST.—First Prizes: Section A, A. Hyde (Kaipara, N.Z.); Section B, E. Smith (Montreal). Second Prizes: Section A, N. F. Keith (Victoria, Australia); Section B, D. R. Edwards (Cape Town, S.A.) Consolation Prizes: A. Huszar (Cairo); R. W. Sallace (Durban, Natal, S.A.)

Still more for 2d



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Also in 6d. Packets and ½ lb. blocks (1/-)

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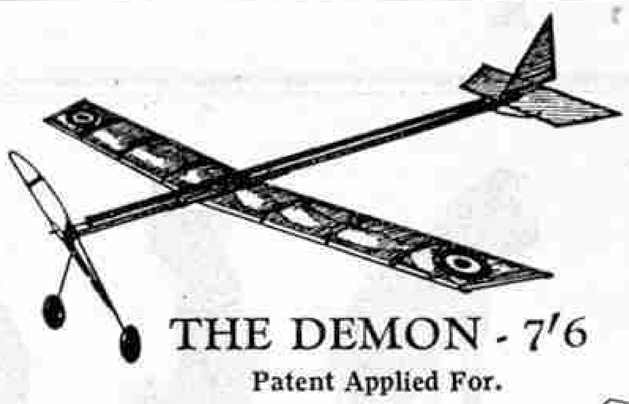
GUARANTEED FLYING MODELS



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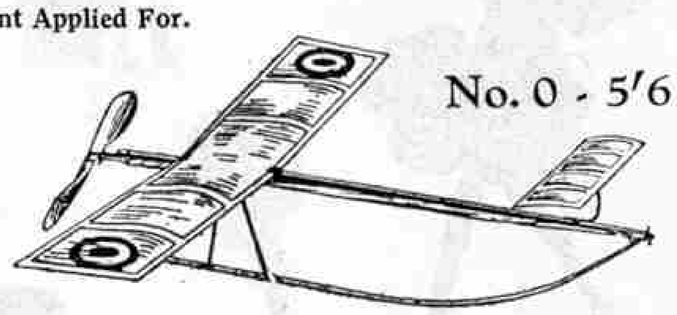
Patent Applied For.

THE 7/6 and 10/6 "TRACTOR" MACHINES are fitted with a combination swivel double bearing and shock-absorbing chassis. This invention gives the propeller a 50% advantage over other Tractor Models regarding breakages.

THE "PUSHER" TYPE MACHINES are practically unbreakable and can be flown into a brick wall without damage.



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Prices: PUSHER TYPE - - 1/6 to 14/6
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The Type 610 Mica Condenser illustrated is made in 21 different standard capacities between 0.00005 and 0.015 at prices ranging from 2/6 to 4/6. It will take either the Parallel or Series Dumetohm Clips. Type 620 is the upright type of the same condenser.

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DUBILIER REGISTERED TRADE MARK

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CHARITY STAMPS

CHARITY stamps had a humble beginning in the kindly thought of a Portuguese postal official who, in 1889, to aid charitable organisations, decreed that no longer need they pay postal charges on their outgoing correspondence. In order to identify their letters the organisations used a stamp of special design, a specimen of which is illustrated on this page. Its colour was rose and black and it had a red cross emblazoned on its centre.

Strangely enough, in spite of the obvious possibilities of the scheme, it attracted little attention outside Portugal, and it was not until 1897 that it was adopted elsewhere. In that year the British Empire was celebrating the Jubilee of Queen Victoria, and Victoria and New South Wales took the opportunity of turning the wave of popular enthusiasm into sentimental channels. Each of these States issued special commemorative stamps bearing face values of 1d. and 2½d. that sold at 1/– and 2/6 respectively. The surplus income arising from the sale of these stamps was devoted to local charities in the case of Victoria, and in New South Wales to the maintenance of consumptive sanatoria and to the furtherance of the State's general work in the fight against tuberculosis.

The Victoria 1d. stamp is illustrated and shows a portrait of Queen Victoria in a plaque mounted on a medallion with the word "Charity" emblazoned below the crown surmounting the plaque. The design of the 2½d. stamp also bears the Queen's portrait in the left half of the stamp, while the right half is occupied by a picture of a small cross and a Madonna and Child. New South Wales had their own designs in which the 1d. stamp showed a winged angel ministering to a reclining female figure. Beneath the picture are the words "But the greatest of these is charity." These two issues were the first in which the word "Charity" actually was used.

With the object of these two issues one can find no cause of complaint, for the intention was to supplement the Government grant to charity's aid. Unfortunately, however, charity stamps have been somewhat abused in recent years, and in some countries the frequency of their issue and the objects involved have evoked sheer ridicule. Mexico once issued a charity stamp to be used in addition to ordinary stamps in franking correspondence, the profits from the sale of which were to be used to fight a plague of grasshoppers ravaging the country! Nicaragua issued a set to raise funds for the rebuilding of a Post Office destroyed by earthquake, while two Swedish series were issued in 1916 and 1918 solely to raise funds to buy uniforms for the *Landstorm*, the name given to Sweden's reserve army which, at the time mentioned, was being held in readiness should necessity for its use arise during the great European war that was raging.

Among other funds that have benefited by the issue of charity stamps have been those to assist widows and orphans, to relieve distress caused by floods and famines, to erect monuments to soldiers, sailors, authors and poets, to assist the development of national sports associations and to provide a guarantee fund in connection with Olympic Games.

It is perhaps unnecessary to remind readers that an unused stamp has not fulfilled its nominal purpose, and such stamps when purchased by collectors represent almost a clear profit to the issuing Government. Because of this easily-earned income certain Governments from time to time have issued what frankly may be termed "speculative issues," solely for the benefit of the collector. Happily, however, the majority of charity stamps are legitimate in every sense of the word.

The success of the earlier issue encouraged Victoria to a further effort in the early days of the present century. The object was the raising of patriotic funds in connection with the despatch of troops to the South African War. The stamps bore nominal values of 1d. and 2d. respectively and were sold at 1/– and 2/–. The 1d. stamp had for its principal design the Victoria Cross, while the 2d. depicted cavalrymen clad in khaki, the general design of the stamp being emerald green. This was the only occasion on which Victoria departed from its custom of incorporating a portrait of Queen Victoria in the design of every stamp issued during Her Majesty's lifetime. Another Australian State, Queensland, issued two charity stamps simultaneously with the Victorian issue and for the same object. The Queensland stamps bore the same face values and sale prices as the Victorian issue, but in this case only one design was used. This shows a group consisting of two soldiers and a sailor flanked on each side by the Union Jack, with a phantom portrait of Queen Victoria in the background. The stamp bears a large label inscribed "Patriotic Fund."

Although since those early ventures other parts of the Empire have made use of the charity stamp on many occasions, the Home Government has never yet adopted the device, and, in fact, stands firm in an uncompromising objection to all stamps outside the recognised general issues. In the whole history of the stamps of Great Britain there is only one commemorative design on record—the British Empire Exhibition stamps of 1924 and 1925.

Since the object of charity stamps generally is the relief of suffering, one would expect to find a big number of issues in the countries immediately associated with the European War. France and Belgium have had resort to this form of raising money on several occasions, and here the funds principally have been devoted to the assistance of the Red Cross Associations, the support of widows and orphans of the War, and the rehabilitation of the devastated areas. It is impossible in the scope of this article to deal in detail with each of these issues, but perhaps at some later date an opportunity will arise to deal specially with the French and Belgian war charity stamps. For the moment we must content ourselves with illustrating specimens of the 1917 French stamps, each of which was sold at approximately twice its face value, the surplus being devoted to the support of War orphans. The first of the French stamps illustrated shows a widow carrying (*Continued on page* 693)

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MAKES ITS OWN AMMUNITION.
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To applicants for **APPROVALS** of **CURRENT FOREIGN and COLONIAL STAMPS** priced from ½d. upwards, we offer 299 stamps and one **NAVARINO** commemorative, free packet, one only for each customer.

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PACKET. 30 good class **ZOOLOGICAL** stamps only—giraffes, elephants, lions, tigers, birds, etc. **BORNEO** (rhinoceros), **NEWFOUNDLAND** (caribou), **IRAQ** (winged bull). These first three stamps alone are usually sold at nearly **twice** the price I am asking for the packet. **UKRAINE, GUATEMALA, POLAND, VOLTA** (dromedary), **SILESIA, MOZAMBIQUE, SUDAN** (camel), **WALLACE Is.** (bird of paradise), **NYASSA, TCHAD** (leopard), and many other fine stamps, Price **4½d.**

In addition, all purchasers of the Packet asking for approval sheets and sending 1½d. postage will be presented with two splendid sets—**8 MALAY** (tigers) usually sold at 10d. and **12 HUNGARY** (Turul—the mystic bird of the Magyars) catalogued 1/-. Send addresses of stamp collecting friends and receive an extra set free.

H. C. WATKINS (M. DEPT.), GRANVILLE ROAD, BARNET

Stamp Collecting—(*continued from page* 691)

a young child in her arms as she roams desolately across a snow-clad battlefield dotted here and there with wooden crosses marking the spots where the fallen lay buried. This stamp was sold at 5c. including a premium of 3c. The second of the two stamps shows two young orphans gazing as it were into the future in an endeavour to discern what lies ahead. This stamp was sold at 10c. the premium being 5c. It will be noted in both cases that the nominal values and premium charge are indicated.

In the same category as France and Belgium one may place the German charity stamps of post-war days. The specimen illustrated is that of the Christmas, 1922, issue on behalf of widows and children. The design shows an allegorical picture of an angel watching the Star of Bethlehem. A particular interest attaches to the Austrian issues that we illustrate, for they are the outcome of a peculiarly interesting discussion on psychology.

Away back in the winter immediately following the close of the War, an American stamp collector met a German nobleman in New York. The German was Baron von Rintelen, who recently had been released from prison where he had been interned during the War. The Baron with his many American interests was discussing with his companion how it would be possible quickly to eliminate the natural feeling of antipathy toward Germany and Austria. His American friend turned to him and said: "The military acts of your country have branded a picture into the mind and heart of mankind that completely effaces the picture of a kindlier, finer Germany that has contributed much to cultural civilisation . . . Why should you not suggest to your country that a silent, but effective, means of once again seeking the favour and liking of the world would be through the portrayal on its postage stamps of the finer things identified with your nation, its literary figures, its composers, its cathedrals, its historic architectural achievements?" The American recognised that art is international and the whole world appreciates the merit and the beauty of the works of the old masters irrespective of their nationality.

The American's suggestion was adopted only after the passage of three years, and then upon the seven charity stamps of Austria's 1922 series there appeared the portraits of seven great Austrian-born composers—Haydn, Mozart, Beethoven, Schubert, Bruckner, Strauss and Wolf. A year later each of nine stamps of a new charity issue depicted the architectural beauties of one or another of the many famous Austrian "show" places. Thus we are shown the glories of Salzburg, Eisenstadt, Klagenfurt, Innsbruck, Linz, Melk and Vienna, in addition to Bregenz and Graz that are depicted on the illustrations on page 691. The proceeds of the sale of the stamps of this issue were allocated to the relief of destitution in the towns illustrated.

Another of the countries that suffered in the War was Italy, and within recent years charity stamp after charity stamp has flowed from Italy's printing presses. Many of these are stamps of exceptional beauty and particular reference must be made to the Fascisti "blackshirt" stamps of 1923. The particular stamp we illustrate bears the date 28th October, 1923, the day of the Fascisti's march upon Rome to establish what is the strangest rule in modern history. Mussolini, the head of the Fascisti, is writing a new chapter in the history of the great country of which he is now the administrative head, and it is probable in the time to come this stamp will possess a significance out of all proportion to its present position. The design shows figures representing the Fascist legion taking their oath with arms outstretched in the form of the old Roman salute. The stamps were sold at twice face value, and the surplus went to the benevolent fund of the Fascisti or, to give the organisation its correct title, the Italian National Militia.

No reference to charity stamps would be complete without mention of the amazingly successful "*Pro Juventute*" issues of Switzerland. These had their beginning in an unofficial "sticker" that was issued at Christmas, 1912, by a Swiss Organisation named "*Pro Juventute*"—"For the Young"—formed to combat tuberculosis among children. Seasonable greetings were inscribed upon them and they were intended to be affixed alongside ordinary stamps, although the "stickers" themselves had no postal status. Over 1½ millions were sold and a revenue exceeding 127,000 francs was secured from the issue.

The organisers were far from satisfied, however, and approached the Swiss postal authorities to endeavour to secure recognition for the "*Pro Juventute*" Christmas stamp. Acquiescence readily was forthcoming and a scheme arranged under which an official postage stamp would be issued at a supplementary price of 5c. above face value. This sum was to be divided as to 4½c. to the "*Pro Juventute*" Society and ½c. to a benefit fund for Swiss postmen.

The number of stamps in each issue has varied between two and four, the customary face values of recent productions being 5, 10, 20, and 30c. The designs in the early issues were representative of national and cantonal juvenile costume, but since 1918 the designs have all been based upon the arms of the various cantons comprising the Swiss Federation, each being taken in turn. Another innovation in 1918 was the incorporation of the year of issue in each design. Each year millions of francs are netted for the children of Switzerland.

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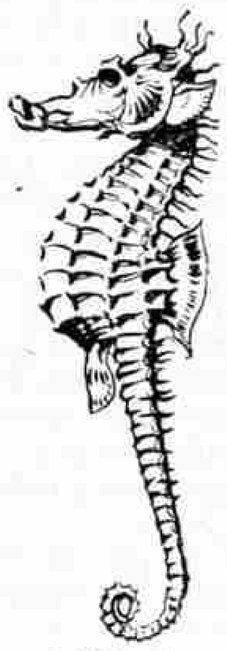
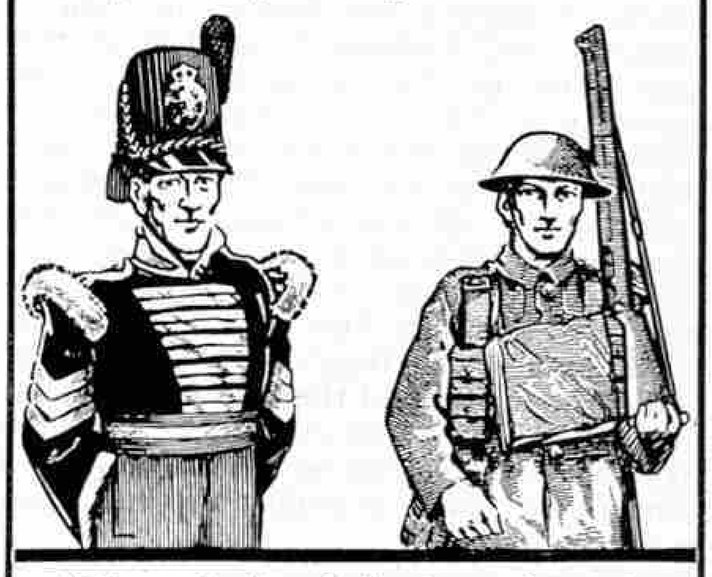
This Pictured Encyclopædia tells the story of the world, and most things in it. It is written by people who can make fascinatingly interesting even subjects you have always thought "dry."



A little Sea Horse from the book



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(*Send this form in unsealed envelope, ½d. postage*).

ADDRESS .....

.....

M.M.E. 1928.

Famous Aero Engines—

(*Continued from page* 663)

filter into which the oil drains from the engine. When the engine is stationary the surplus oil passes from the crankcase and collects in this sump, flooding of the crankcase and lower cylinders being thus prevented. Oil is drawn from the sump by a scavenge oil pump situated underneath the pressure pump, the scavenge oil pump then delivering the oil to the oil tank on the aircraft. On its way to the oil tank the oil passes through the jacketing of the carburetter and induction elbow, thereby imparting a positive degree of heating to the induction system.

A gear type petrol pump and relief valve of approved design are carried at the rear end of the engine, prolonged tests having proved this pump to be very successful.

A tachometer drive fitted to the engine is situated just above the petrol pump. The drive points towards the rear of the engine in order to avoid unnecessary bends in the tachometer flexible shaft.

Provision for priming is made by fitting a distributing ring at the rear of the engine, the ring having small branch pipes leading to each induction pipe. Each branch pipe terminates with a small atomising jet fitted to the induction pipes. The distribution ring is fed by means of a primer pump, filter and T piece, these parts being supplied loose with the engine.

Attached to the rear end of the engine is a conical bearer plate by means of which the engine is mounted in the aircraft.

Famous Trains—(*continued from page* 645)

our connecting train. The additional 45 miles of journey are booked to take 75 minutes, and Pretoria is reached at 6.25 p.m. But at Johannesburg, the headquarters of the South African Railway administration, the journey of the "*Union Express*" is at an end. It has covered 1,000 miles—all but a mere 44—and has risen from sea-level to an altitude of no less than 5,735 ft. in the course of the journey. Perhaps the most remarkable of the impressions that will remain with us when the memory of this trip has vanished into the past is that it should have been possible to travel for so great a length of time in such perfect comfort over so narrow a gauge.

Producing the "*M.M.*"

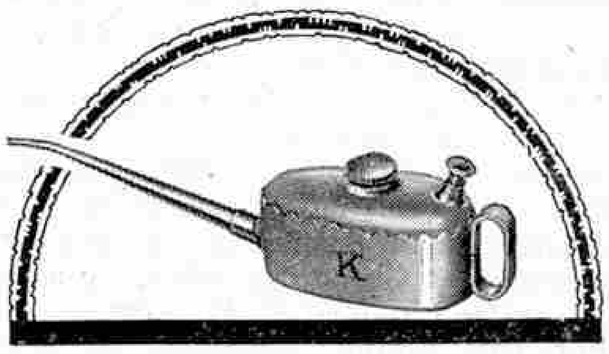
(*Continued from page* 637)

captions, the Editor has next to decide the size of type that he desires to be used for the article. If he writes "10 pt.," he requires the largest type that is used in the "*M.M.*" for articles; this is the type that is used every month for the "Reader's Page." More often the indication will be "8 pt.," a smaller type in which the Editorial notes are printed month by month. For certain purposes an even smaller type known as "6 pt." is used; "Our Mail Bag" is set in this type.

Having thus been provided with a layout that gives complete working instructions, the printer sets the type and submits proof sheets of his work. These proofs are scrutinised minutely by the editorial staff for any errors that may have crept in. As a further safeguard, proofs of articles that have been specially written are sent to the authors for examination and comment. Any necessary corrections are clearly marked in ink, and the corrected proofs are then returned to the printer, who afterwards submits a revised proof that usually requires no further alteration. When a corrected page is received, it is pinned or gummed in its pre-arranged position in the dummy, which gradually grows in to a completed dummy of the month's issue.

There yet remains the problem of dealing with "overset" matter—that is the small amount of matter that overflows from various articles. An article that was originally planned for, let us say, three pages, may, when it is set up in type, overflow its space by, say, 30 lines. Sometimes it is necessary to "edit" the end of this article and cut out sufficient lines to make the whole fit exactly the three pages. Very often, however, there are small spaces left here and there on other pages where the articles have not been long enough, and possibly this overset matter may be accommodated in one such space, with an indication at the foot of the main article as to where the continuation is to be found (see Fig. 2).

Finally, when all these details are attended to, the printer is given the word, and before long his machines are busily running, and in due course, when the printing is completed, the magazines are distributed by rail and steamship to their eager readers in all parts of the world.



A Perfect Miniature "K" Type Oil-Can

All Meccano and Hornby Train enthusiasts will be interested to know that we have introduced a miniature "K" type oilcan for use in oiling Meccano models, Hornby Trains, etc. The oil is ejected drop by drop by depressing the valve, as in the full-sized model, and in all other respects the oiler is perfect in every detail. It is made for us by Messrs. Joseph Kaye & Sons Ltd., of Leeds, the largest manufacturers of this class of goods in the world. Exhibited on our stand at the British Industries Fair, it was the subject of considerable attention. One of the oilcans has recently been sent to H.R.H. the Prince of Wales, and a gracious letter of acknowledgment has been received expressing H.R.H.'s admiration of the beautiful lines and perfect finish of this model.

Every Meccano model-builder and miniature railway enthusiast should add one of these oilcans to his equipment. They may be obtained from any Meccano dealer (price 3/6) or direct from Meccano Ltd., Liverpool (price 3/8 post free).

MECCANO LTD.
BINNS ROAD
LIVERPOOL

OUR MAIL BAG

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

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

L. H. Stone (London, S.E.18).—We think our articles on the Motor Car will have interested you and we should be glad to hear your opinion of them. You are quite right in thinking that it is wrong to speak of a ship travelling so many knots an hour. A knot is a measure of speed not of distance, one knot being equivalent to a speed of one nautical mile per hour.

W. E. Waight (Weymouth).—We are glad to hear that the "*M.M.*" helps you and your friends to keep up to date in the latest developments in engineering. This, of course, is one of our main objects, and appreciation such as yours is of great encouragement to us. We have many good articles in store for the "Inventors" series.

N. Burgess (Tweed River, N.S.W.).—"I think I would rather lose my dinner than my '*M.M.*'"! This is the right spirit Norman, but judging by the enormous size of the bunches of bananas in your photograph we do not think that you are in danger of starving. We can imagine you with the "*M.M.*" in one hand and a banana in the other, enjoying both mental and physical refreshment at the same time! You would see your article on the "Readers' Page" for June, and we hope that you will send us others from time to time.

T. Harwood (Rondebosch, S.A.).—You send us quite cheery news about your examination success, and we are glad that your father has promised to buy you a bicycle in recognition of your good work. We wish you many pleasant rides and no punctures! The display of Meccano at the Rosebank Show must have been very attractive. We are glad to hear that you are bringing up your young cousin in the way he should go and that he is already a Hornby Train enthusiast.

Daphne Pooley (Victoria, B.C.).—Your enthusiasm for model-building is quite refreshing, and we are glad to hear that you have got your clockwork motor. We quite agree with you when you say that "it makes a wonderful difference when the models you construct can be worked without your having to turn a handle, and any trouble you have taken in completing your work seems very much more worth while when you look at the finished article working just right."

C. M. Grosett (Westcliff-on-Sea).—"It must be done with cold steel—a pen nib not a bayonet, so here you find me writing to you for the first time." You really ought to be ashamed of yourself, C.M., for not having written long ago. We are interested to hear that you caught the contagious Meccano disease in Jamaica, and that, so far from being cured, your model-building temperature is steadily rising!

K. Black (London, N.21).—We wish we could find space for your "*Song of Meccano*," but we are afraid this is impossible. Your first verse has just the right swing and spirit:—"Angles and girders, plates, pulleys and strips, for motors and engines, for lorries and ships. Clockwork, electric and tall derrick cranes, everything wanted to run Hornby trains. Collars and sprockets, grubs, bosses and worms, the language we talk is full of strange terms. Chorus—M..E..C..C..A..N..O, we are the fellows who make things GO!"

P. J. Acton (Birkenhead).—It is good news to hear that the information contained in the "*M.M.*" has been so helpful to you in your school work and that your physics master has complimented you. We agree that the "*M.M.*" should give first place to subjects of engineering or of a general scientific nature, but at the same time you must remember that we have many thousands of readers who, although keen on these subjects, at the same time have other interests, and we cannot afford to neglect them. If, for instance, we were to do away with the stamp pages we should raise a storm of protest.

N. E. Bagshaw (Wallasey, Ches.).—"I would like to say that you have realised your ambition to make the "*M.M.*" the brightest and best Magazine for boys." Many thanks, Norman. We hope that the articles on the production of the "*M.M.*" commenced last month, are what you desire. A little later we shall publish the story of Meccano. Articles on the exploration of the Antarctic are in course of preparation, but it may be a few months before we can find room to start this series.

Electrification of the Metropolitan Railway—

(*Continued from page* 653)

11,000-volt oil selector switches for throwing the generators and feeders on to either one of the two sets of bus-bars. The next gallery contained the generator and feeder main circuit breakers.

The main characteristics of the switchboard structure were the directness and simplicity of the connections, the safety of the general arrangement and the fireproof construction. The two sets of main bus-bars mounted on porcelain insulators were situated in separate and distinct structures and the fireproof partition that separated each bus-bar from the others was wide enough to make it practically impossible for an arc to travel around it. Viewed from the end the arrangement presented a row of horizontal cells which ran the entire length of the switchboard gallery; while looked at from the top a row of vertical cells was seen in which the various cables taking current away from the bus-bars were carried. This construction effectively separated the cables from each other and from the bus-bars. The instrument board was constructed of marble panels and carried the instruments for the generators and feeders. The control switchboard was of the desk type made up of marble panels, the control switches being mounted on the incline base. The electrically operated alternator group and feeder circuit breakers were worked from here and also the electrically operated field switches, rheostats, and turbine governors. An outline diagram of the arrangement and connections of the generators, bus-bars and switching apparatus was laid out on the control desk thus placing before the attendant complete information of the whole controlling organisation.

In 1908 a new 5,000 kw. Westinghouse-Rateau impulse type turbine was installed together with six new boilers exactly similar to the original ones and the ash and coal handling plant was altered to bring the coaling capacity up to 70 tons per hour. Under this scheme the single conveyor originally installed to deal with both ashes and coal was converted into two separate conveyors, and additional horizontal tipping tray conveyors were installed in the ash basement and over the extended coal bunkers the capacity of which was increased to 136,000 cu. ft.

In 1920 a Bennis coal tipper also was installed.

Under the present arrangements the coal is unloaded by means of the tipper which completely overturns the wagons and pours the coal into the hopper below. From this point the coal is discharged by means of a rotary filler to the buckets of either of the two vertical bucket conveyors that were formed from the original ones. These carry the fuel to the top of the hopper tower where they tip it on to the new horizontal conveyors running over the bunkers which in turn distribute it to the desired boilers. The ashes are shovelled from the ashpits, the doors of which open into the basement facing the conveyor on to the trays of the horizontal conveyors. They are thus transported to the bucket elevator at the ash tower end of the building where the elevator carries a dump into the hopper ready for discharge either to railway wagons or road vehicles as may be convenient.

The original electrical installation was extended from time to time as the demand for current became greater. These extensions, most of which were carried out by the Metropolitan Vickers Electrical Company, have increased the full load capacity of the station to 35,000 kw. This great increase in the capacity of the station has necessitated among other matters a completely new installation of 11,000-volt switchgear. The power house is now 481 ft. in length and together with the subsidiary buildings occupies an area of seven acres. It furnishes energy to more than 85 miles of electrically operated railway and generates about 1,250,000 units per week.

On leaving the power station the current is transmitted to sub-stations through three-core cables, paper insulated, lead covered and armoured. Altogether there were 72 miles of this cable laid when the electric service was first opened and these have been added to as required from time to time until there is now in service over 103 miles of high tension cable. In the near future the total length of cable installed will reach 124 miles. When the line was first opened for electric traffic six sub-stations were in use and these have been now increased in number to ten. The current received from the station is three-phase alternating current at a pressure of 11,000 volts. This is too high a voltage for immediate use, and therefore it is transformed down to 370 volts and ultimately converted into direct current at about 600 volts for operating the trains.

(*To be continued*)

Electric Signals on the Southern Railway

Courtesy] [*Southern Railway*

The colour light signal apparatus guarding the approach to the Southern Railway's bridge over the Thames at Charing Cross Station. A vast traffic is handled here and the working across the bridge demands the most modern methods

A Meccano Pennant

A novelty that will make a strong appeal to every Meccano boy, is the attractive Meccano pennant, prepared in the standard Meccano red and green colours, and recently placed on the market by the "Q" Accessories Company.

The pennant is of strong cloth and measures 8 in. × 4 in. It is supplied ready for fixing to Meccano models, and looks exceptionally effective when surmounting a tower or similar tall structure. The ingenious mind of the Meccano boy will suggest a host of other uses. Meccano club cycling sections will find it a distinctive badge when flown from the handlebars of their machines. A special clip for this purpose is supplied at an additional cost of 2d. above the pennant's ordinary price of 9d. post free. Further details are given in our advertisement columns.

Photographic Toners and Stains

We have received an interesting booklet dealing with the use of "Tabloid" toners and "Soloid" Stains for producing varied coloured effects on photographic prints. The booklet gives illustrations in colour showing exactly the charming effects that may be produced by toning bromide or gaslight papers blue, green, sepia, etc., according to the nature of the subject. The blue toner is particularly useful as it is extremely effective for a wide range of subjects, including seascapes, mountain scenery, and winter scenes. Remarkable results may be obtained by multiple toning. In this case a crystal varnish is used to cover the portions of the print that are not intended to take the colour of the particular toning bath in use.

The production of colour effects by "Soloid" stains is even simpler still and the colours available are blue, green, red, and yellow. Various modifications in tone may be obtained by varying the quantity of water used in making up the staining bath, and also by mixing the stains. A copy of this booklet will be sent to any reader of the "*M.M.*" on application to Burroughs Wellcome & Co., Snow Hill Buildings, London, E.C.1.

MECCANO WRITING PADS

These Writing Pads are just the thing to use when writing to your friends, for the special notepaper shows at once that you are a Meccano boy.

The pads are supplied in two sizes, each consisting of 50 printed sheets of tinted bank paper with cover. Prices—Large, 1/- each (post free); Small, 6d. each (post free), from Meccano Ltd., Binns Road, Liverpool.

Meccano & Hornby Train Supplies

All the dealers whose advertisements appear on this page carry full stocks of Meccano Outfits, Accessory Outfits and Meccano parts, Hornby Trains and Hornby Train Accessories all the year round. The names are arranged in alphabetical order of town.

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ALTRINCHAM.

J. BELL,
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256, Grange Road,
'Phone : B'head 621 BIRKENHEAD.

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BIRMINGHAM.

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BLACKBURN.

BATESON'S SPORTS DEPOT,
Abingdon Street,
BLACKPOOL.

SELLEN'S BAZAAR,
54, Waterloo Road,
BLACKPOOL, S.S.

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70, Knowsley Street,
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BRIGHTON.

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Tel. : Brighton 957 BRIGHTON.

BRISTOL TOY EXCHANGE,
92b, Whiteladies Road,
Clifton, BRISTOL.

GYLES BROS. LTD.,
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188, Whiteladies Road, Clifton, BRISTOL.
Tel. 143

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PANTOYS LTD.,
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37, Westgate Street, GLOUCESTER.

THOMAS JAMES & SON,
High Street,
CINDERFORD.

R. H. JEPSON,
1, Cross Cheaping,
COVENTRY.

PURSEY & MOCKRIDGE,
The Sports Outfitters,
Tel. Dartford 173 DARTFORD.

HENRY WHALLEY,
195, Duckworth Street,
DARWEN.

RATCLIFFES TOYERIES,
19, Osmaston Road,
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JAMES L. DIXON,
14, Suffolk Street,
Tel. Dublin 1528 (off Grafton St.), DUBLIN.

DIXON'S
41, High Street,
Telephone No. 5810 DUNDEE.

BASSETT-LOWKE LTD.,
5, Frederick Street,
EDINBURGH.

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The London Motor, Cycle & Sports Co.,
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E. M. COLLINS,
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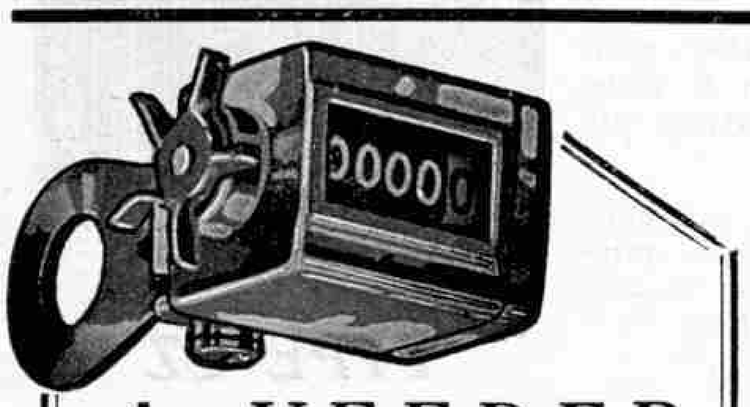

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CYCLOMETER FITTED TO YOUR BICYCLE TELLS YOU :
How far you have been.
Distance from one place to another.
Service your tyres give you.
Number of miles to destination.
Distance travelled, etc.

Make your riding doubly interesting. Its accuracy has been endorsed by all the best authorities and the experience of your fathers for 30 years.

Insist upon a genuine Veeder—see the name thereon.

Made in Two Models :
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F. E. DICKINSON,
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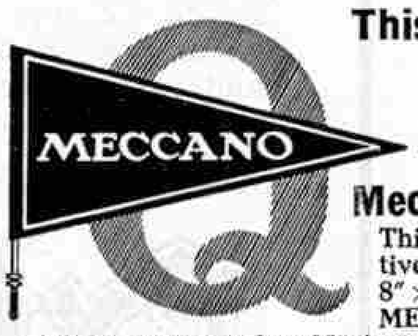

This "Q" Pennant on your cycle shows you are a Meccano Engineer

This bright and attractive Pennant, size 8" × 4", in correct MECCANO Red and Green, with Rustless Mast and Fixing Nuts to fit your Cycle or Model. Think of the finish it will give a MECCANO Tower, etc. ! ! Send a P.O. 9d. (not stamps) and it will arrive nicely packed, post paid, by return. Handle Bar Clips 2d. extra.

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Liberal Discounts to Meccano Dealers.

This Space is set to ½ inch s.c. and costs 5/- per month. The sum is the 80th of £20, the price of a whole page advertisement. Over 56,500 copies of the May number were sold in various parts of the world. Your advertisement therefore reaches this exclusive public for approximately 1d.1,000.

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More popular than ever.
All our Skates are extension type and adjustable to any size.

Send for a pair now. You will be delighted with them.

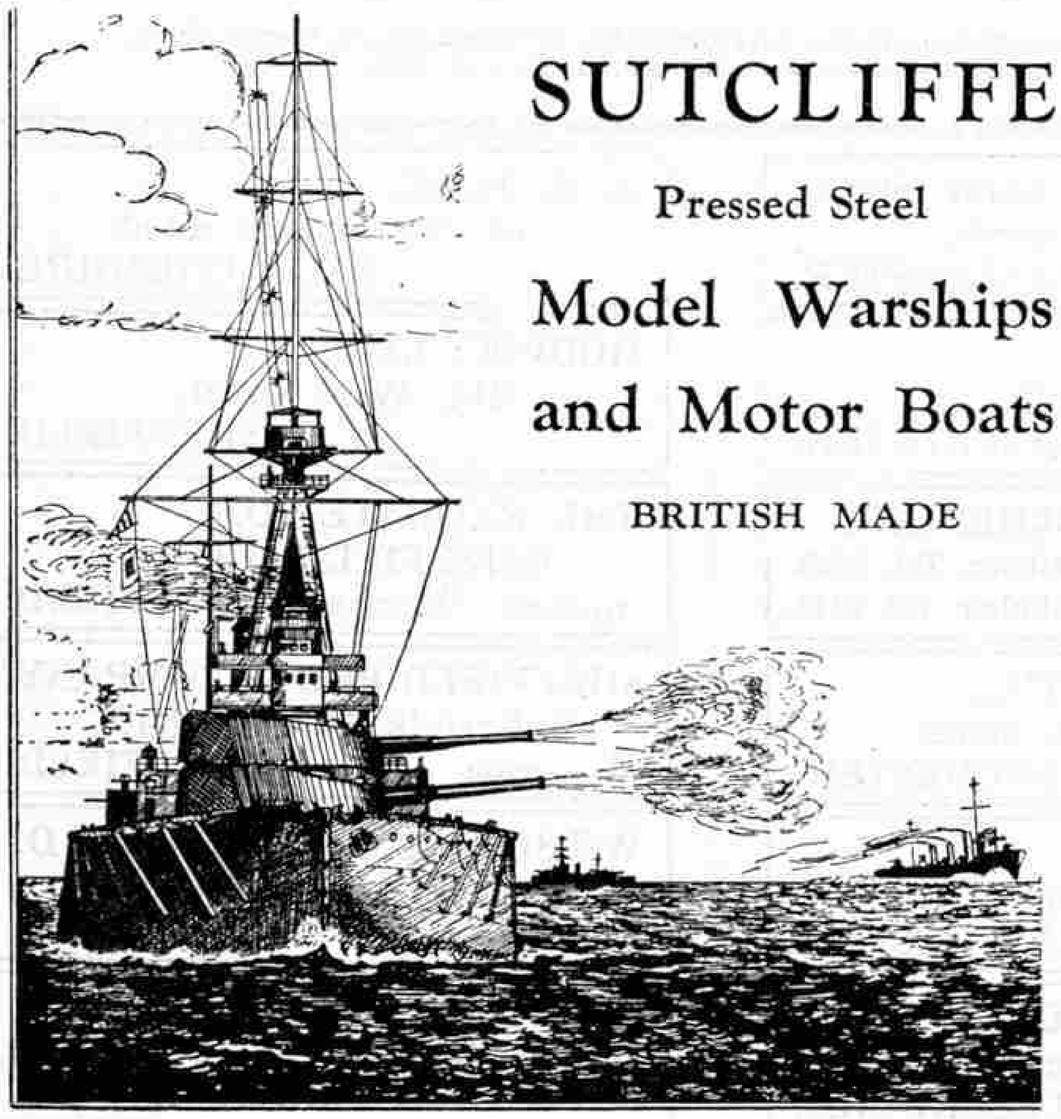
They make an ideal birthday gift.

No. 3 with Threaded Clamps and Case-hardened Steel Wheels ... 5/- pair
No. 5 with Best Ball-Bearing Wheels 10/- ,,
No. 6 with Best Ball-Bearing Wheels and Block Heels, as illustrated ... 11/- ,,

Postage and Packing 1/-. Colonies and Abroad 5/-

Bateson's Sports Depôt, Blackpool

Half-a-mile at a stretch!



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Pressed Steel

Model Warships and Motor Boats

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Wouldn't you like a model boat which will travel half-a-mile at a stretch without attention, and which never gets out of order?

Sutcliffe models are really wonderful toys because they will travel two miles at a cost of only one penny and will go on working for year after year without ever getting out of order. There is no engine, no boiler, no clockwork, no electricity—but they go! The method of driving is a mysterious and most ingenious arrangement and will puzzle and interest you—and your Dad too! You must have a Sutcliffe model for your holidays this year.

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Send a postcard to-day for free booklet

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THE SUPER TOCK TOCK
(Patented)

SPEED BOAT

For the Lake. For the Bath. For the Stream. For the Basin.

Will tow 5 times its own weight.

INSTANT ACCELERATION. NO WAITING.
NO CLOCKWORK. NO EXPENSIVE BATTERIES.
Fitted with Rudder. Draught 2", Length 9".
Easily carried from place to place.

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The continuous Tock Tock appeals to all. It cannot be found in any other boat.

See Demonstrations at Exhibition of Inventions and Model Engineers' Exhibition.

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Overheard: "Never judge by outward appearance. Who would think that there was milk in a cocoanut?"
"Yes, and who would think that Tock Tock would give out such a cheery noise?"

TO HEAR IT, IS TO BUY IT.

THE UNIVERSAL LOW TENSION BATTERY

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Whether your set has one or seven valves—whether your valves require 2 or 6 volts, a CZ type Exide battery will suit your needs.

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Capacities from 20 to 60 Amp. hrs.
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These batteries are also suitable for operating Meccano electrical models, but for this purpose we specially recommend **Exide patent unspillable cells.**

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1ft. 8ins. Long.
Illustration here is one third actual size.

During The British Industries Fair
This Real Steam Express Loco ran 183 miles!

It was re-filled every 40 minutes, and pulled six large coaches throughout—a real express run of 1½ miles at each filling.

Price of Loco, 27/6 Price of Tender, 7/6

Postage U.K., 1/-; Abroad extra.

Your dealer has it—if not, send P.O. direct and mention his name.

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BOWMAN MODELS

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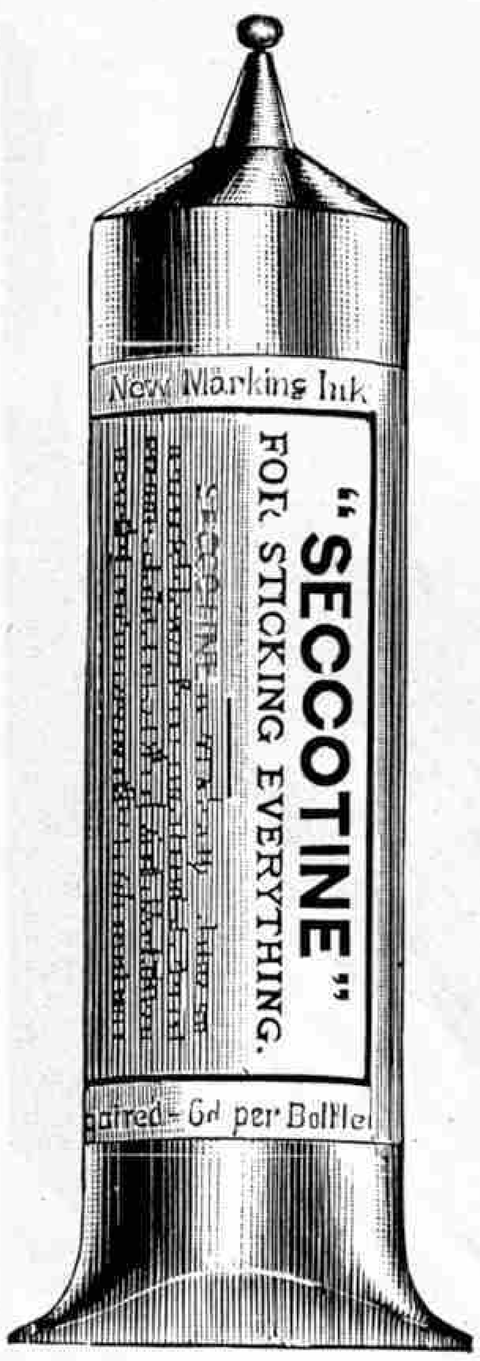

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The World's Great Adhesive. Registered Trade Mark.

WITH it he can mend a thousand things—his bats, balls, boats, boxes, bags, books, &c. He can make numberless things that a boy likes. He can help his mother by mending breakages in house furniture, anything—everything.

NOTE. There is nothing messy about Seccotine. Use the spike or pin supplied to open a new tube—at top of cone—press gently at end of tube (at folded part) for as much adhesive as is needed—then replace spike or pin which acts as stopper. Keep folding tube end as contents are withdrawn. Give mended article adequate time for drying.

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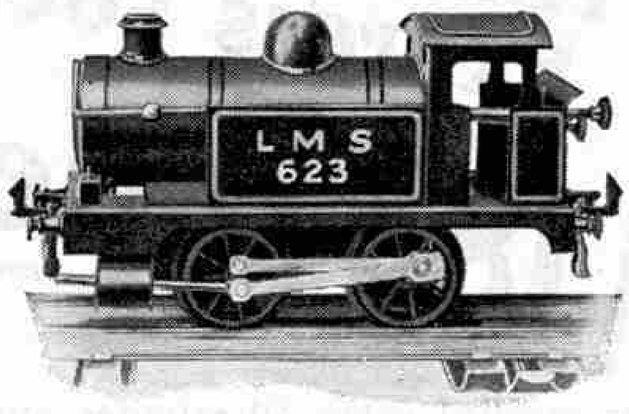
The Linenhall Works BELFAST

HORNBY TANK LOCOS



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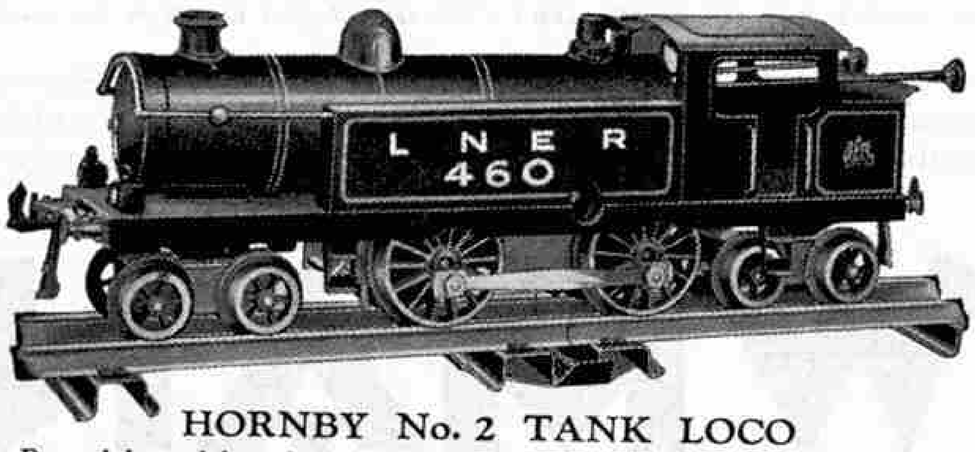
Strong and durable loco capable of any amount of hard work; richly enamelled and highly finished; fitted with reversing gear, brake and governor.

Gauge 0, in colours to represent L.M.S., L.N.E. or G.W. Railway Companies' Locos ... ... Price **12/6**

Hornby No. 1 Tank Loco, fitted for Hornby Control ... „ **15/-**



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Powerful model embodying all the splendid Hornby characteristics. It is 10½" in length and is fitted at both ends with a four-wheeled bogey. Beautifully finished in colours to represent L.M.S., L.N.E. or G.W. Railway Companies' Locos, and suitably lettered. Fitted with reversing gear, brake and governor. Suitable for 2-ft. radius rails only. Price **22/6**

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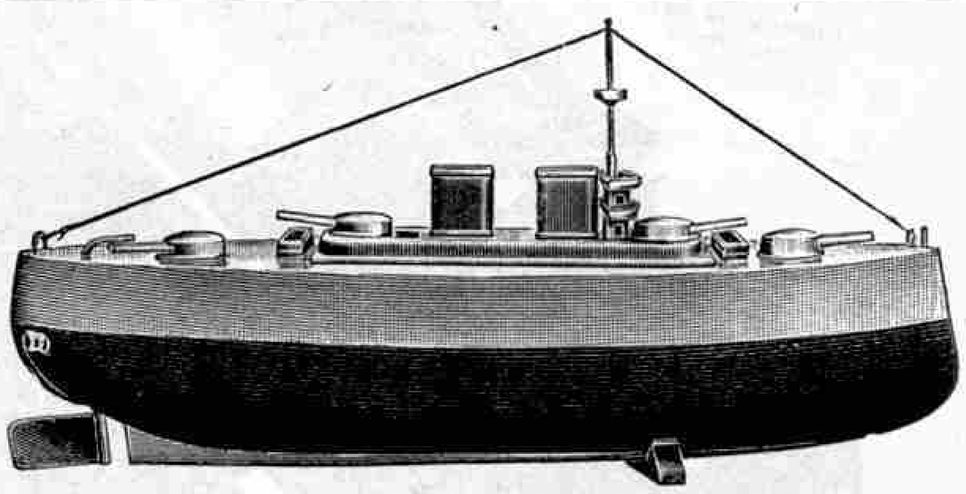

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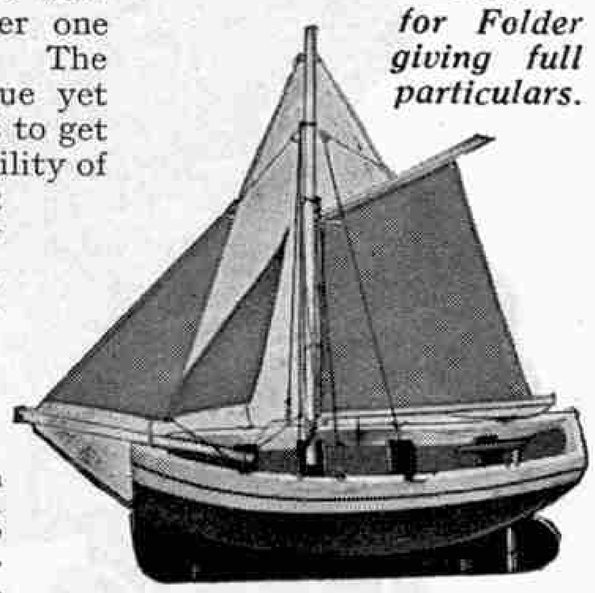
Correctly rigged with blocks enabling sails to be set or lowered. Hull hand-carved from the solid. Brown canvas sails. These boats are guaranteed to sail. Length 17½ ins. Price **4/6.**



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JAEGER
Pure Wool

The 1928 Jaeger "Meccano" Jersey

is made with smaller dice effect in the borders round neck, sleeves and base. It can also now be had with Knickers (with fly opening) to match, at prices quoted below.

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22″	24″	26″	28″	30″ Chest
7/–	7/9	8/6	9/3	10/–

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20″	22″	24″	26″
13/–	14/–	15/–	16/–

Colours :—Navy with Royal Blue and Saxe border.
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Three-quarter Hose, Turnover Tops to match

3, 4	5, 6, 7	8, 9, 10
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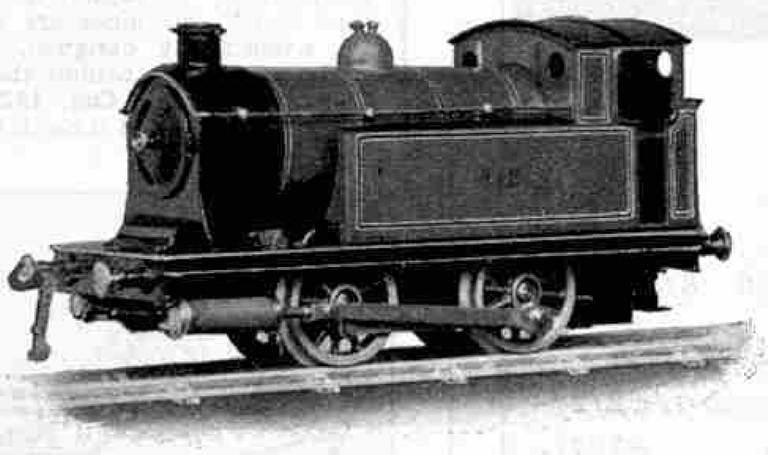
Scale-model Standard 112 Tank Locomotive, Gauge 0, Clockwork, Steam or Electric.

£2 : 5 : 0



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Scientifically Designed.

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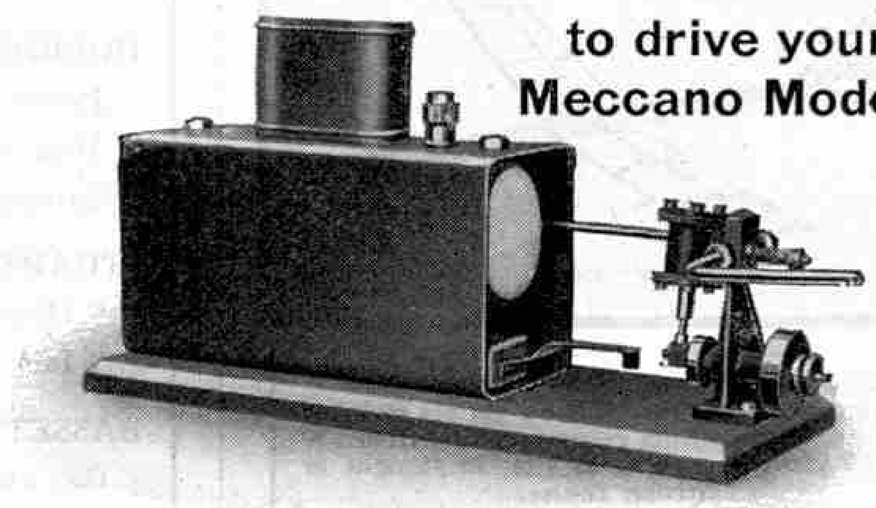
You must have the S.T. ENGINE
to drive your Meccano Models



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TRADE MARK 'TABLOID' BRAND 'TANCOL' TRADE MARK

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THE NEW 1928 IMPROVED MODEL OF THE FAMOUS

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From your dealer	3½ × 2½	6 for 9d.	12 for 1/3
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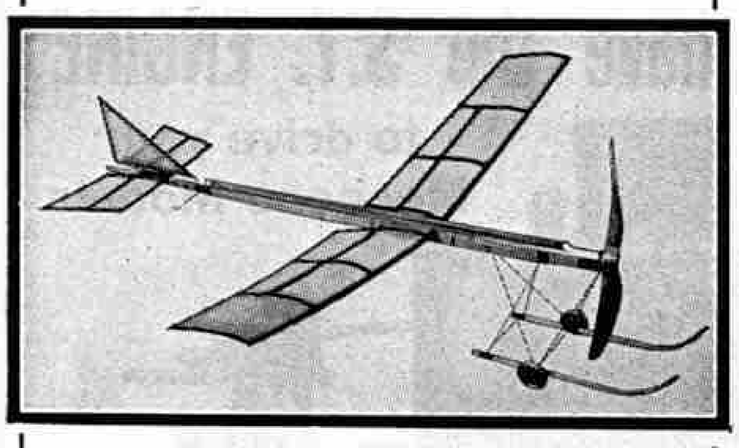
THE MOST POPULAR FLYING MODEL

THE FAMOUS "SKISAIL" Tractor Monoplane



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No. 0	Price	18/6	No. 3	Price	8/6
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Wing Span of our 4/6 Model 21 in., 10/6 Model 27 in. Span, with Patent Safety Chassis.

The 1928 "Skisail Model de Luxe"

Wing Span 43 ins. Price 27/6 carr. paid.

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THE PROVED BEST MODEL AEROPLANE

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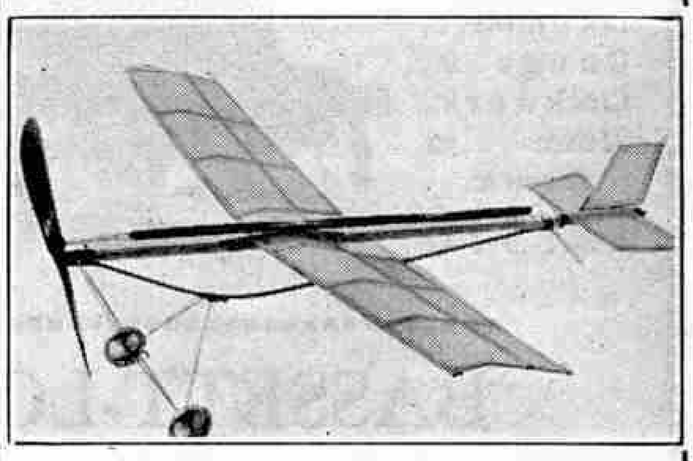

No. 6 TRACTOR MONOPLANE, as shown, span 22 ins., flies 150 yards, length 24 ins., rises from the ground, fitted with **Hand-Carved** propeller. Price **10/6**

Carriage and packing U.K. 9d. extra.

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No. 4B. Span 21 ins., flies 130 yards, length 22 ins. Price **7/9**

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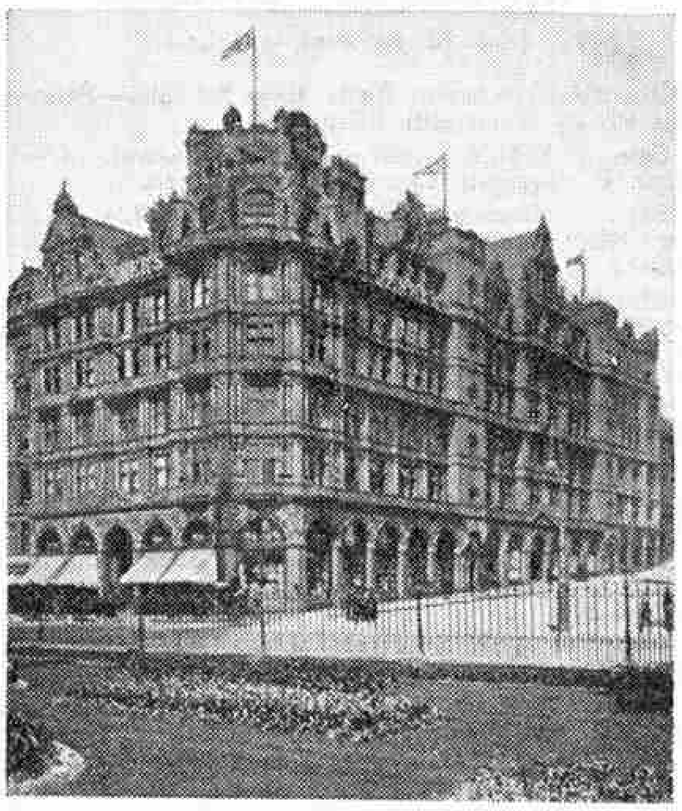

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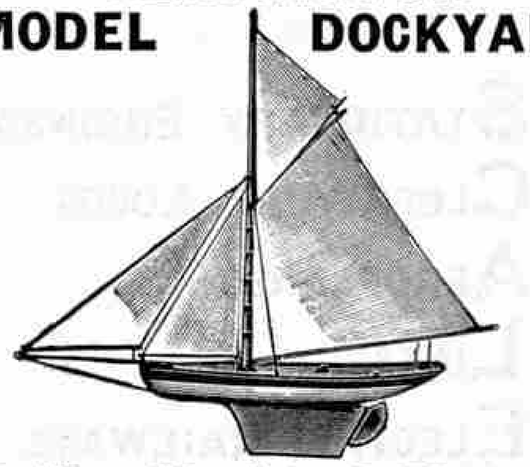

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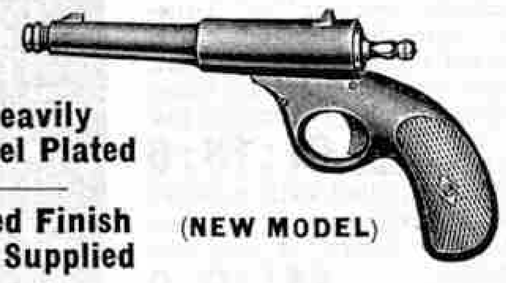

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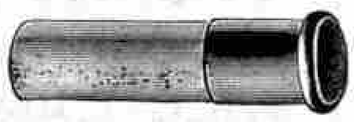

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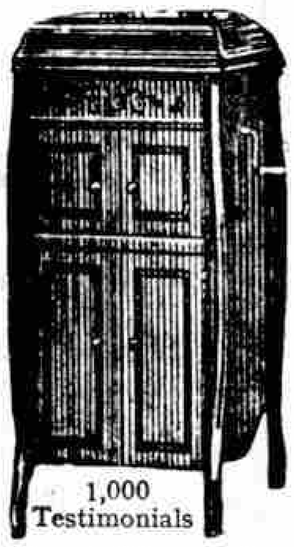

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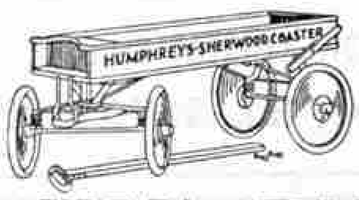

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Publication Date. The "*M.M.*" is published on the 1st of each month and may be ordered from any Meccano dealer, or from any bookstall or newsagent, price 6d. per copy. It will be mailed direct from this office, 4/- for six issues and 8/- for twelve issues.

To Contributors. The Editor will consider articles and photographs of general interest and payment will be made for those published. Whilst every care will be taken of articles, etc., submitted, the Editor cannot accept responsibility for any loss or damage. A stamped addressed envelope of the requisite size should be sent where the contribution is to be returned if unacceptable.

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Readers Overseas and in foreign countries may order the *Meccano Magazine* from regular Meccano dealers, or direct from this office. The price and subscription rates are as above, except in the case of Australia, where the price is 1/- per copy (postage extra), and the subscription rates 8/- for six months and 16/- for 12 months (post free).

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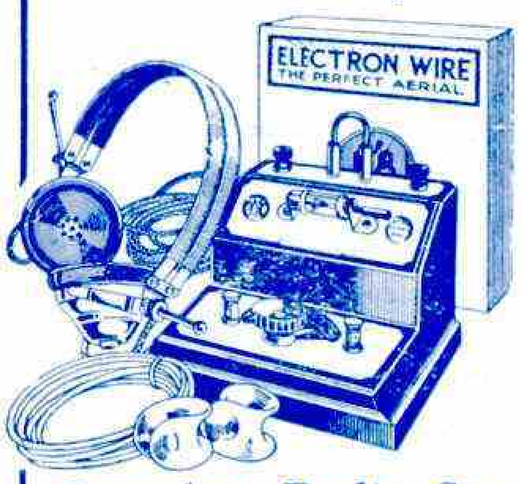

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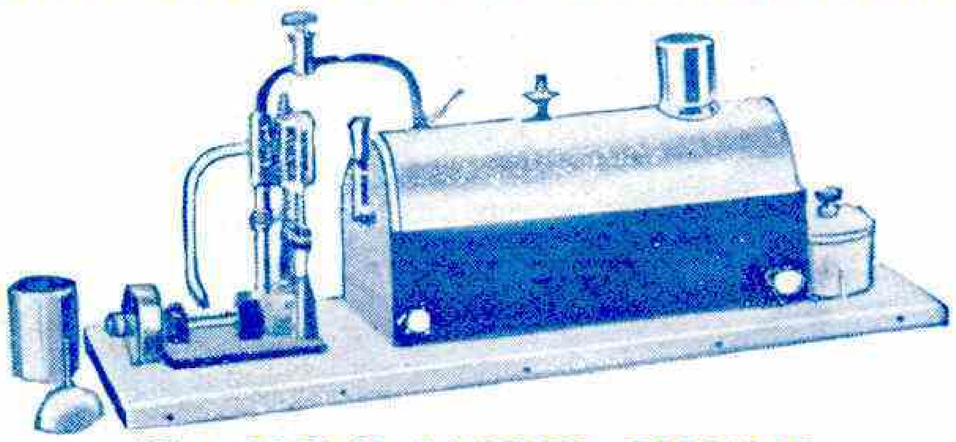

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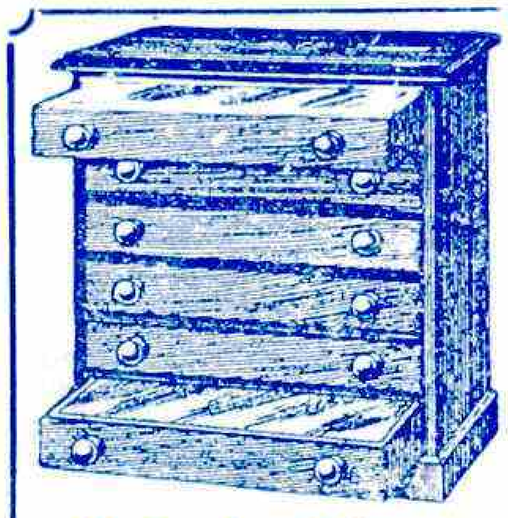

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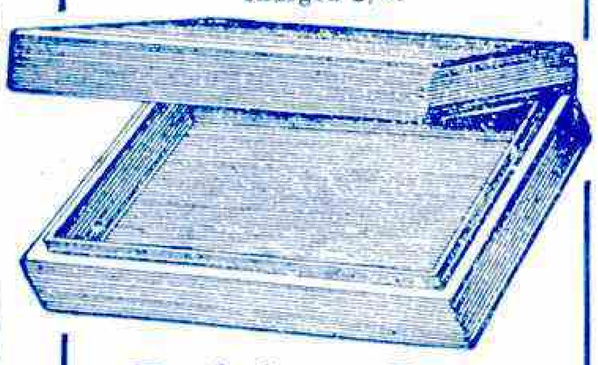

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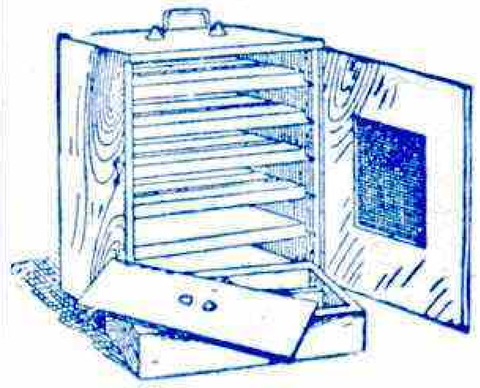

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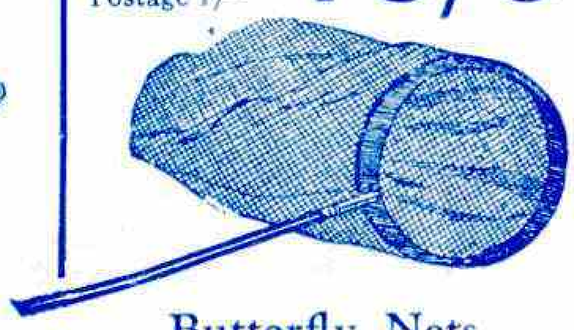

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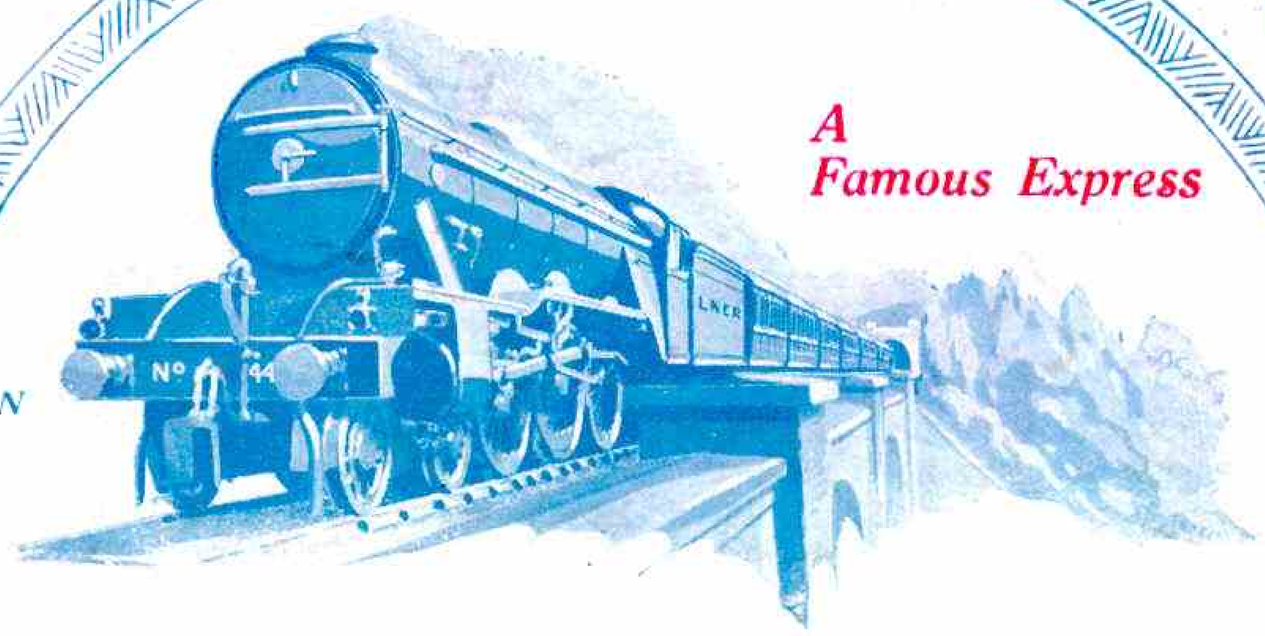

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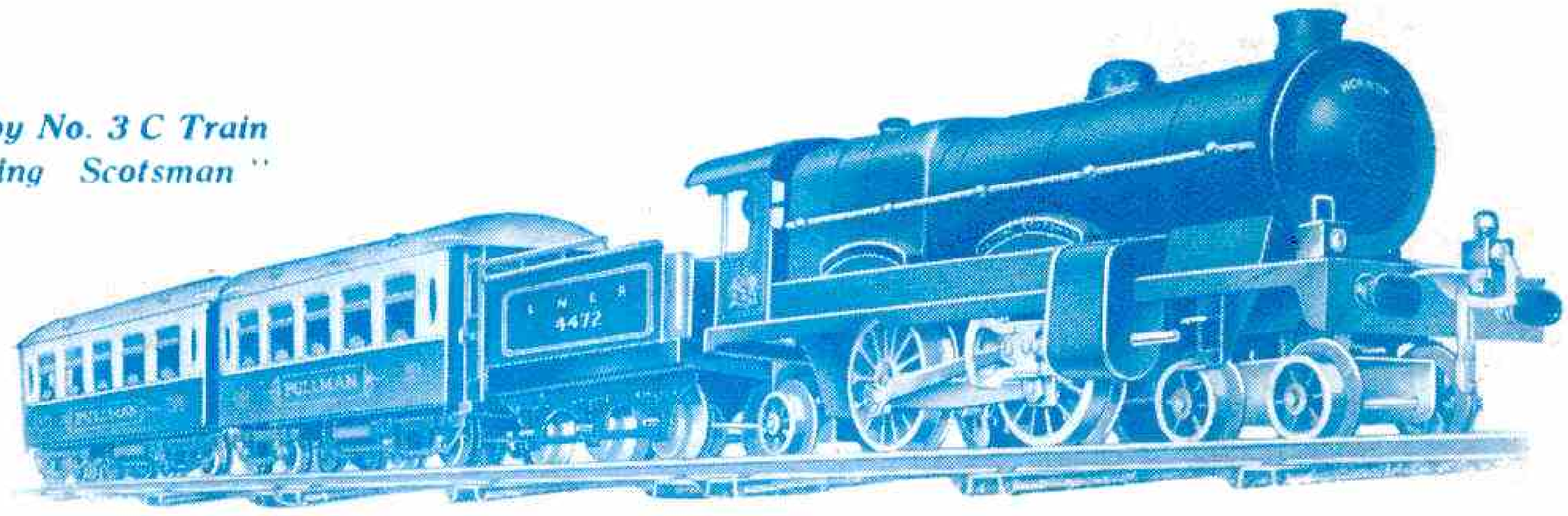

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