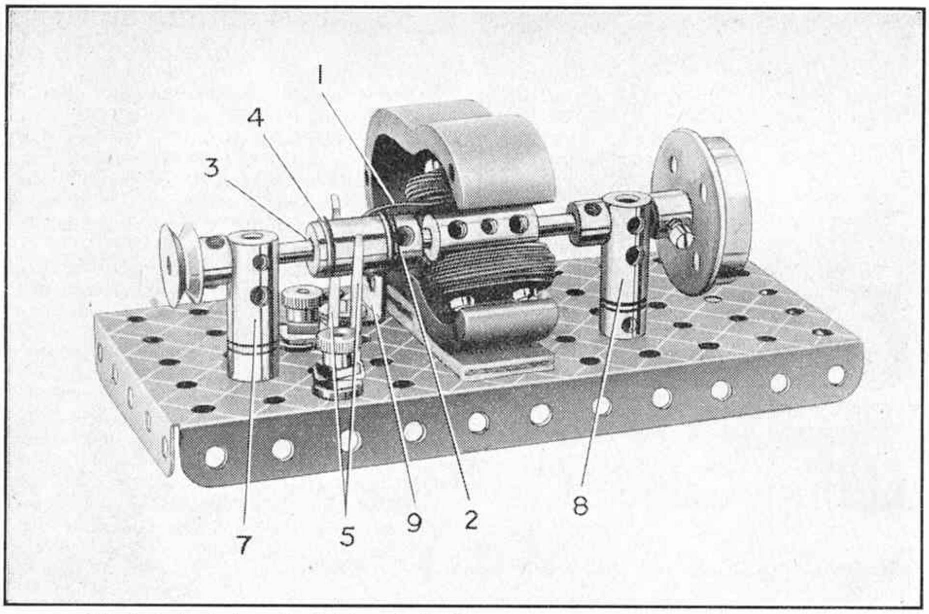

Fig. 1. A simple two-pole electric motor built from Meccano parts and a permanent magnet.

Build Your Own Electric Motors

Working Models Constructed from Meccano Parts

CONSTRUCTING from Meccano parts electric motors that really work is a fascinating branch of model-building. It is not difficult, and in this article we describe four simple working electric motors of different types that any reader can build quite easily. All that he requires are a few Meccano parts, a few yards of Nos. 23 and 26 Single Cotton Covered Wire, a small piece of sheet tin or brass, and one of the special permanent magnets referred to in an announcement on page ix of this issue.

All four motors are designed to run on direct current. This may be supplied from a 6-volt accumulator, or from alternating current mains through a Meccano Transformer-Rectifier. It should be noted particularly that the motors will not operate from a Meccano T6, T6M or T6A Transformer, as the output of these is alternating current.

The simplest motor of those illustrated is that shown in Fig. 1. This is of the two-pole type and is quite easy to build. It is best to commence by building up the armature, which rotates between the poles of the magnet. This consists entirely of Meccano parts, and is illustrated at A in Fig. 2. First two Collars are pressed on a 4" Rod. Four $\frac{3}{8}$" Bolts are then fitted with two Flat Brackets spaced apart by five Washers, the Bolts being screwed tightly into the Collars, so as to fix them to the Rod. The Washers and Flat Brackets form the poles. A strip of thin paper is then wrapped around each pole and gummed in place.

The windings consist of two lengths of No. 26 S.W.G. S.C.C. Copper Wire each 7 ft. long. One length of wire is wound on each pole, but it should be noted that the winding on one pole is laid on in a clockwise direction while that on the other is wound in an anti-clockwise direction. The wire must be wound on evenly, and when winding is finished the coil should be tested to ensure that there is no short circuit between the wire and the Washers or Flat Brackets. The *inner* end of one coil and the *outer* end of the other should then be twisted together. The remaining ends of the two coils are later to be attached to the commutator and should be left free for the present.

The construction of the commutator is equally simple. It consists essentially of a Coupling 3 around which a strip of paper is wrapped and glued in place. Next, a piece of thin sheet tin measuring $\frac{5}{8}$" × 1" is cut into halves across its width, and each half is bent to semi-circular shape so that it fits closely the circumference of the Coupling. The two pieces are fixed in position on the Coupling by wrapping pieces of wire or cotton round their ends as shown at 4, and when in place they must not touch each other, but must be separated by gaps about $\frac{1}{16}$" wide.

The complete commutator is then pressed on the Rod forming the armature spindle, and the ends 1 and 2 of the pole windings are either soldered, or bound with cotton, one to each segment of the commutator. If cotton is used a thin layer of glue will prevent it from becoming loose or frayed. It will also be beneficial to file the surfaces of the commutator segments so that they provide smooth contacts for the brushes.

The bearings for the armature shaft are provided by the upper holes of two Threaded Couplings 7 and 8, each of which is held in place on the $5\frac{1}{2}$" × $2\frac{1}{2}$" Flanged Plate forming the base by a $\frac{3}{8}$" Bolt. The Couplings are spaced from the base plate by Collars and Washers. The special permanent magnet is now fixed in place, and is spaced from the base plate by a strip of cardboard or thin wood. For clamping it in position two Reversed Angle Brackets are used, and one of these is shown at 9.

To complete the motor it is only necessary to fit the brushes. These consist of Commutator Contact Brushes (Elektron Part No. 1559) and they are fixed to the base, but insulated from it, by 6 B.A. Bolts, Insulating Bushes and Washers. Each Bolt is fitted with a Terminal.

The motor is now ready and to set it in operation the brush terminals are connected to the terminals of a 6-volt accumulator or a Meccano Transformer-Rectifier. As the motor is not self-starting it will be necessary to spin the armature to set it in motion, and the tension of the brushes is then carefully adjusted until the armature revolves at its highest speed.

The next motor to be described is that shown in Fig. 3 and is a little more elaborate and powerful than the one already described. It is fitted with a three-pole armature and is self-starting. In this case also it is best to commence by building the armature. This is shown at B (Fig. 2) and consists of 24 Flat Brackets, through the slotted holes of which is pushed a Rod. The Flat Brackets are then sorted out to form three separate groups spaced at 120 deg. to each other as shown. At their free ends they are spaced apart by Washers, and Pivot Bolts are then passed through the outer holes of the Flat Brackets and of the spacing washers, and held in place by nuts.

It is important that the Flat Brackets are pushed inwards towards the shaft as far as possible so as to provide sufficient clearance for the armature to rotate in the magnet. After each pole has been suitably insulated with paper in the manner described for the two-pole motor, the winding can be commenced. Each pole is wound with 7 ft. of No. 26 S.W.G. Copper Wire and all are wound in a clockwise direction, a little gum being applied to the finished windings to keep them in place. In connecting the coils, the bared outer end of the first is joined to the bared inner of the second and the outer end of this is connected to the inner end of the third. The remaining ends of the third and first coils are also connected together. In each case the bared ends of the wires must be twisted together as indicated at 1. The three leads thus provided are attached to the segments

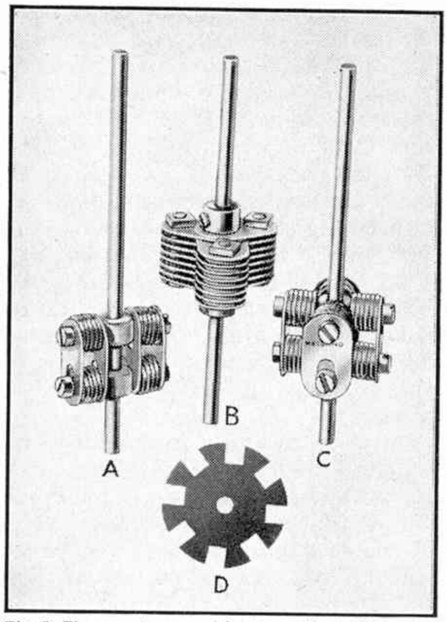

Fig. 2. The armatures used in the small electric motors described in the accompanying article.

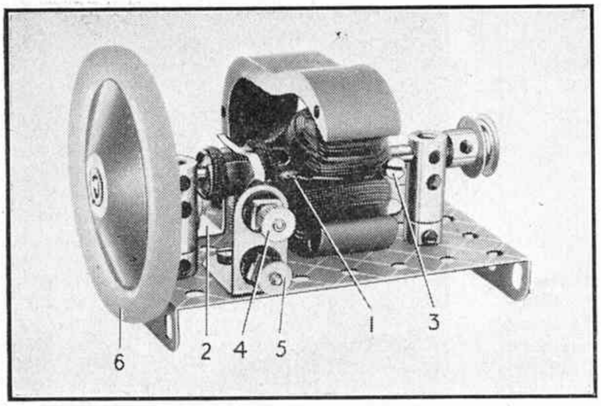

Fig. 3. A neat and compact three-pole motor.

of the commutator at a later stage of construction.

The commutator is built up in the same way as the one described for the two-pole motor except that it has three segments of tin or brass instead of two. When completed it must be fixed on the Rod so that each of the segments lies between two poles of the armature, the three coil leads are then attached to their respective segments. A bolt 3 screwed into a Collar is used to fix the armature to the shaft.

A 3½″×2½″ Flanged Plate forms a base for the motor, and the magnet is fixed to it by Reversed Angle Brackets 2, which are bolted to the base and connected by a 1½″ Strip. The ¾″ Bolts connecting the latter to the Brackets pass also through the base plate. The brushes are fixed by Terminals 4 and 5 to a 1″×1″ Angle Bracket and are bent to a horizontal position. The Road Wheel 6 forms a flywheel.

The motor shown in Fig. 5 is more powerful than either of those already described and has a four-pole armature of the type shown at C in Fig. 2. This consists of two "spiders," removed from Swivel Bearings, into which are screwed ⅜″ Bolts. Each Bolt carries six washers and is passed through one end of a Flat Bracket. Winding is done with 26 S.W.G. Copper Wire, 8 ft. being wound on each pole. The Cord 1 retains the wire in place. The winding of each pole is done in a clockwise direction, as in the case of the three-pole motor, and when winding is complete the inner ends of the four coils are bared and twisted together at 2 while their outer ends are led to the segments of the commutator.

The commutator has four segments so arranged that each is opposite one of the poles of the armature. The outer end 4 of coil 3 is fixed to segment 5; the outer end of the next coil is fixed to the segment opposite to it, and so on until all the connections have been made.

The bearings and magnet of this motor are set up in exactly the same way as those of the first motor. The Cone Pulley (part No. 123) fitted on the armature shaft acts both as a flywheel and a driving pulley.

To build the motor shown in Fig. 4 it is necessary for the constructor to possess a hacksaw and a flat file, preferably a coarse one. This motor has what is known as an eight-pole drum armature, but as it is wound in only four sections it is quite easy to assemble. It is built up from 22 1¼″ Discs, which are cut to the shape of the Disc shown at D in Fig. 2. The slots are ¼ in. wide and $\frac{3}{16}$ in. deep, and the operation of cutting them can be carried out on each Disc separately, or all the Discs can be clamped on a Screwed Rod and cut together. The latter is the quicker and more accurate method. Saw cuts should first be made on each side of the holes in the Discs and the metal between them then removed. The slots thus made should then be finished by filing. Next insulation paper is applied, and this operation must be carried out very carefully. Discs of paper are glued over the ends of the armature and then narrow strips of paper are glued to the sides and bottoms of the slots. No metal edges should show when the job is completed.

Winding can now be commenced and reference to Fig. 4 will show how the coils are wound. It will be seen that the windings of each coil lie in two slots opposite each other. Each Coil consists of 12 feet of No.

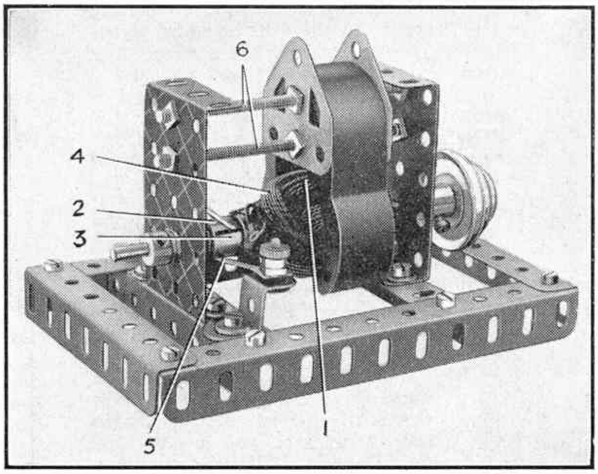

Fig. 4. A powerful motor with a cogged drum armature.

23 S.W.G. Single Cotton Covered Copper Wire, and this should be wound in the slots as evenly as possible. As each coil is completed it may be found that it projects out of the slot slightly and it must be gently tapped into place with a smooth piece of wood such as a hammer shaft. This treatment is necessary owing to the very small amount of clearance between the armature and the magnet.

A four-segment commutator is now built up and fixed to the armature shaft in such a position that the spaces between the segments coincide with the poles separating each coil. The connections to the commutator are made as follows. The inner end of coil 1, the numbers referring to Fig. 4, is fixed to segment 2 and its outer end is fixed to segment 3, similarly the inner end of coil 4 is fixed to segment 3 and its outer end to segment 5, while the next coil is wired to the next two segments and so on until the four coils are connected up.

The next step is to build the frame that carries the bearings for the armature shaft and the magnet. This is shown in Fig. 4 and consists of a rectangular frame made from 5½″ and 3½″ Angle Girders. Two of the four 3½″ Angle Girders are bolted 4 holes apart and carry 2½″×1½″ Flanged Plates. The armature shaft must be journalled in these before bolting them down, and if desired the bearings can be reinforced by 1½″ Strips. The magnet is now slid into position and the Screwed Rods 6, complete with Flat Trunnions and nuts, are fitted in position. The Screwed Rods are lock-nutted to the 2½″×1½″ Flanged Plates and the magnet is then adjusted until the armature spins freely. The nuts are then tightened securely. Collars prevent end play in the armature shaft, and a Cone Pulley forms a combined flywheel and driving pulley.

The brushes are arranged in a horizontal position and are mounted on 1″ and ½″ Reversed Angle Brackets. Each brush is fitted with a Terminal.

The following suggestions will be found helpful in adjusting the motors to obtain the best possible running. First, the bearings of the motor should be examined to ensure that they are in line and the armature turns quite freely. The commutator segments should be carefully smoothed, especially at the edges and this can be done with a small piece of fine emery cloth. A good plan is to roll the segment around a Coupling before fitting them in place.

Another important point to watch is the position of the brushes in relation to the armature poles. Before bolting the brushes to the base they must be adjusted so that the maximum speed is obtained.

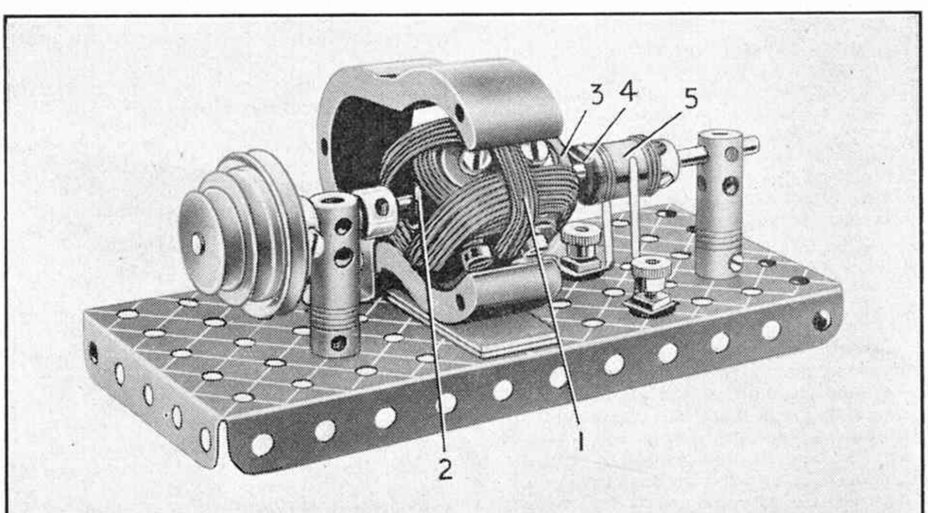

Fig. 5. A robust four-pole motor suitable for driving small models.

Meccano Suggestions Section

By "Spanner"

(452) A Unique Drive

(Gian Singh, Innitsar, India)

An ingenious scheme for connecting shafts that are placed out of line is shown in Fig. 452. This is suitable for use in almost every case where lack of space prevents Universal Couplings or Flexible Coupling Units from being employed.

The driving shaft 1 is approximately $\frac{1}{2}$ in. out of line with the Rod 2, and each Rod carries at its end a Face Plate. Four Flat Brackets are pivotally attached to the Plates by means of $\frac{3}{8}''$ Bolts, each of which carries two nuts for holding the Brackets in place. Washers are used for spacing purposes, and when in position the Bolts should be sufficiently loose to allow the Flat Brackets to move freely.

As the Rod 1 rotates, the movement of the one Face Plate is imparted to the other by means of the Flat Brackets.

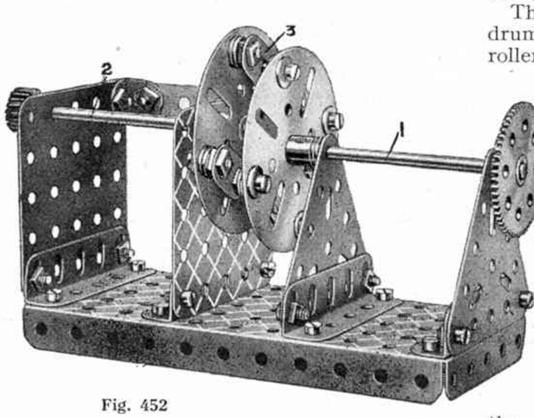

Fig. 452

(453) A Meccano Morse Code Recorder

(G. Hooper, Wallasey)

The novel apparatus shown in Fig. 453 will help readers interested in telegraphy to improve their knowledge of the Morse Code and give them good practice in tapping out correctly spaced signals.

The apparatus consists essentially of a pen actuated by an electro-magnet in such a manner that it may be made to press lightly on a travelling strip of paper when the magnet is energised. As the ribbon is in continual motion the pen makes long or short marks on the paper, according to the time that the key controlling the energising current of the magnet is held down. The aid of a friend may be sought to read the messages as they come through on the tape, and it is advisable that the partners be in separate rooms so that the temptation to communicate verbally is removed.

Two Meccano Bobbins wound to capacity with 26 D.C.C. copper wire, are mounted on $2''$ Screwed Rods, which are secured to two $1\frac{1}{2}''$ Strips placed face to face. The Strips are attached by a $\frac{1}{2}''\times\frac{1}{2}''$ Angle Bracket to the base of the model in the position shown, and are inclined at a slight angle to the horizontal. The end of the winding of one Bobbin is connected to the commencement of the winding of the other, and the two remaining free ends are secured to terminals, one of which is insulated from the frame by Insulating Bushes and Washers.

The fountain pen is clamped rigidly between two Bush Wheels on a Rod journalled in two vertical Strips. The Rod carries a Coupling in which is secured a short Rod 2 that forms the armature for the electro-magnets. The latter projects over, and a short distance above, the pole faces of the electro-magnets. A short piece of Spring Cord, attached to the Coupling and to the frame, serves to maintain the pen normally raised clear of the tape, but on passing current through the electro-magnets it is brought into contact with the moving tape.

The ribbon of paper is wound off the drum 3 by being pulled through a pair of rollers at the other end of the device. The top roller 5 consists of a pair of $1''$ fast Pulleys shod with $1''$ Rubber Tyres and secured to a Rod that is driven by the Electric Motor. The second roller consists of a $\frac{1}{2}''$ Pinion, and it is immediately below the first, so that it makes light contact with the tyres.

The tape passes over a smooth piece of cardboard, at the point where the nib of the pen makes contact with it, and it also runs under two Rods that form guides. One of the Rods is journalled in the bottom holes of the vertical Strips carrying the pen Rod, and the other is mounted in Flat Brackets that are attached to the Motor end of the base. Care should be taken to see that when the Rod 2 is attracted by the magnets, the pen rests only lightly on the tape. Also the ink must flow freely from the pen when the recorder is in operation.

It will be found a great advantage to incorporate a Resistance Controller in the Motor circuit, so that the speed of the tape may be varied to suit the speed at which the message is transmitted, for this is liable to considerable variation when beginners get busy! The instrument is also useful for recording Morse signals heard on the wireless.

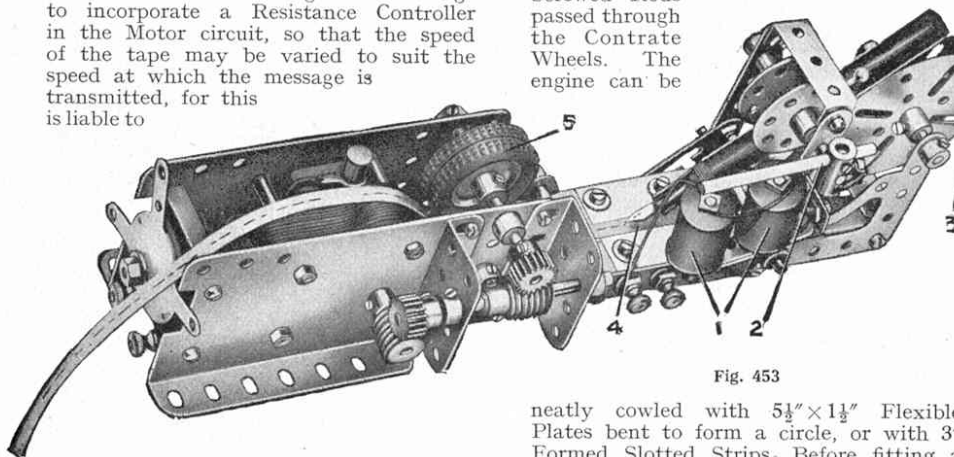

Fig. 453

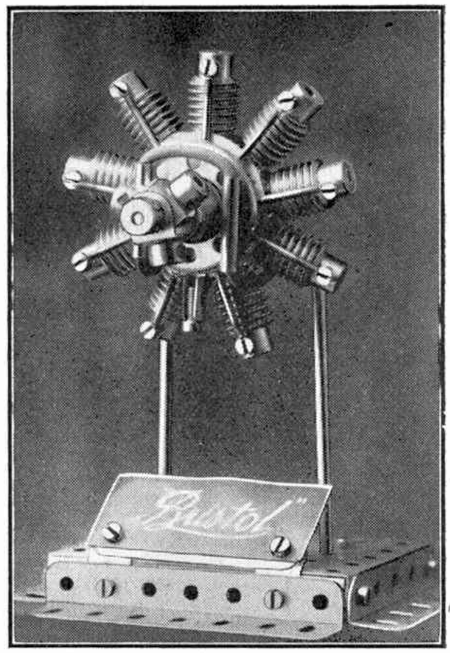

Fig. 454

(454) Bristol "Mercury" Aeroplane Engine

(A. Spring, Cainscross)

In reply to the large number of enquiries I have received I illustrate in Fig. 454 a dummy model of an aeroplane engine that can be fitted in Meccano aeroplanes. In the illustration the engine is shown mounted on a demonstration stand just as the real engine would be if it were on exhibition, and it is complete with a variable pitch propeller hub. The engine was designed by A. Spring, Cainscross, and was awarded a prize in a recent competition.

The crank-case of the model is made from two $1\frac{1}{2}''$ Contrate Wheels, between which are clamped nine Worms, disposed radially in the manner shown. The Worms are fitted with bolts and lengths of Spring Cord to represent the rocker arm casings and push rod casings respectively. The reduction gear housing is a Chimney Adaptor, and three Large Fork Pieces form the variable pitch propeller hub. The complete engine can be mounted in a model aeroplane by Screwed Rods passed through the Contrate Wheels. The engine can be neatly cowled with $5\frac{1}{2}''\times1\frac{1}{2}''$ Flexible Plates bent to form a circle, or with $3''$ Formed Slotted Strips. Before fitting a cowling, the engine should first be mounted on a back-plate formed by a Face Plate or Pulley.