

HOW THINGS ARE MADE

Steam Units for Road and Rail

The "Sentinel" Works at Shrewsbury

ONE of the most interesting works of its kind in the country is the home of the well-known "Sentinel" steam wagons and locomotives at Shrewsbury. The great factory is situated on a plot of land 65 acres in extent, and occupies a site that flanks the road between Shrewsbury and Whitchurch. The works proper are on the western side of the road, the eastern side being reserved for a garden village, playing fields, and open spaces for recreation of all kinds. There is a canteen that will seat 1,000, where good food may be obtained by the work-people at practically cost price. Staff dining rooms are attached to the canteen.

The two-storey ferro-concrete building that is at the entrance to the works, and which abuts immediately upon the road, is used for the offices. The ground floor of this building is devoted to an extensive drawing office with some 50 draughtsmen and tracers, and to the administrative offices under the supervision of the works manager. The floor above is divided equally between the accounting department and the sales department. Owing to the nature of the products made by the company, it has been found that single-storey saw-tooth buildings suit their purpose best, and accordingly all the shops are built on this plan. In order to simplify construction and to facilitate alterations and extensions all the roof trusses throughout the entire works are standardised. Further, all the principals are not riveted, but bolted together, so that it is a simple matter to erect them or move them according to requirements. Whenever a new bay or a new building is erected, provision is made at all the columns for the connection of further bays or buildings. Throughout the whole works the spacing and layout of all buildings is a multiple of the bays; thus when extensions become necessary there is no difficulty in fitting buildings in between those already in existence.

The works are laid out upon what is known as the "constant flow" principle. In other words, as far as is possible all materials for manufacture travel in one direction from the spot at which they enter the works to the place where the finished product is delivered. This principle has a very important bearing upon the economics of manufacturing, and it is largely responsible for the successful development of mass production.

In the "Sentinel" works the flow is from a siding at the western side of the works to a road at the eastern side, the works being laid out between the L.M.S. main line from Shrewsbury to Crewe and the road already mentioned. Most of the raw material required in manufacture comes in by rail, and in order to maintain

the direction of flow without interruption all material that comes in by road is sent to the railway siding to be put into circulation from that point.

Immediately flanking the large concrete off-loading platform, which abuts on to the siding, is a large rough-part store. Into this are received all materials that require no preliminary treatment. Certain castings after being received must be "aged," and these are stacked in a special space adjoining the siding. Others must be "pickled" before they are fit to be machined, and therefore a pickling tank and gear are situated at one end of the off-loading platform.

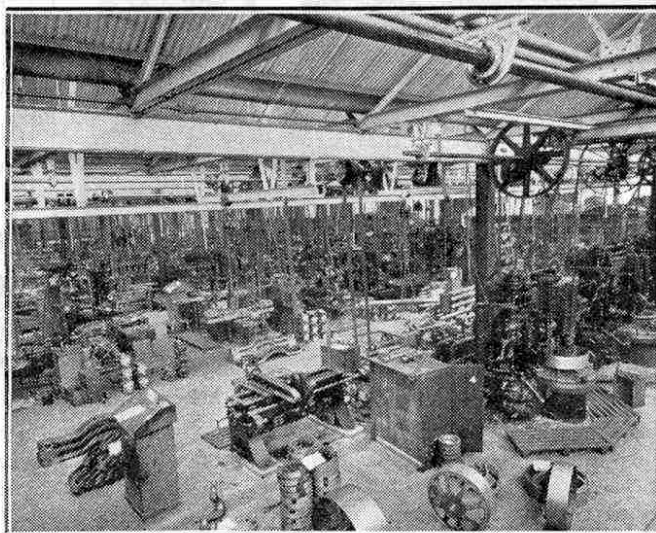
The main rough-part stores runs completely along the end of all the bays that constitute the main machine shop. This shop has an area of over 45,000 sq. ft. and, in addition to being fitted with all the most modern machine tools, it also houses a large number of special machines expressly evolved for carrying out work on "Sentinel" engines and other units. Among these special machine tools may be mentioned the inserted tooth straddle milling machine for facing the ends of the crank cases and for facing cylinder castings to length; and the compound lathes

that carry out the boring of the crank case end covers, while at the same time they form the spherical bearings by which the engine is hung in the chassis. There is also a special drilling machine which, at one operation, drills all the chain wheel bolt holes in the spokes of the road wheels, and at another operation reamers the holes already drilled.

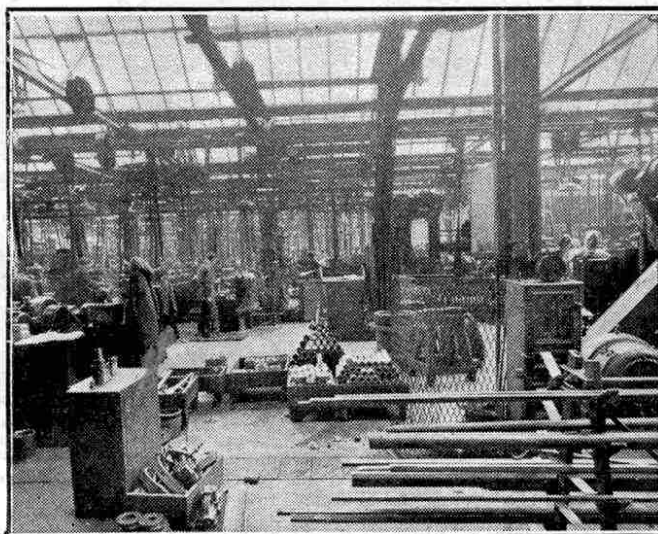
A feature of this and all the other shops is that they are driven electrically by means of individual motors installed in each bay, and that every yard of shafting throughout the entire works is carried on anti-friction ball bearings. The saving in power thus effected amounts probably to some 25 per cent. of the useful power that is employed throughout the works.

In prolongation of the main machine shop and separated from it by one of the works streets are the spare parts machine shop and the erecting and the paint shops. The second of these covers 16,200 sq. ft. and is divided into two portions that constitute the wagon and the locomotive erecting departments respectively. The former is a plain shop practically devoid of machinery. Into it are brought frames from the frame shop,

engines complete from the engine erecting bed, and the axle assemblies from the sub-assembly erecting shop in the machine shop. The frames are laid upon trestles of such a height that the axle assemblies can be slipped under them readily. The engine is dropped into place by means of an overhead crane, and



The photographs on this page show views of the extensive main machine shop in the "Sentinel" Steam Wagon Works at Shrewsbury (see below)



The machine shop, which has a floor space of more than 25,000 sq. ft. For the above illustrations we are indebted to "Modern Transport"

at the same time the cab, boiler and other fittings reach the erecting shops by roads specially laid for each purpose.

Adjacent to the wagon erecting shop is the pipe-bending department where all piping is made for both wagons and locomotives. Before any "Sentinel" engine leaves the engine erecting bed it is tested by compressed air and the valve clearances and settings are checked. When completed, the wagons are passed out at the farther end of the assembly shop and sent for test.

The other half of the erecting shop is devoted to the erection and testing of "Sentinel" locomotives and power-units for the well known "Sentinel-Cammell" rail-car.

In this shop there is a bed for testing the pulling powers and general running of the locomotives placed half-way down the shop. This testing bed, which was developed specially for testing "Sentinel" locomotives, consists essentially of three sets of rollers, grooved in such a manner as to accommodate any gauge from 75 mm. up to 5 ft. 6 in. The rollers are carried in substantial plummer blocks sliding upon machined beds, the latter being sunk in a pit under the floor of the erecting shop. By means of suitable screw gear, the distance from roller to roller can be varied so as to accommodate locomotives of different wheelbases, as well as of different gauges. Through suitable gearing the rollers drive two generators, the output of which is absorbed in resistances of the liquid type placed alongside the test bed. The whole outfit is provided with speed indicator, dynamometer, voltmeter and ammeter, so that the performance of any locomotive under test can be readily determined. Every "Sentinel" locomotive passes over this test bed before it is allowed to leave the works.

Wagons are tested upon a similar machine, placed in what is known as the running shop, or garage. The differences arising from the use of rubber tyres and a fixed gauge call for the use of wood-faced drums on the wagon testing machine instead of rollers as used for locomotives. It is possible on the wagon testing machine to alter the pitch of the drums in order to accommodate wagons of different wheelbases. The load imposed by the wagon testing machine when in operation is equivalent to running a wagon up a 1 in 10 hill for four hours, a test far more severe than any that could be met with on the road.

Since these testing machines were installed it has been found easier to turn out a standardised product than was the case when testing on the road alone was relied upon. It might seem quite a simple matter to devise a standardised road test, but this is not the case. The atmospheric conditions are never exactly

alike on two successive days, and the state of the roads, visibility, and the traffic also vary from day to day. By eliminating these variable features, as is done on the testing machines, standardising has been developed to such an extent that every wagon that leaves the "Sentinel" shops is exactly the same as regards fuel consumption and every other detail of its performance. Naturally, all wagons go through a final test on the road, after coming off the test bed, to ensure that the steering and brake gears are functioning perfectly.

The paint shop, which lies adjacent to the wagon side of the erecting shop, is 9,000 sq. ft. in extent. For work in the winter and at night, a system of lighting has been devised that gives an effect almost equivalent to daylight. The painting of wagons might be thought a very simple affair, but as a matter of fact the process is both long and difficult, occupying from 12 to 15 days, during which period every wagon receives 12 coats of paint. Locomotives receive similar treatment, but as there is usually a smaller amount of lettering required, the work can be done in less time.

The running shed, in which is situated the wagon testing machine already referred to, measures 20,800 sq. ft. It is fitted with a special smoke exhausting system consisting of a sheet iron flue running the whole length of one side of the building. This flue has opening out of it a number of downtakes arranged so that they come immediately over the chimneys of each wagon as it is garaged.

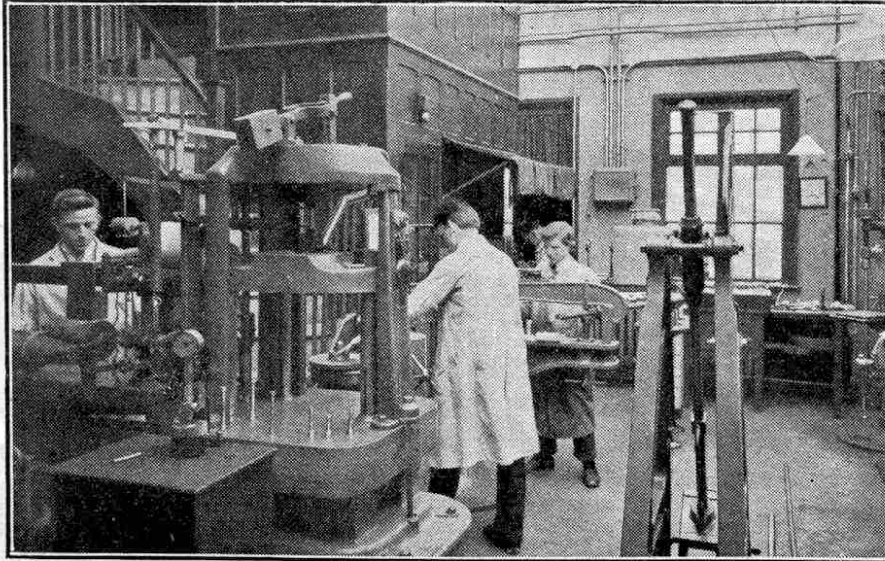
In this manner the fumes from the wagon are made to pass straight into the flue, from where they are exhausted rapidly by means of an electrically driven fan.

The woodworking and body-building shops are situated by themselves on the north side of the works. They are laid out upon the same principle of uni-flow of material that is adopted in all the other parts of the works. A great deal of special machinery has been designed for use in the woodwork shop, including a machine that not only deals with the ends of cross members by reducing them so that they fit the standardised

ironwork of the body, but also at the same time drills the necessary bolt holes. Each body is built upon trestles, and is moved down toward the end of the shop as one operation after another takes place.

The works laboratory is exceedingly interesting. It is divided into two parts, physical and chemical, and the work is carried out by a thoroughly competent staff under the control of a works metallurgist. In this laboratory tests are made of two per cent. of all the materials delivered, so that there may be absolute assurance that these comply with the rigid specifications laid down.

To supply power and light to the works there is an efficient



Courtesy]

The laboratory in which physical and chemical tests of raw materials are carried out

[“Modern Transport”



Courtesy]

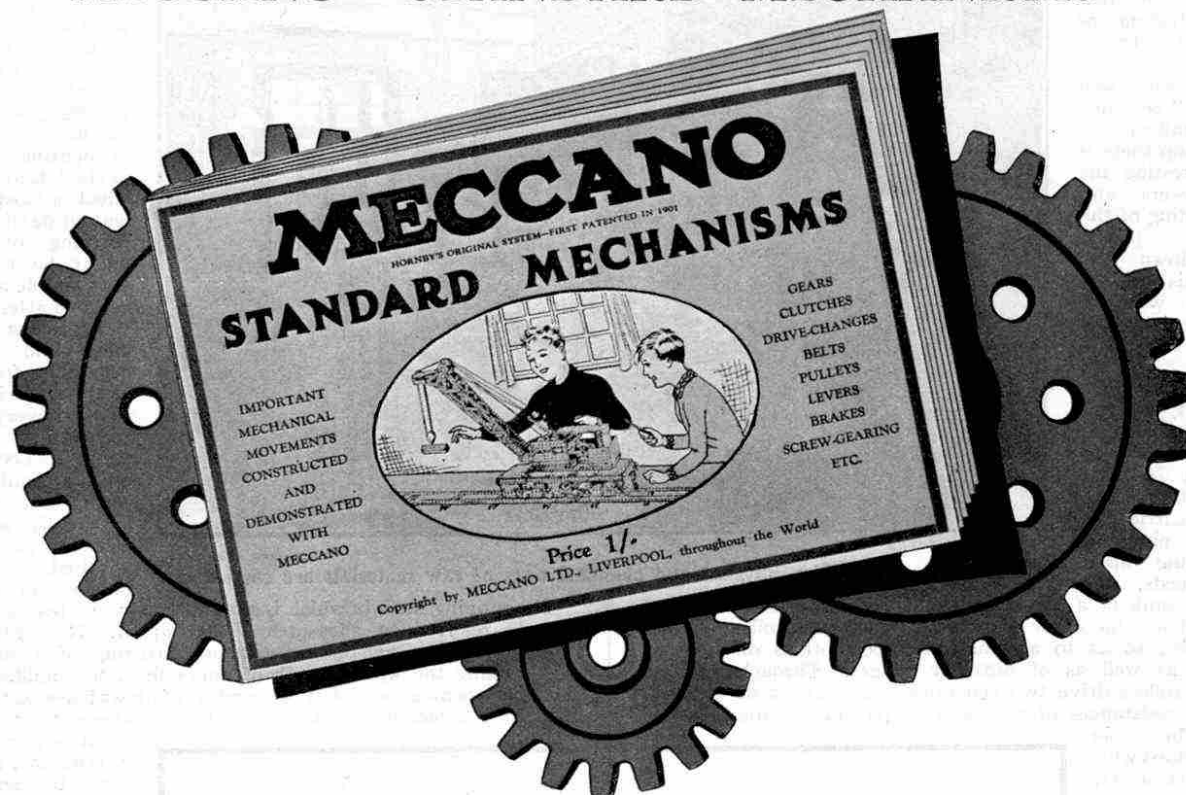
The office and main entrance gates of the "Sentinel" Works.

[“Sentinel” Wagon Works Ltd.

A six-wheeled "Sentinel" is seen leaving for road test

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MECCANO "STANDARD MECHANISMS"



The great development of the Meccano system during the last few years has made possible a large number of new mechanisms, and movements and it has been necessary to bring the Meccano "Standard Mechanisms Manual" up-to-date. We have pleasure therefore in announcing the publication of a new and revised edition.

The new Meccano Standard Mechanisms Manual is full of information that is invaluable to every keen Meccano model-builder. It deals with gear boxes, clutches, drive-changing mechanisms, belt and pulley mechanism, levers, brakes of all types, screw

mechanisms and a large number of other movements.

Considerable space is devoted to particulars of the many new mechanisms that can be devised with the aid of the new Socket Coupling, elongated Pinions, and Bevel Wheels, etc. The uses of the new Roller and Ball Bearings are also dealt with fully. In addition, electric braking and governing devices have been included, and these form valuable additions to the range of existing mechanisms. The book contains over a hundred beautiful half-tone illustrations, which greatly simplify the construction of the more complicated movements.

HOW TO OBTAIN THE MANUAL

The 1929 Meccano Standard Mechanisms Manual may be obtained from any Meccano dealer, price 1/-, or direct from Meccano Ltd., Old Swan, Liverpool, price 1/1½ post free.

There is a special edition for Overseas, price 1/6 from dealers or 1/8 post free, from the agents (Canadian price 35 cents from dealers or 38 cents post free, from Toronto).

Readers in Australia, New Zealand, South Africa or Canada who require copies should apply to their dealers or should address their orders to our agencies as detailed below. Readers living in countries other than those mentioned should order from Meccano Ltd., Old Swan, Liverpool, sending a remittance of 1/1½ with their order.

Australia : E. G. Page & Co., 52, Clarence Street, Sydney. (P.O. Box 1832).

New Zealand : Models Ltd., Kingston Street, Auckland. (P.O. Box 129).

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BINNS ROAD

OLD SWAN

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and up-to-date power house. This is situated in the extreme corner of the works. The equipment consists of two Bellis and Morcom compound high-speed engines driving two tandem generators of 200 kw. each. For the supply of compressed air in the works, where it is extensively used for driving hand drills, riveters, chisels, etc., there are four Alley and McLellan compressors driven by standard "Sentinel" wagon engines. In addition to supplying power and light to the works, the power house also supplies light and hot water to the garden suburb on the other side of the road. This suburb was brought into being by the shortage of houses experienced immediately after the war. It consists at present of 100 houses of the village type, but eventually the scheme visualises 400 houses.

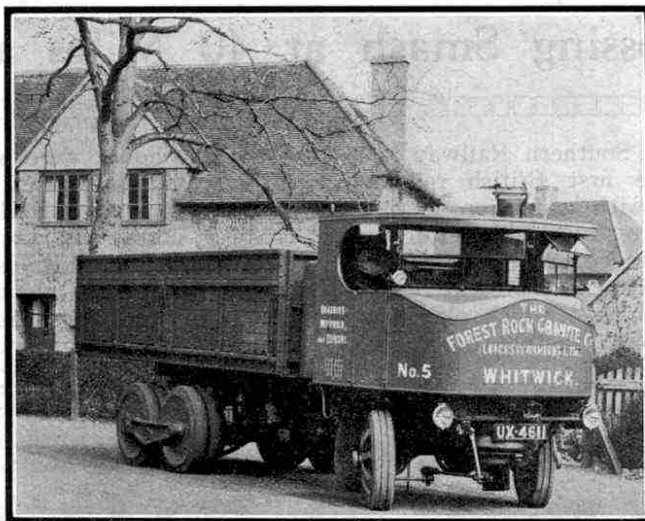
For over 25 years the "Sentinel," and subsequently the "Super-Sentinel," steam wagons have been familiar on every road in the country. More recently a new model has made its appearance. This wagon is a six-wheeler with a load capacity of from 12 to 15 tons, and has been introduced with the special object of dealing with the heavier loads that have become customary since the War. It has many novel and interesting features, prominent among which is the oscillating rear bogie that carries

the four driving wheels. This bogie consists essentially of a fixed axle of great strength, on each end of which is pivoted a pair of cast steel arms. At each end of these pairs of arms are short fixed axles on which the rear wheels run.

The result of this arrangement is that, no matter what irregularities may be met with on the surface of the road, the arms will swing automatically and allow the weight of the wagon and its load to be distributed evenly between both wheels on each side of the vehicle. This, of course, reduces the amount of power required to propel the "Sentinel" D.G.6, as this model is called, for instead of the power of the engine being absorbed in lifting the weight of the wagon and load over irregularities, it is expended usefully in driving it forward. The result is that less steam is required for the engine, and consequently less coal needs to be burnt in the boiler.

To-day the steam wagon is being used more and more for the transport of heavy loads, and from a national point of view this is all to the good, as every one put into service on our roads adds its quota of employment for the miners and keeps money

in the country that otherwise would go abroad to pay for imported liquid fuel.



Courtesy]

["Sentinel" Wagon Works Ltd.]

A "Sentinel" six-wheeler standing outside the Garden Suburb in which many of the men employed in the "Sentinel" Works reside

How to Use Meccano Parts—

(Continued from page 638)

employing the special units. Such a built-up Roller Bearing, employing guide races formed from Channel Segments, is described under Standard Mechanism No. 131.

The standard Meccano Ball Bearing (part No. 168) is illustrated in Fig. 14, and as will be seen it consists of three sections, namely, one Flanged Ball Race, one Geared Ball Race, and one Ball Casing complete with Balls. With its aid a structure may be turned about a central pivot freely and in a steadier manner than is possible with ordinary bearings. It is intended for use, of course, where the Roller Bearing would prove unnecessarily cumbersome.

Fig. 13 shows the application of the Ball Bearing to a small crane. The Flanged Ball Race 1 is secured by bolts to the $5\frac{1}{2}$ " x $2\frac{1}{2}$ " Flanged Plate 2, and the Geared Ball Race 8 is fastened to the swivelling structure. The Ball Casing is placed between these two parts so that the Flanged Ball Race rests upon the Balls. Hence the weight of the structure rests entirely upon rolling surfaces, with the result that friction is reduced to a minimum. A short Rod passed through the centre of the Ball Races 1 and 8 and maintained in its position by Collars, holds the unit together. The superstructure is rotated by means of a Sprocket Chain passing round the teeth of the Geared Ball Race 8 and engaging a 1" Sprocket Wheel 3 which is secured to a driven Rod 4.

Another example of the use of the Ball Bearing unit is illustrated in Fig. 12. Here it is shown applied to a model mechanical digger and in this case the Flanged Ball Race 1 rests upon the Balls, although in the illustration it is seen lifted clear. Also, spur gearing is employed to rotate the superstructure instead of Sprocket Chain mechanism as in Fig. 13.

The $3\frac{1}{2}$ " Gear Wheel 2, which replaces the Geared Ball Race, is secured to Girders in the travelling base of the model by four $\frac{1}{2}$ " Reversed Angle Brackets 4. The $\frac{1}{2}$ " Pinion 5, which is secured to a Rod that is driven by any suitable means from the motive power carried on the superstructure, engages with the Gear Wheel 2 and thus effects the swivelling movement.

New Meccano Models—(Continued from page 635)

consists of two triangular frames formed from $5\frac{1}{2}$ " Strips, and connected together by $2\frac{1}{2}$ " x $\frac{1}{2}$ " Double Angle Strips. Two Flat Trunnions form bearings for a Crank Handle upon which the lower ends of the bascules are pivoted. The latter each consist of two $12\frac{1}{2}$ " Strips spaced apart by means of Double Angle Strips. If necessary cardboard may be added to form a roadway.

Two separate lengths of cord are wound round the shaft of the Crank Handle, each length being passed over a 1" Pulley Wheel journaled on a $3\frac{1}{2}$ " Rod passed through the $5\frac{1}{2}$ " Strips and secured to the top of its respective bascule.

The parts required to build this model are as follows:—4 of No. 1; 6 of No. 2; 1 of No. 16; 1 of No. 19s; 2 of No. 22; 8 of No. 35; 16 of No. 37; 2 of No. 38; 6 of No. 48a; 2 of No. 126a.

Foot Treadle Hammer

The prototype of the model shown in Fig. 7 may often be found in a small forge or village smithy, the owner of which has not yet called in the aid of steam or electricity to assist him at his task!

To build the model hammer, four $5\frac{1}{2}$ " Strips should be bolted to a $5\frac{1}{2}$ " x $2\frac{1}{2}$ " Flanged Plate and connected together at their upper ends by two $2\frac{1}{2}$ " Strips and two $2\frac{1}{2}$ " x $\frac{1}{2}$ " Double Angle Strips.

The "hammer" consists of a $5\frac{1}{2}$ " Strip bolted to a Bush Wheel that is mounted on a $3\frac{1}{2}$ " Rod journaled in one

of the pairs of $5\frac{1}{2}$ " Strips. The Rod also carries two 1" Pulleys butted against a $2\frac{1}{2}$ " Strip. A weight consisting of a number of short Strips is secured to the end of this $2\frac{1}{2}$ " Strip, so that the hammer is raised automatically after each stroke.

Parts required to build the Treadle Hammer are:—6 of No. 2; 1 of No. 3; 9 of No. 5; 1 of No. 12; 2 of No. 16; 4 of No. 22; 1 of No. 24; 2 of No. 35; 15 of No. 37; 4 of No. 37a; 2 of No. 38; 2 of No. 48a; 1 of No. 52; 4 of No. 90a; 2 of No. 111c.

Models in the £100 Contest—

(Continued from page 653)

and a $1\frac{1}{2}$ " Angle Girder secured to the end of the exhaust pipe to form the "baffle chambers," while a Corner Piece represents a "fish tail" of extra large size!

In addition to the solo machines, model cycle and sidecar combinations were to be found in great profusion, constructors here again showing preference for the racing types of machines. Many interesting types of sidecars were to be found amongst these models, the examples ranging from flat "stream-line" patterns composed of Sector Plates and Flat Girders, to graceful boat-shaped bodies built up from various sizes of Curved Strips.

An original feature of C. R. Weller's model cycle and sidecar is the inclusion of a two-speed gear box. The engine in this machine has been represented by an Electric Motor, and the gears comprising the speed change mechanism are mounted in the perforated side plates of the Motor. In this instance, the additional speed ratio will be found useful, as a rather massive sidecar is attached to the cycle.

By employing a Meccano Clockwork or Electric Motor, the attraction of a model motor cycle is enhanced considerably, but unless special care is taken in fitting, the appearance of the complete machine is likely to suffer.