

# The New Meccano Motor Chassis

## An Example of the Latest Meccano Construction

THE Meccano Motor Chassis forms not only an excellent example of the adaptability of the Meccano parts but also a striking illustration of the educational value of the Meccano system. It shows how, with the aid of a number of ordinary Meccano parts, any intelligent boy may build a complete working model that demonstrates the principles of modern motor engineering so well that replicas of it have been used to instruct pupils in numerous technical schools.

The motor chassis about to be described embodies numerous improvements upon models of a similar type that have been published previously, and it may be regarded as representing the latest Meccano practice. Amongst the improvements may be mentioned the unit principle of construction that has been adopted. The motor, clutch and gearbox are all mounted on a rigid frame, which may be detached from the chassis merely by loosening two or three screws. The differential and rear axle casing, with torque rods, etc., also form a complete unit, the removal of which is the work of a few seconds only.

The gearbox provides three speeds forward and reverse gear, and is controlled by a central gear-change lever sliding in a quadrant that retains it in position after each change is effected. The clutch is controlled by a foot pedal and providing that a small rubber ring is used in the manner to be described later, the drive from the motor may be taken up very smoothly and gradually and transmitted to the road wheels. The differential gear has been improved and made more compact. The back axle unit is mounted on cantilever springs and any twisting tendency set up by the thrust of the propeller shaft is counteracted by torque rods attached to the main frame by a spring connection.

The steering gear is designed according to the Ackermann principle, which provides for a different angle of turning movement in each front road wheel. Internal expanding brakes are attached to the rear wheels and a pedal-operated brake is fitted to the cardan shaft immediately in front of the universal joint. Other refinements of the model include a radiator cooling fan and a motor starting switch mounted on the dashboard.

The chassis will carry easily the weight of the Meccano 8 ampere-hour Accumulator, even on top gear. The Accumulator should

be placed on the luggage carrier at the rear of the model, thus converting the chassis into a self-contained power unit. A complete list of parts required to build the model will be found at the end of this article.

### The Frame and Springs

The construction of the model should be commenced by building the main frame, which is shown more clearly in Fig. 2. Each side consists of two  $12\frac{1}{2}$ " Angle Girders 1 bolted together in the form of a channel section to give maximum rigidity. The side girders are held together by a cross member 2 composed of a  $5\frac{1}{2}$ " Angle Girder and their front ends are extended by  $5\frac{1}{2}$ " Curved Strips to carry the ends of the front semi-elliptic springs. Each inner  $5\frac{1}{2}$ " Curved Strip is secured to the upper Girder of its respective side member by means of two Angle Brackets. Two of the bolts that serve to secure the Curved Strips also serve as pivots for the shackles (Flat Brackets 3) supporting the rear ends of the front springs (see also Figs. 4 and 6). The bolts should be secured to the side members by two locked nuts (see Meccano Standard Mechanism No. 262) so that the Flat Brackets are quite free to turn on their shanks.

The main frame is extended and carried over the back axle by means of a series of  $2\frac{1}{2}$ " large radius Curved Strips 4 bolted together in the manner shown. The luggage carrier 5 is composed of two 3" Strips connected by four  $4\frac{1}{2}$ " x  $\frac{1}{2}$ " Double Angle Strips. The carrier is bolted to the end holes in the main frame, and nuts on bolts 6 inserted in the end holes of the 3" Strips strike against the Curved Strips 4 and thereby maintain the carrier in a horizontal position. The carrier is designed to hold the Meccano 8 amp. Accumulator, and when not in use it may be folded back.

The radiator is represented by a  $3\frac{1}{2}$ " x  $2\frac{1}{2}$ " Flanged Plate 7 with two  $3\frac{1}{2}$ " x  $\frac{1}{2}$ " Double Angle Strips bolted at the sides. It is secured to a  $4\frac{1}{2}$ " Strip 7a secured between the front  $5\frac{1}{2}$ " Curved Strips of the frame. The  $5\frac{1}{2}$ " x  $2\frac{1}{2}$ " Flat Plate 8 is secured to a  $5\frac{1}{2}$ " Angle Girder bolted to the main side Girders 1 and is extended at the top by a  $5\frac{1}{2}$ " Strip 9 secured at each end by Flat Brackets. The dashboard 10 consists of a  $5\frac{1}{2}$ " Strip and a  $5\frac{1}{2}$ " Curved Strip attached

Fig. 3. Diagram showing car in act of turning

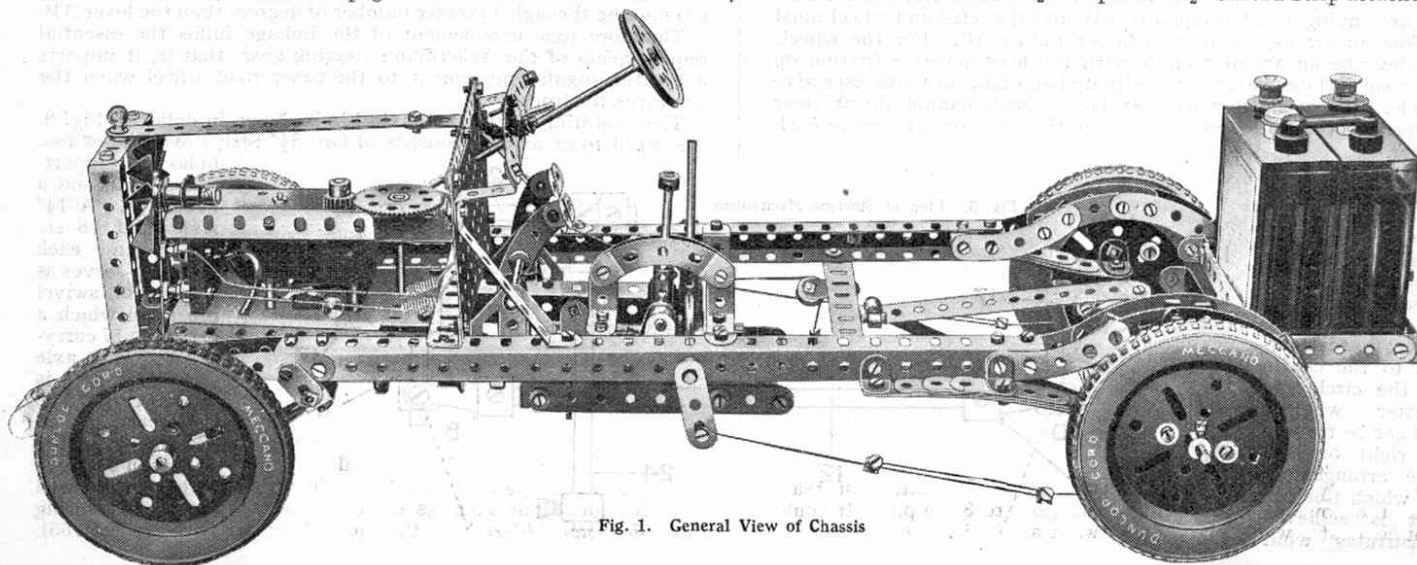
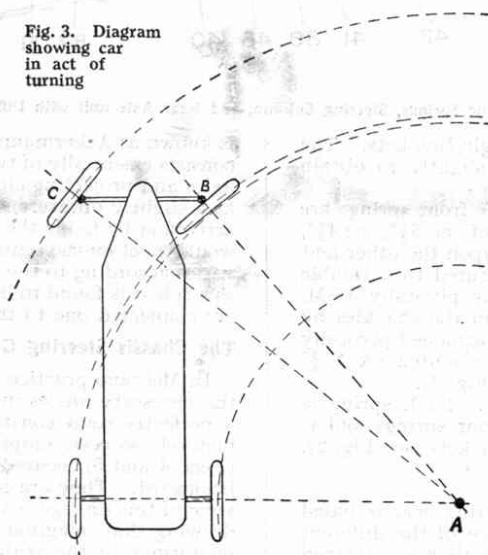


Fig. 1. General View of Chassis

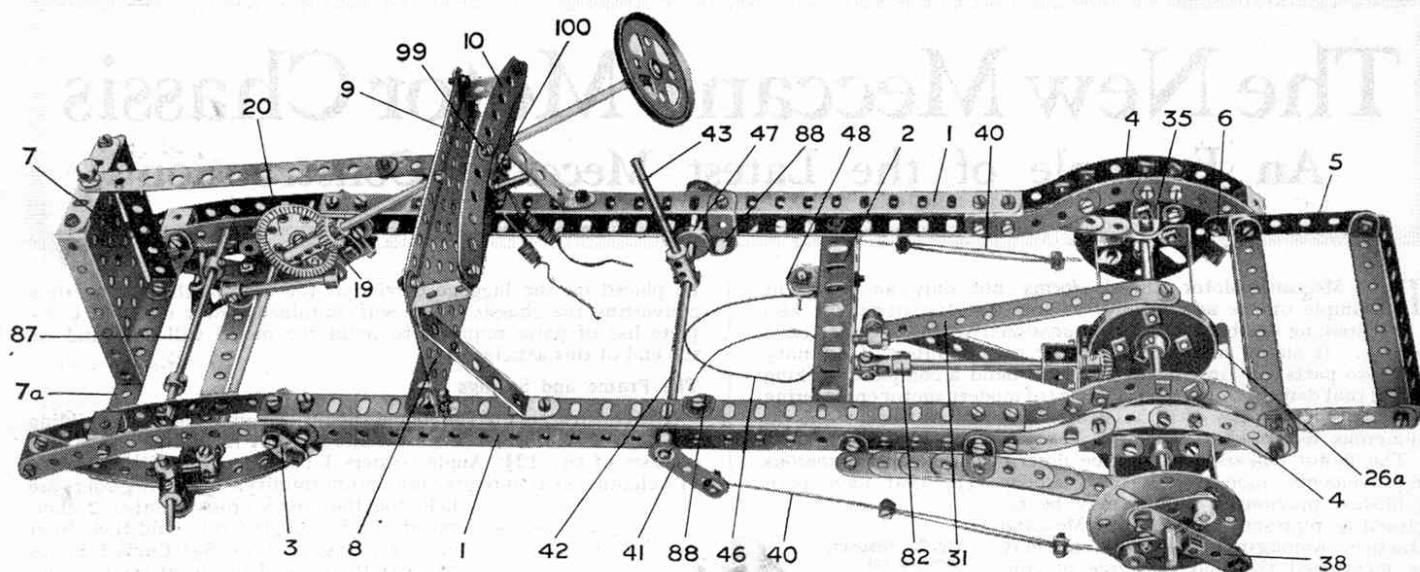


Fig. 2. Frame, showing Springs, Steering Column, and Rear Axle unit with Differential removed

to the Plate 8 by means of two 1" Reversed Angle Brackets. The outer ends of these Brackets should be bent slightly to obtain the correct angle for the dashboard.

It will be seen clearly from Fig. 6 that the front springs are of the semi-elliptic type, and that each consists of one  $5\frac{1}{2}$ ", one  $4\frac{1}{2}$ ", one  $3\frac{1}{2}$ ", one  $2\frac{1}{2}$ ", and one  $1\frac{1}{2}$ " Strip placed one upon the other and slightly bent. Each end of the  $5\frac{1}{2}$ " Strip is secured to a Double Bracket. The rear Double Bracket is bolted pivotally (S.M. 262) to the pair of Flat Brackets 3, which form the shackles by means of which the rear ends of the springs are attached pivotally to the frame. The front Double Bracket is mounted on a  $\frac{3}{4}$ " Bolt passing through the side frame members (Fig. 4).

The rear springs are of the cantilever type. Each spring is built up from the same components as the front springs and is attached rigidly to the frame by two Angle Brackets (see Fig. 2).

#### Principles of Ackermann Steering

It has already been mentioned that the steering gear is based on the Ackermann principle but the importance of the different angularities of the front wheels may be a point that has escaped the notice of many Meccano boys. Perhaps it will not be out of place, therefore, to insert here a brief summary of the principle of the gear.

When a car turns a corner the near side road wheels describe a sharper curve than the outer wheels. This will be clear on reference to Fig. 3. The drawing is intended to represent a car turning a corner, and in doing so it will be apparent that the wheels must describe an arc or portion of a circle whose centre is shown at A. Now although both front wheels must turn about this centre they are situated at varying distances from it. This means to say that the right-hand front road wheel must follow an arc having a radius equal to AB, and the left-hand wheel must follow an arc struck from a larger radius AC. For the wheels to describe an arc of a circle with the least possible friction on the road surface, each must be situated at a tangent to its respective circle. But it is obvious that both wheels cannot lie at their respective tangents and at the same time remain parallel to each other.

Hence it becomes necessary to incorporate in the steering gear some method by means of which a greater angle can be given to the wheel that is nearest to the centre of the circle, no matter whether the car be turning to right or left. The arrangement by which this object is achieved constitutes what

is known as Ackermann steering gear. In actual practice, the gear consists essentially of two short levers rigidly connected to the stub axles and projecting either forward or backward. These levers lie at a slightly obtuse angle to the stub axles. The correct angle is arrived at by fixing the levers so that their centre lines, if produced, would meet on the centre line of the car. The exact meeting place varies according to the size of the car and length of the levers, but as a rule it is found to be just in front of the back axle. The levers are connected one to the other by a tie rod.

#### The Chassis Steering Gear

In Meccano practice it has been found a little difficult to secure the necessary angles in the levers and at the same time maintain a perfectly rigid construction, and therefore, a slightly different method has been adopted. This comprises short Rods 11 and 11a (Figs. 4 and 5) secured just behind the stub axles and protruding backward. They are connected together by a 5" Rod 12. A plan view of this linkage is shown in Fig. 5, and it will be seen from the drawing that imaginary lines AB, CD drawn through the pivotal mountings of the stub axles and through the points where the tie rod 12 is attached to the rods 11 and 11a correspond roughly to the angles at which the levers would be placed in actual practice.

Now if the car is to be turned to the right when looking at the gearing as in Fig. 5, the road wheel on the stub axle 13 must be deflected in that direction and the imaginary lever AB will be moved through a certain number of degrees to the left. In doing so it pushes the lever corresponding to CD in our sketch in the same direction, but owing to the difference in angularity between the two levers, lever CD and therefore the road wheel attached to its stub axle 13a, moves through a lesser number of degrees. If the car moves to the left exactly the opposite occurs, the lever CD moving through a greater number of degrees than the lever AB.

Therefore this arrangement of the linkage fulfils the essential requirements of the Ackermann steering gear, that is, it imparts a greater angular movement to the inner road wheel when the car turns a corner.

The mounting of the stub axle 13a is shown in detail in Fig. 6. The fixed front axle 14 consists of two  $5\frac{1}{2}$ " Strips overlapped two

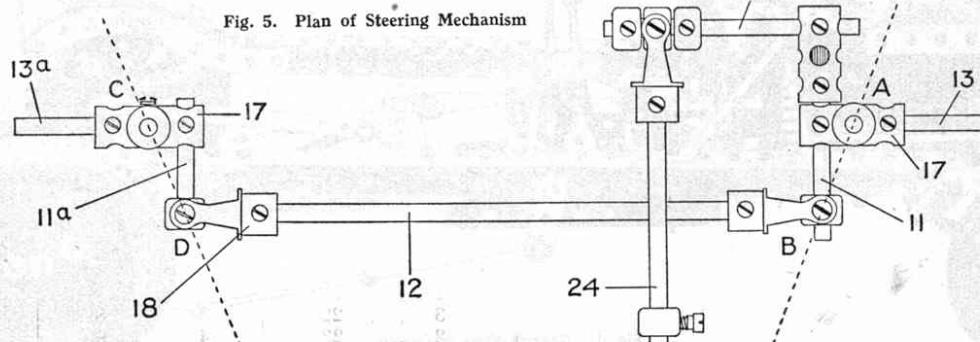


Fig. 5. Plan of Steering Mechanism

holes and supporting at each end a Crank 15. A  $1\frac{1}{2}$ " Axle Rod 16 secured in each Crank 15 serves as a vertical swivel pin upon which a Coupling 17 carrying the stub axle (a 1" Axle Rod) is free to turn. The Coupling 17 in Fig. 6 carries the 1" Rod 11a, to which is secured a Swivel Bearing 18 (Part No. 165).



The fork of the latter is fixed to the tie rod 12, the other end of which is connected to the other stub axle by another Swivel Bearing secured to the  $1\frac{1}{2}$ " Rod 11 (Figs. 4 and 5).

The connections between the steering wheel and the road wheels form another important point that must be considered in connection with the steering gear. The gear ratio, or extent of movement of the road wheels to a given movement of the steering wheel, must not be too high, otherwise a slight twist of the wheel would result in a considerable deflection of the car, which would be dangerous and might easily cause accidents. On the other hand, if the ratio is too low the car would be slow to respond to the wheel and therefore difficult to manage in dense traffic. In actual practice the gear reduction is effected in various ways, principally by worm and nut mechanism, but in the Meccano model the most convenient method was found by gearing a  $\frac{1}{2}$ " Bevel 19 with a  $1\frac{1}{2}$ " Bevel Wheel 20, Fig. 4. The latter is free to turn on a  $1\frac{1}{2}$ " Rod journaled in the side frame member and secured in the centre of a Coupling 21. One end of this Coupling forms a journal bearing for the end of the steering column 22, which consists of an 8" Rod carrying a 2" Pulley Wheel to represent the steering wheel.

A Flat Bracket 23 bolted to the  $1\frac{1}{2}$ " Bevel Wheel 20 forms the steering lever, and a set-screw passed through its elongated hole is used to secure a Collar to the  $2\frac{1}{2}$ " Rod 24. The other end of this Rod 24 carries a Swivel Bearing, the collar of which is free to turn between two Collars and set-screws on the 2" Rod 25. Nuts should be placed on the bolts against the collar of the Swivel Bearing, to hold the bolts rigid without gripping the Rod 25. The latter rod is fixed in a Coupling secured to the  $1\frac{1}{2}$ " Rod 11. It will now be seen that the movement of the steering wheel is transmitted to the right-hand road wheel via the Bevel Wheel 20 and linkage 24 and 25, and the left-hand wheel is caused to move simultaneously but at a different angle, as has been explained already, by means of the Rods 11 and 11a and tie rod 12.

The fixed front axle 14 is secured to the front chassis springs by means of  $\frac{3}{8}$ " Bolts. The Cranks 15 should be bent so that the fixed swivel pins 16 are slightly out of the vertical, with their upper ends pointing outward. This brings the points of contact between the front wheels and the ground as nearly as possible beneath the centres of the swivel pins. In actual practice the object of canting the swivel pins in this way is to save the driver from fatigue and road shock, for if the centre line of each road wheel was parallel with the centre line of the swivel pin, all shock or vibrations in the road wheel would act on the steering wheel with a leverage equal to the distance that separates them. It is specially important in cars fitted with four-wheel brakes, for the application of such brakes on a car where pin and wheel are parallel would tend to "toe out" the wheels.

The instructions for building the New Motor Chassis will be concluded in next month's "M.M." The second instalment of the article will describe the back axle unit, the transmission gear and differential, etc.

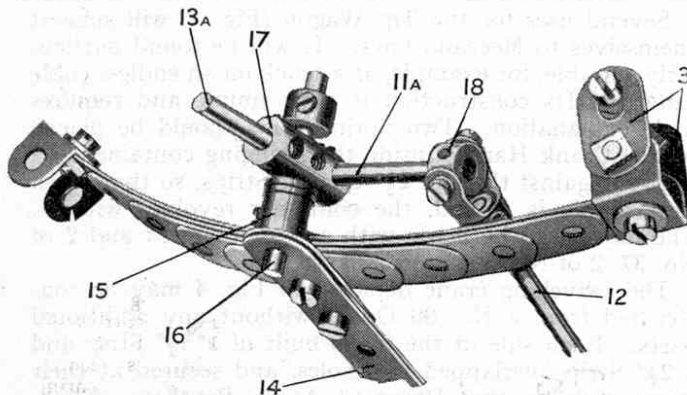


Fig. 6. Detail of Left-hand Stub Axle

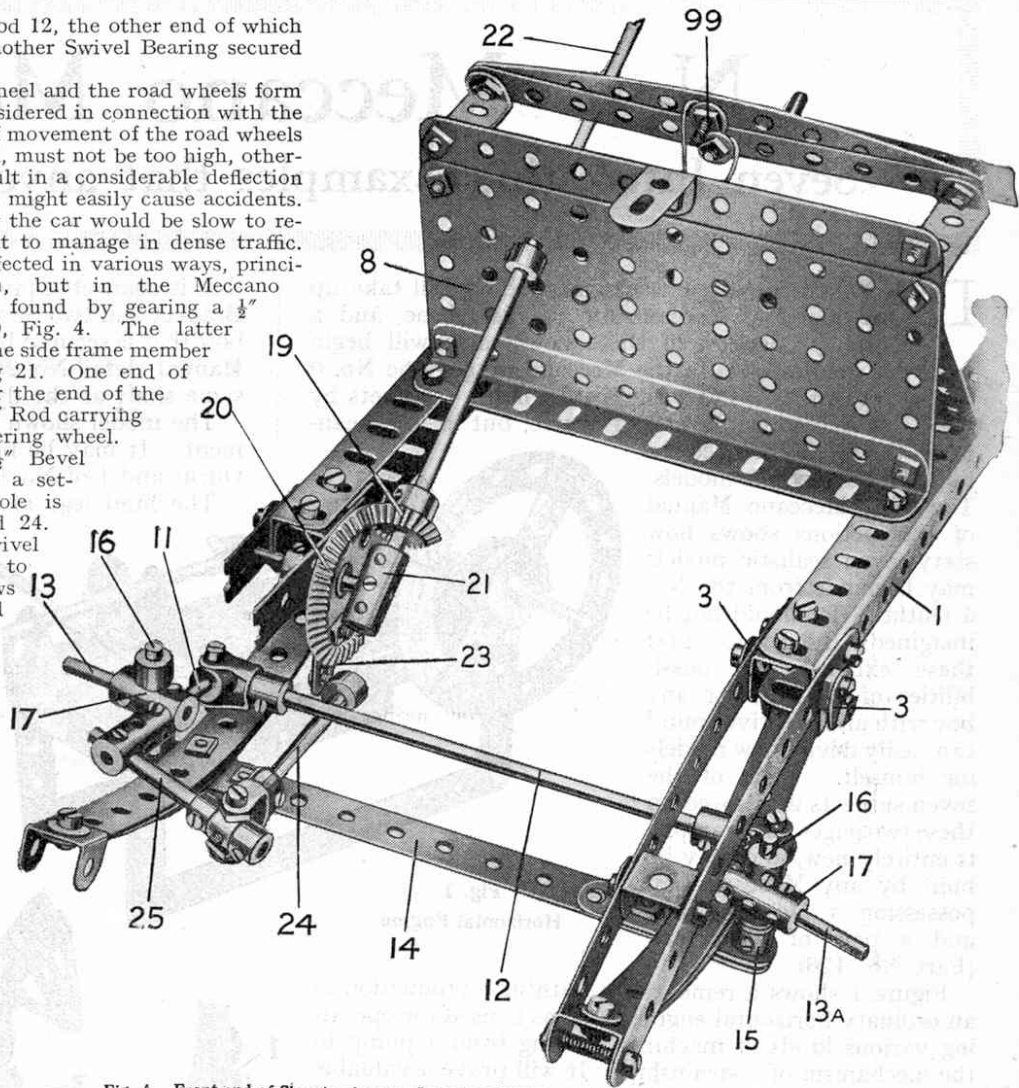


Fig. 4. Front end of Chassis, showing Steering Mechanism

### Parts Required

The following is a complete list of the parts required to build the revised Motor Chassis:—

11 of No. 2	1 of No. 23A	2 of No. 90A
9 " " 2A	2 " " 25	4 " " 101
4 " " 3	4 " " 26	1 " " 102
6 " " 4	2 " " 27	2 " " 109
6 " " 5	1 " " 27A	5 " " 111
9 " " 6A	1 " " 28	8 " " 111A
4 " " 8	4 " " 30	9 " " 111C
2 " " 9	2 " " 30A	1 " " 115
12 " " 10	2 " " 30C	2 " " 120B
8 " " 11	4 " " 31	4 " " 124
24 " " 12	178 " " 37	2 " " 125
4 " " 12A	38 " " 37A	2 " " 126
4 " " 12B	40 " " 38	1 " " 136
1 " " 13A	1 " " 45	4 " " 137
2 " " 14	2 " " 46	5 " " 140
2 " " 15	2 " " 47A	4 " " 142B
1 " " 15A	9 " " 48A	2 " " 147B
5 " " 16	2 " " 48B	1 " " 157
2 " " 16A	4 " " 48C	2 6BA Screws
1 " " 16B	1 " " 53	2 6BA Nuts
5 " " 17	1 " " 55A	2 Insulating Bushes
5 " " 18A	3 " " 58	2 Insulating Washers
3 " " 18B	42 " " 59	1 Small Rubber Ring
4 " " 19B	5 " " 62	1 4-volt Electric Motor
1 " " 20	9 " " 63	
1 " " 20A	1 " " 70	
3 " " 22	5 " " 89	
2 " " 23	14 " " 90	