# MECCANO CONSTRUCTORS GUIDE

**by B. N. Love** **Part 12**

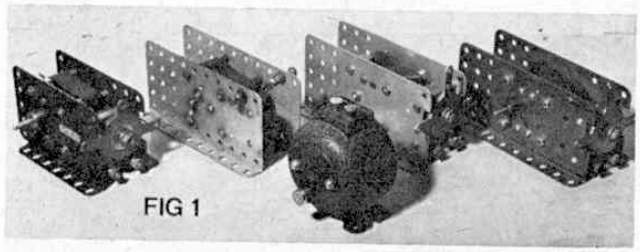
## ELECTRICAL CIRCUITS FOR MOTORS AND LIGHTS

SO MANY TYPES of electric motor have been available to the Meccano enthusiast over the years that he may well be confused at times as to what is required in the way of power supplies and, as the number of transformers and controllers is equally profuse, a short explanation of general requirements may help to clarify the matter. Essentially, two types of Meccano motor are available to the constructor, one being known as a " universal " type and the other as a D.C. type. For a period of some 40 years or more, Meccano Ltd. produced the first type in large quantities and in several patterns, a selection of which are shown in Fig. 1. These are all known as ' side plate ' motors with the exception of the spherical enclosed motor which is affectionately known as a ' cricket ball " type.

All these motors are of the " Universal " type, which means that they may be very conveniently run, *via a suitable transformer*, from Alternating Current (A.C.) as supplied to houses in most parts of the world, or from Direct Current (D.C.) as supplied by a battery or transformer/rectifier.

Alternating Current is constantly changing direction 50 times per second in most European countries and 60 times per second in the U.S.A. Since an A.C. motor consists basically of an electro-magnetic armature driven by repulsion and attraction from an electro-magnetic set of field coils, the change of direction of current, being the same at any instant of time for both the armature and the field coils, means that the magnetic relationship between the two parts of the motor is constant, in terms of direction of rotation. D.C. motors for model driving, on the other hand, commonly have permanent magnet yokes acting in place of field coils, which means that the field of such a motor is not reversible. If such a motor had an armature supplied with alternating current it would try to start and reverse 50 times per second which would result in a complete cancellation of rotation—not to mention a probable burned-out armature! The D.C. motor has several advantages however, since it is only necessary to supply current to the armature.

With modern development of nickel alloy permanent magnets, motor fields can be very dense and very compact with long life characteristics—a failing in early D.C. motors for model driving. Hence, a battery, fitted with a switch which will change over the feed wire contacts will operate a D.C. motor in either direction and has the great advantage of portability making the model independent of trailing power supply leads.



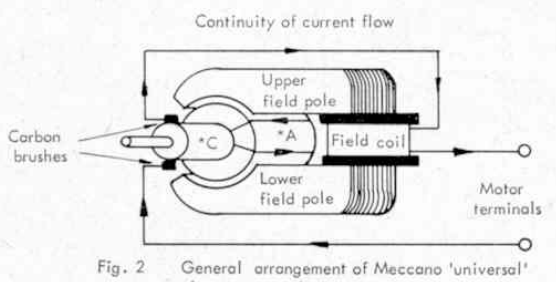




Fig. 2 General arrangement of Meccano 'universal' electric motor showing 'series' wound arrangement for Field coil and armature. *C - commutator *A - armature

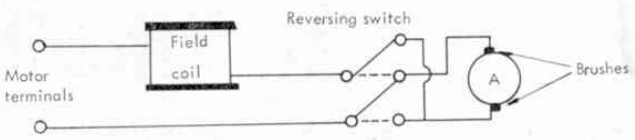



Fig. 2 b. Reverse switching arrangement common to Meccano 6 volt, 15 volt and 20 volt 'universal' ( A.C. / D.C. ) motors.

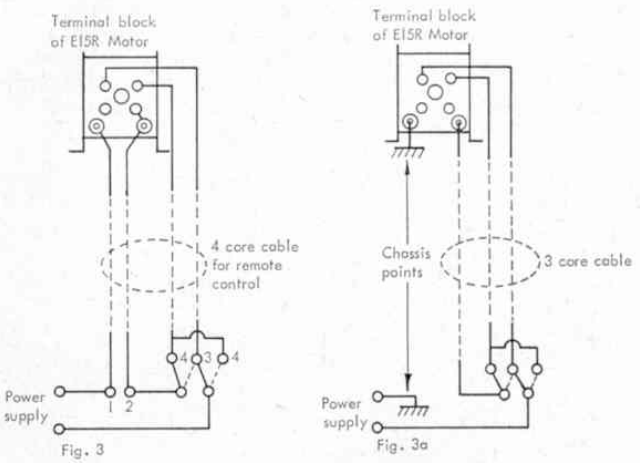



Fig. 3 Fig. 3a

Alternate methods of wiring the E15R and similar Meccano 'universal' motors for reversing by remote control. Fig. 3 - 4 core system. Fig 3a - 3 core system with one lead 'earthed' to chassis model. A Double Pole, Double Throw change-over switch is required for the remote reversing.

Early Meccano motors were intended to be operated from lead-acid accumulators as their current demands and low efficiency made dry battery operation unsatisfactory and very expensive. Four-volt motors were quite common in the early 20's to suit the accumulator but low voltage means high current consumption for the power required. By the late 20's the voltage rating had been increased to 6 volts and attempts made to drive Meccano motors from house mains. Few districts in U.K. were on A.C. supplies and one Meccano motor was manufactured to run from 110 volts, this being supplied from the then 220 volt D.C. domestic supply

by dropping 110 volts or more through a household carbon filament lamp and a rheostat or variable resistor, the whole arrangement bordering on the semi-lethal! With the widespread change-over to domestic A.C. supplies, Meccano Ltd. produced an excellent range of transformers so that their popular 6 volt universal motors could be run either from a 6 volt accumulator for those enthusiasts living in houses without mains electricity, or from the mains where an A.C. installation was provided.

One puzzling feature of operating the A.C. motor is that changing round the transformer leads to the motor has no effect on its direction of rotation. On the other hand, a D.C. motor will immediately reverse if the battery leads are reversed. The explanation is as follows. In the case of the D.C. motor with a permanent magnet field, a change of direction of current through its armature will cause a change of magnetic polarity. Since the field cannot change, being a permanent magnet, the armature will turn in the opposite direction on having its current reversed. In the case of the ' universal ' motor, reversing the battery leads or transformer leads simply reverses the magnetic polarity in both the armature and the field and we are back to square one, still going in the same direction.

In order to reverse a universal motor (A.C./D.C.) we must maintain the winding sense in the field coils but change over the polarity to the armature only, or vice versa. In the case of the current Meccano universal motor, the E15R (Electric, 15 volt, Reversing), one terminal is wired directly to the field coil and the other to a change-over switch. Current flow may then be considered to be through the field coil and then through the armature, the armature being reversible by means of the change-over switch to put it into opposite ' phase ' to that of the filed coils and hence cause reverse of motion. The arrangement of wiring described is known as ' series ' winding which means that the field and armature are in series, like two fairy lights on a string of tree lights at Christmas, which means that the current is the same in both parts of the motor from the D.C. point of view, and they ' share ' the total voltage, commonly 6, 15 or 20 volts in the general range of Meccano electric motors. They do not necessarily have exactly half the voltage in each part of the motor, A.C. circuit theory not being quite so straightforward where electrical quantities, combining resistance and inductance, are involved.

Fig. 2 shows the general arrangement of the Meccano universal motors, a non-reversing type being illustrated. This demonstrates the series winding, direction of flow round the windings being illustrated for a D.C. input of appropriate polarity. Fig. 2(b) shows the switching arrangements built into the reversing motors manufactured by Meccano Ltd. over the past 50 years or more. This arrangement also highlights a disadvantage of the universal motor. In order to reverse its direction it is necessary to operate a mechanical reversing switch on the site of the motor so that it is not directly suitable for remote control. Long mechanical linkages could be fitted but this would be clumsy and seldom satisfactory. A D.C. motor, such as the Power Drive Unit with 6 speed Gearbox, the Junior Power Drive or the now-discontinued Emebo motor can readily be controlled remotely simply by fitting long leads to the battery or power unit and reversing the leads at the source of power by a simple change-over switch. However, there is a way of controlling the E15R motor and similar universal motors, remotely, by using four leads to a remote change-over switch, but this requires direct wiring to the motor terminal block after removing the fitted reversing lever and modifying the internal connections. Advanced modellers and those well acquainted with motor wiring may tackle such a modification, details of which are shown in Fig. 3.

Lead 1 goes straight to the motor terminal which is already connected to the field coil. The other field connection is made to the second motor terminal, internal modification being carried out as required. Finally, the brush leads in the motor are connected to the top two studs of the switch block after removing the reverse lever. The remote switch requires terminals and contacts as shown in Fig. 3 and a simple switch of this kind can be made from electrical parts in the Meccano system. Failing this, a radio-type switch, known as a D.P.D.T. (double-pole, double-throw switch) will do the trick.

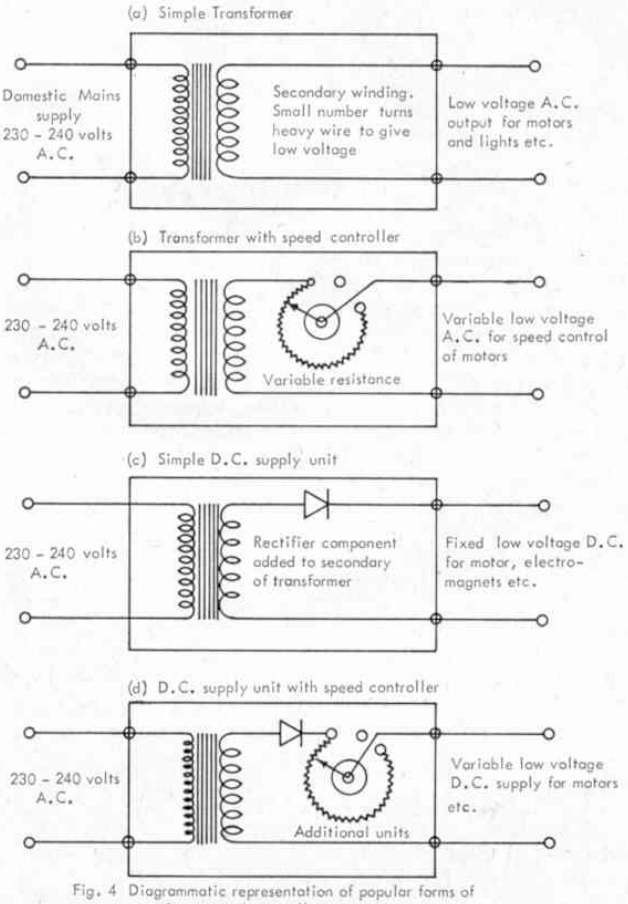



Fig. 4 Diagrammatic representation of popular forms of transformers and controllers.

Fig. 3(a) shows how the remote leads can be reduced from a four-core cable to a three-core system by making use of the chassis of the model, such as one would find in a large crane etc., and ' earthing ' lead 1 to the model and one side of the power supply. The modern zinc finish on Meccano parts is an excellent conductor of electricity and, if contacts are made to parts with such a finish, no difficulty should be encountered in making a good return circuit.

With regard to power supplies for the various motors, while a 6 volt or 12 volt dry battery is quite suitable for the modern Meccano D.C. Power Drive motors, the majority of constructors will make use of mains supplies suitably reduced by means of transformers etc. A look at Fig. 4 will show the four basic types, in simplified form, which the Meccano builder is likely to come in contact with. Generally speaking, the

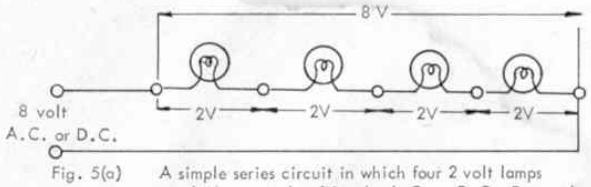



Fig. 5(a) A simple series circuit in which four 2 volt lamps are lit by a supply of 8 volts A.C. or D.C. Removal of one lamp will extinguish all lights.

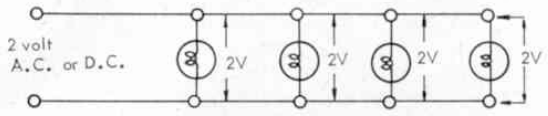



Fig. 5 (b) A simple parallel circuit in which four 2 volt lamps are lit by a supply of 2 volts A.C. or D.C. Removing any lamp will not extinguish the others.

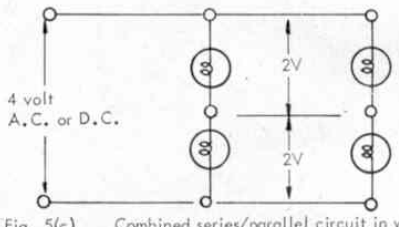



Fig. 5(c) Combined series/parallel circuit in which four 2 volt lamps are lit from a 4 volt A.C. or D.C. supply. Removal of one lamp will not extinguish the other two left in series across the 4 volt supply.

universal motors run at their best on full voltage, speed reduction being obtained by appropriate gearing. A simple transformer is required in this case, see Fig. 4(a). Essentially, a coil of many hundreds of turns of wire is wound round a metal core of soft iron and then, after layers of insulation are added, a second coil of wire, in thicker gauge, with a small number of turns is wound over the first. The long coil is known as the 'primary' and this receives the full 230 or 240 volts from the house mains. The smaller coil of thicker wire is called the 'secondary' and this provides the reduced voltage to the universal motor. Some transformers are fitted with speed controllers as shown in Fig. 4(b), the controller in this case being a variable resistance connected in the secondary circuit. Such a transformer is commonly used for operating 6 volt or 20 volt A.C. trains but its speed regulation properties are not particularly good.

If D.C. apparatus is to be powered, an additional item is required in the secondary side of the transformer to permit the A.C. current to flow in one direction only, thus converting it to D.C. This item is called a 'rectifier' and is shown diagrammatically in Fig. 4(c).

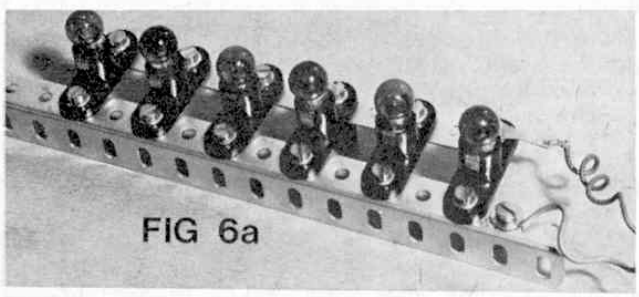


FIG 6a

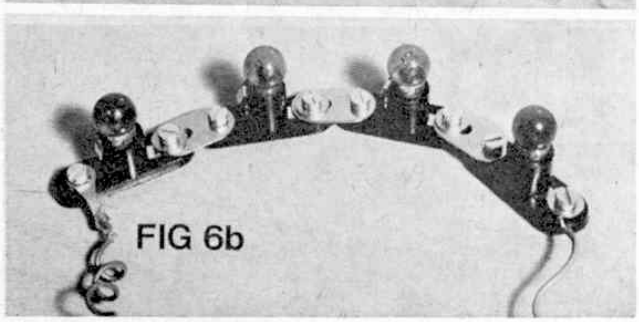


FIG 6b

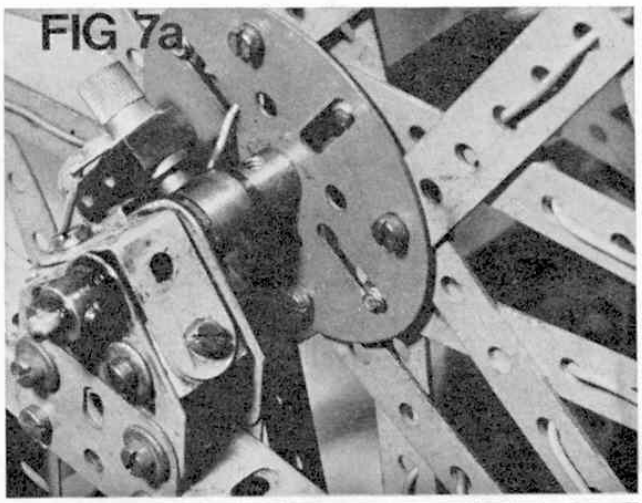


FIG 7a

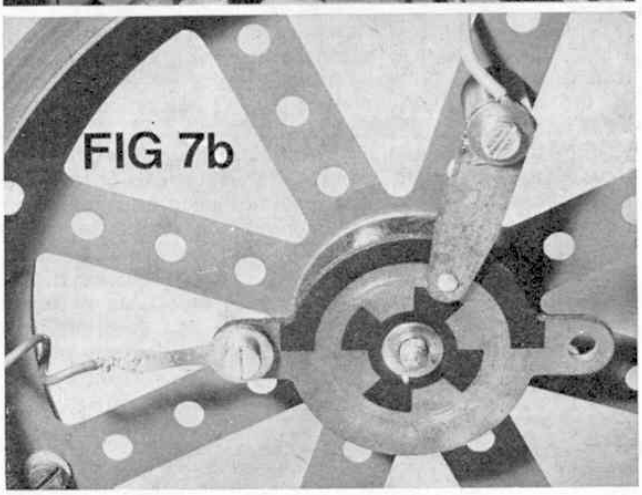


FIG 7b

When combined with a variable resistance, Fig. 4(d), the unit becomes a D.C. controller and is popularly used with small-gauge railways etc., because of its simple reversing qualities. The last refinement of the D.C. controller is to incorporate a change-over switch with the variable resistance, thus allowing motors, locomotives, etc., to be reversed from the controller.

Although the modern Meccano D.C. Power Drive motors are adequately powered by dry batteries, they may also be powered by mains-operated D.C. control units such as are used for model railways. A word of warning is required here, however. As the two Power Drive motors are primarily designed for battery operation they are not suppressed against radio and T.V. interference. If they are used with mains-driven controllers, they become highly effective (and illegal) inter-

ference transmitters! Suppressor circuits can be added and advice from a local radio dealer could be helpful in this respect.

Apart from motion, nothing adds more to the realism of a model, whether working or static, than a good display of coloured lights. Thanks to Meccano Electrical Parts, the modeller can decorate his structures to great effect. Three basic forms of circuit wiring are available to the constructor and these are illustrated in Fig. 5. The first is series wiring, all lamps strung out like fairy lights, current passing through each lamp in turn. This arrangement would be suitable for a string of six 2 volt lamps if a 12 volt transformer was used, as the voltages of the lamps, in series, are added for the total.

The second arrangement is a straightforward parallel circuit in which the lampholders are arranged like the rungs of a ladder and each lamp receives the full voltage of the supply available. The coloured lamps supplied by Meccano are for 12 volt working but each lamp draws only .04 amps. This means that no less than 100 Meccano 12 volt lamps could be illuminated by a 12 volt transformer rated at 4 amps. 'Popular' 12 volt transformers have a current rating of 1-2 amps so that 25 to 50 lamps could be driven from such transformers. The Electrical Part Lamp Holder has an all-insulated casing, but its securing holes are also contact bushes for wiring. A number of such Lamp Holders can be virtually built up like a ladder as shown in Fig. 6, no wiring being required between Holders as all current is carried by the Perforated Strips. Standard Bolts, ($\frac{3}{8}$ in. preferred) fit the holes but there must always be a gap in the metal contacting the two holes of any one Lamp Holder, as the brass bushes in the Lamp Holders are not insulated. They can, of course, be mounted on any part of the surface of the Fibre Insulated Plates, the simple rule being to make sure that there is no metal connection across the two holes of the holder as this would give a short circuit, no light and possibly a burnt-out transformer.

Very little wiring is required with the Lamp Holders, thanks to the versatility of the Electrical Parts, and Fishplates or frameworks provide neat and adequate current paths as shown in Fig. 6(a). It must always be borne in mind that low-voltage supplies are to be used with these parts. In theory, 20 Lamp Holders fitted with Meccano 12 volt Lamps could be strung in series across 240 volt house mains, but, in this case, all bare screws and tags on the lamp holders would be a potential lethal danger!

FIG 9

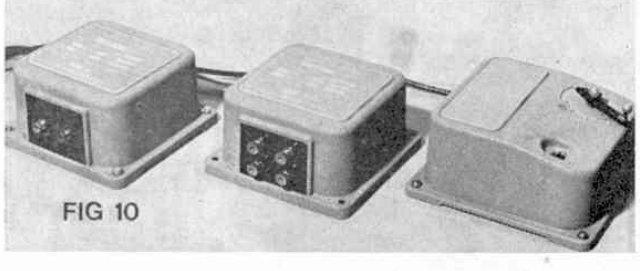


FIG 10

Finally, we may add further interest to illuminating models by arranging for lights to rotate with the superstructure of Big Wheels, Roundabouts and similar models. Fig. 7(a) shows how current is passed from the 'A' frames of a Ferris Wheel to the wheel itself by means of a carbon brush holder attached to the 'A' frame which contacts a simple copper ring commutator mounted on, but insulated from, the main spindle. The Electrical Part Flat Commutator is shown in Fig. 7(b) with a short Wiper Arm located to wipe on its surface. This Commutator has three tracks which give 180°, 360° and four equally-spaced intervals of 45°, respectively, and it may be used for intermittent contact as required.

As well as supplying current for lights to rotating structures, the Commutator will also carry the current required for any of the Meccano Electric Motors. Wiring should be carried out in plastic insulated cable, trimmed carefully to retain all strands, connections being made securely below a Washer or by means of a soldered tag where the constructor has facilities for soldering. Bare metal-to-metal contacts must be maintained and, if the framework of a model is employed for the 'earth' return path, it will serve both for A.C. and D.C. circuits, as shown in Fig. 8.

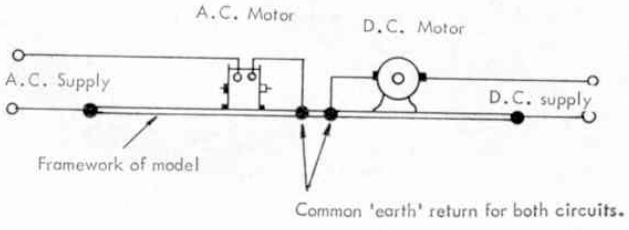



Fig. 8 If the chassis of a model is used for the return path wiring for motor or lights a common earth point may be used for both circuits as shown above, despite the apparent 'mixture' of A.C. and D.C. supply. The motors may still be reversed by their reversing levers but separate earth leads will be needed if multiple remote control is required.

**As this is the closing chapter of the series, the writer would like to thank all those enthusiasts who have written so many encouraging letters to him during the course of the publication of the Constructors' Guide.**

**In particular he would like to thank those members of the Midlands Meccano Guild who have provided some of the material used in the various chapters and for their permission to take photographs in certain cases.**

**Because of the world wide interest shown, the Guild is now preparing an International Register of Meccano Constructors (over 18 years old). Any enthusiast actively engaged in model building in Meccano is invited to apply for entry on to the Register. This may be done by sending a stamped addressed envelope (International Reply Coupon for overseas constructors) to B. N. LOVE, Hon. Sec. Midlands Meccano Guild, 61, Southam Road, Hall Green, Birmingham, 28.**