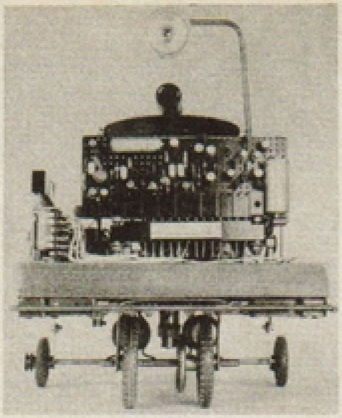
CYCLOPS



PART TWO

by
L. C. Galitz

This is the second article in a series about robots and cybernetic devices. The first article was concerned with various types of robot and introduced Cyclops, an auto-robot. This article deals with the construction of the chassis and the mechanics of Cyclops.

Cyclops is rather an unusual electronic device, because he must be totally self-contained and mobile. Therefore, all the various bits and pieces must be mounted on a stout chassis.

In the good old days of radio, a piece of electronic equipment was not a piece of electronic equipment unless it was built on a sturdy professional-looking metal chassis; and the electronics enthusiast of that bygone age also had to be handy with his chassis punch, Allen Keys, and thread tapping sets. Unfortunately, his present-day contemporary excels with the use of the soldering iron, but his heart is not with the field of mechanics. For this reason, all the metalwork and gearing systems in Cyclops are based on readily available Meccano, and the main chassis is made of wood.

The author chose a piece of veneered chipboard for two main reasons. Firstly, it is very easy to work with, and secondly, it has a pleasing appearance. Those more capable at the art of woodwork may chose a piece of blockboard, and some may prefer a sheet of metal. Whatever material is chosen, it must be light, rigid and strong, because relays, batteries or accumulators, and motors will be supported by the chassis, and it is useless if the material sags or twists under the strain.

CHASSIS LAYOUT

The chassis is 10in. by 7in., and, in the author's case, was ¾in. thick. Fig. 6 shows the layout of the mechanics, and also the positions of the various pieces of equipment mounted on the chassis.

It will be remembered from the first article that there are two motors. One motor (Motor 1) drives a pair of front wheels mounted on a common axle so that the robot can move. These two front wheels are mounted on a unit which (due to Motor 2) revolves about a vertical axis, and thereby changes the direction in which the front wheels are pointing. Thus, rotation of the front wheel unit changes the direction in which the robot moves.

The most obvious way of arranging the rotation of the front wheel unit, whilst still allowing mechanical power to be applied to the front wheels, is given by mounting the front drive motor on the unit itself, with electrical power fed to it by a system of slip rings. The scan motor (i.e. Motor 2) would then rotate the entire front drive unit complete with its own motor. This method was in fact used on earlier prototypes, but had to be discarded for several reasons. Firstly, there is always difficulty in arranging slip rings which give low

losses. Further, home-made slip rings often supply power to the rotating unit intermittently. Finally, there is the problem that the rotating front wheel unit must be fairly bulky to accommodate the motor, gears and the big front wheels whereupon, since this unit has to be pivoted at the top, the result is very poor overall stability of the assembly.

For these reasons, a method was sought by means of which *both* motors could be secured firmly to the chassis, and reference to Fig. 7(a) and (b) shows how this is accomplished. In this diagram the identifying numbers are the corresponding Meccano part numbers.

Power from the main drive motor is transmitted through the small pinion (part no. 26) to the contrate wheel (part no. 28). This gearing turns the mechanical power through 90°, so that it is now in a vertical plane. The power goes through the shaft (part no. 15b) which is supported by the double bent strip (part no. 45) and the hole in the chassis. Below the chassis the shaft passes through several washers, through the centre hole of a large gear wheel (part no 27b), to which it is *not* secured and, after several further washers, terminates in a second pinion (part no 26.) This pinion engages with a second contrate wheel (part no. 28) which is coupled to the axle of the front wheels. Thus,

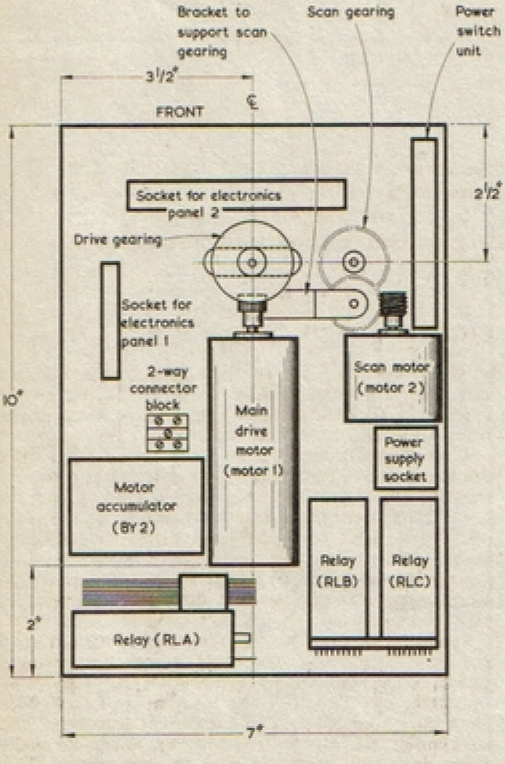


Fig. 6. Top view, illustrating the layout of the main components on the chassis of Cyclops. Some of the parts shown are discussed in later articles

COMPONENTS

Meccano Parts

1 off	1a	9½in.	Perforated Strip
			Large Bracket.
1 off	3	3½in.	Perforated Strip
			Bracket for Scan Gearing
2 off	5	2½in.	Perforated Strip
			Front Wheel Brackets
2 off	6	2in.	Perforated Strip
			Rear Axle Supports.
1 off	6a	1½in.	Perforated Strip
			Scan Gearing Support
1 off	13a	8in.	Axle Road
			Rear Axle
1 off	15b	4in.	Axle Rod
			Vertical Drive Shaft
1 off	16b	3in.	Axle Rod
			Front Axle
2 off	21	1½in.	Pulley
			Front Wheels
2 off	22	1in.	Pulley
			Rear Wheels
1 off	23a	½in.	Pulley
			Rear Wheel Keeper
2 off	26		Pinion ¾in. diam. ¼in face
			Main Drive Pinions
2 off	27b	3½in.	Gear Wheels
			Front Drive and Eye Unit Supports
2 off	28	1½in.	Contrate Wheels
			Main Drive Gears
1 off	37		Nuts and Bolts. Pkt. of 24
2 off	45		Double Bent Strip
			Jack Socket Mount and Main Drive Guide
2 off	126		Trunnion
			Rear Axle Bracket
2 off	142c	1in.	Motor Tyre
			Motor Tyres for Rear Wheels
2 off	142d	1½in.	Motor Tyre
			Motor Tyres for Front Wheels

Ripmax Gears and Shafts

(Available from good model shops)

3 off	10-tooth gears	
1 off	30-tooth gears	
1 off	Worm Set	(Consists of one worm gear and one 36-tooth matching gear)
1 off	steel shaft, 5½in. long	
1 off	steel shaft, 2½in. long	

Motors

Main Drive Motor: Richard II Monoperm Super, Marx Luder EM52 (Ripmax Ltd.)

Scanning Motor: Ripmax Orbit EM505 (Ripmax, Ltd.)

Miscellaneous

One 3.5mm Jack Plug and Socket
Washers (as required)
10in × 7in Chassis (see text)

M. W. Models, 165 Reading Road, Henley-on-Thames, Oxon, RG9 1DP, are offering special Kits of the Meccano parts-see small advertisements.

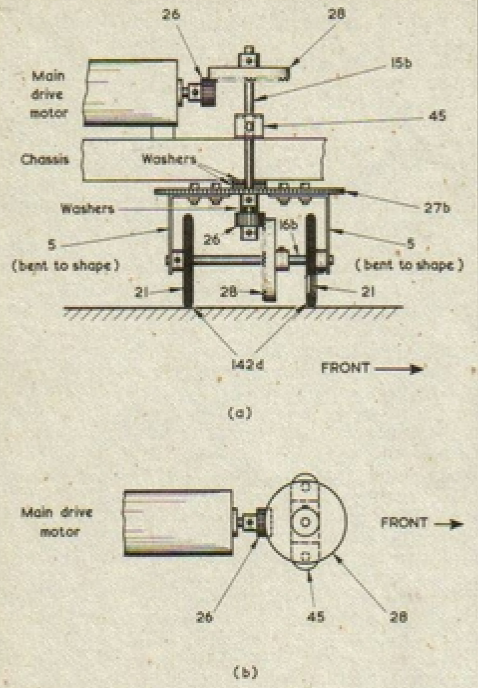


Fig. 7(a). Side view, demonstrating the manner in which power from the main drive motor is applied to the front wheels. To assist in illustrating operation, part of the assembly is shown in section. It is assumed that the wheels are orientated so that their axle is parallel with the long sides of the chassis. The identifying numbers are Meccano part numbers
(b). Top view, giving a detail of the parts immediately associated with the motor

the power from the main drive motor, which is firmly mounted on the chassis, is finally applied to these wheels, causing them to rotate.

The front wheel axle is secured at its ends by two perforated strips (part no. 5) bent to shape, these being secured to the large gear wheel (part no 27b).

The rear wheels are mounted on a rear axle supported by two brackets, as shown in Figs. 8(a) and (b), taking up the position illustrated in Fig. 9. One wheel is bolted onto the axle, whilst the other is free to rotate. This method of assembly is adopted because, if both wheels were bolted directly to the axle, one wheel would be forced to skid when Cyclops moved in a direction other than straight forward or straight backward. The free wheel is kept in place by a small pulley bolted to the axle. It was found that the spring retaining clips made for the purpose created too much friction when rubbing against the wheel.

SCANNING MECHANISM

The front wheel unit is mounted on a large gear wheel so that the scanning mechanism can be directly coupled to it. The scan motor is smaller than the main drive motor and has a Ripmax worm gear bolted to its output shaft. This engages with the gear train shown in basic form in Fig. 10(a). The worm gear drives a Ripmax 36-tooth gear mounted on the same shaft as a Ripmax 10-tooth gear. The latter, in its turn, drives a Ripmax 30-tooth gear mounted on a long shaft which passes through the chassis. Below the chassis a Ripmax 10-tooth gear mounted on this shaft engages with the large Meccano gear wheel (part no. 27b) on which the front wheels are mounted. Above the chassis, and in the upper part of the robot assembly, another Ripmax 10-tooth gear on the long shaft engages with a further large Meccano gear (also part no. 27b) on which the eye is mounted. This upper 10-tooth gear can be seen in the photographs accompanying this and last month's article. It will be helpful also to refer to Figs. 10(b) and (c). Fig. 10(b) shows the 36-tooth and 10-tooth gears on their common shaft, whilst Fig. 10(c) shows the long shaft which carries the two 10-tooth gears which engage with the large Meccano gear wheels on the front wheel unit and the eye unit. In Fig. 10(c) the large gear wheel for the eye unit is omitted.

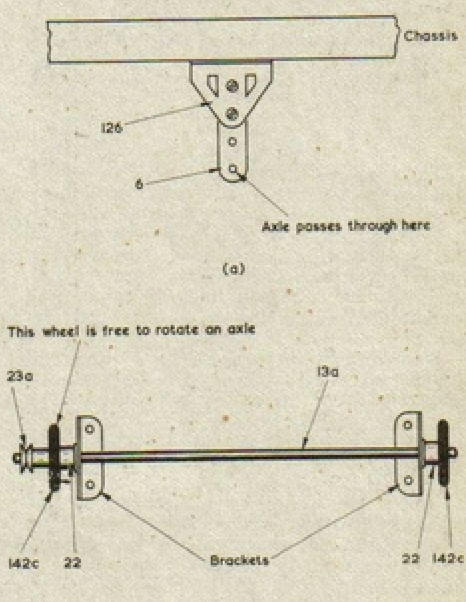


Fig. 8(a). Making up the brackets for the rear axle. two brackets are required
(b). The rear axle assembly. The two brackets are those of (a), and they are screwed to the underside of the robot chassis

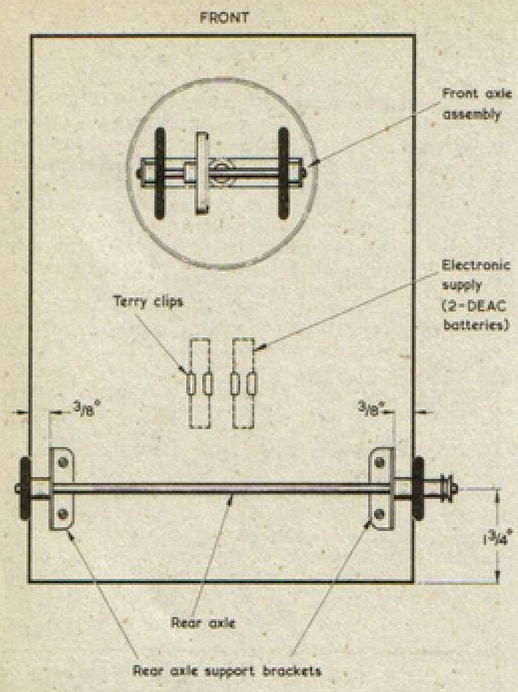


Fig. 9. Underside view, illustrating the position taken up by the rear axle assembly. Also shown are two Deac batteries. These will later be used to power the electronics

The two vertical shafts of Figs. 10(b) and (c) are steadied by means of perforated Meccano strips. Washers are soldered to these to provide smaller holes for the shafts to pass through. It will be appreciated that, since the large gears carrying the front wheels and the eye are turned by similar gear wheels on a common shaft, the two large gears rotate in unison. In consequence, Cyclops always looks in the direction he is going.

A further point is that the eye gear wheel rotates on a jack plug, which acts as a pivot. The use of a jack plug for this function is discussed in detail later in this article.

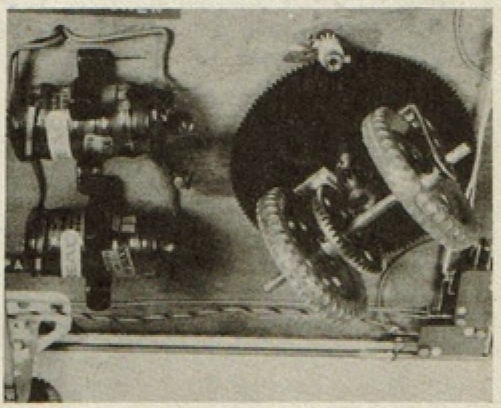
MECHANICAL CONSTRUCTION

Before commencing the mechanical construction a suitable chassis material must be chosen. As was mentioned earlier, this must be strong because it supports several heavy pieces of equipment, and must not sag under the strain. After all, Cyclops tips the scales at half a stone! This chassis is 10in. by 7in.

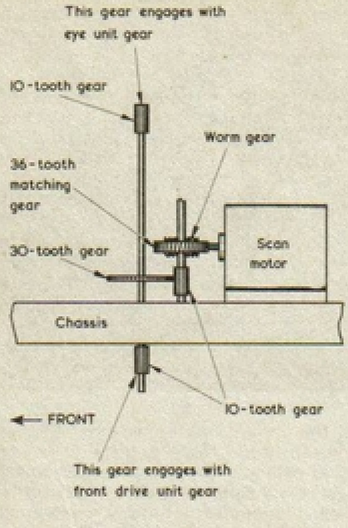
Firstly, the main drive equipment must be made. The main drive motor is one which has an integral gearbox. The motor itself is a 'Monoperm Super' and the entire motor and gearbox is manufactured by Marx Luder. The gearbox has six ratios, the one which is used here being 6:1. The more experienced constructor may wish to choose alternative gear arrangements, but the author found it of advantage to have a variable torque available. This facility is especially useful when components differing in weight are employed in other parts of the construction since a different ratio may then be required to give optimum running conditions. Also, high precision is required to mount gears handling high torques efficiently if these are external to the motor.

The motor has an integral bracket and is screwed to the chassis so that its axis coincides with the centre line of the chassis, and is positioned such that its rearmost point is 2in. from the rear of the chassis. A $\frac{5}{32}$in. hole is then drilled in the chassis $2\frac{1}{4}$in. from the front, this hole lying on the centre line of the chassis. This hole takes the vertical drive shaft. As shown in Fig. 7, a double-bent strip (part no. 45) is then screwed to the chassis so that its centre hole coincides with the hole just drilled. A contrate wheel is now bolted to the vertical shaft and this assembly passed through the chassis from above. A pinion is bolted onto the motor shaft such that the contrate wheel meshes with it.

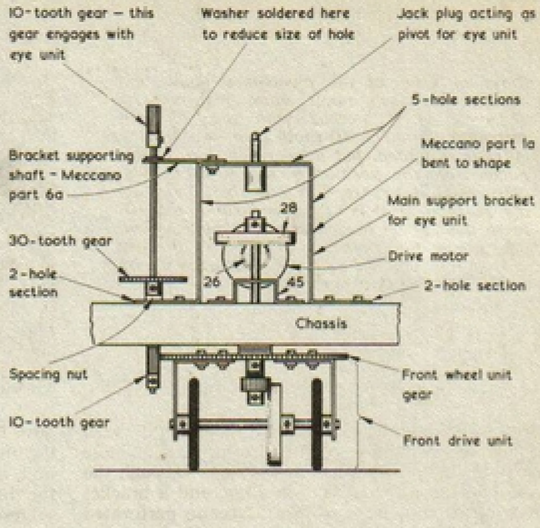
The front drive unit is now made up as in Fig. 7(a). A large gear wheel is taken, and two brackets are bolted to the holes provided. These brackets are Meccano strips (part no. 5) bent so that two holes lie to one side of the bend, and the remaining three to the other side of the bend. Also, the curved ends of the 2-hole strip sections are cut away so that the strips clear the bush of the large gear wheel. The bend is a 90° one, and the brackets are bolted to the large gear wheel with two screws so that the three-hole sections are at right angles to the wheel surface. The front wheel axle is passed through the end holes of the brackets, taking up the two road wheels and the other contrate wheel. The two road wheels are next bolted to the axle with their bushes close to the brackets. Two washers are passed over the vertical shaft to allow the bolts on the large gear wheel to clear the underside of the chassis, and then the front drive unit is placed onto the vertical shaft. Two more washers are passed onto the vertical



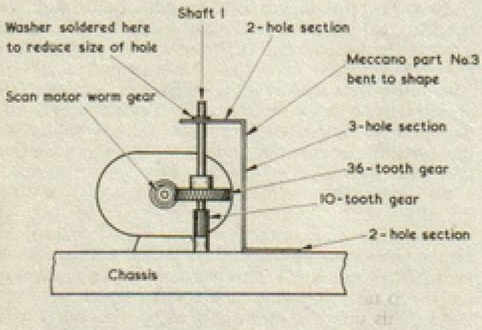
View under the chassis, showing the front wheel assembly. The small white 10-tooth gear in the scanning train which rotates the front wheel unit is clearly visible, as also are the pinion and contrate wheel which drive the front wheels themselves. Also to be seen are the two Deac batteries which power the electronics and two microswitches in the touch stimulus system



(a)



(c)



(b)

Fig. 10(a). Side view showing the basic scanning gear chain, as seen from the chassis side further away from the scan motor. For simplicity, securing brackets and gear bushes are omitted. All gears in this diagram are Ripmax types
(b). Front view, illustrating how the intermediate shaft with the 36-tooth and 10-tooth gears is held in position
(c). Another front view. This gives details for the bracket on which the eye unit is mounted. Also shown is the bracket which supports the long shaft in the scanning gear train

shaft, and then a pinion is bolted on such that when the front wheel unit is pushed against the chassis the drive motor pinion meshes easily, and without any pressure, with the contrate wheel above the chassis. The second contrate wheel is bolted to the road wheel axle so that it, too, meshes easily with its pinion. If desired, the motor can be powered by a 6-volt d.c. supply whereupon, if the large gear wheel is held still, the road wheels should rotate.

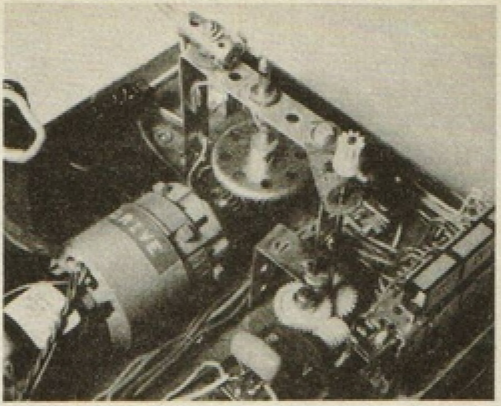
The rear wheel assembly is next made up. Two trunnions are taken, and onto each one is bolted a 2in. perforated strip with two nuts and bolts, as in Fig. 8(a). The two resulting brackets are then screwed to the underside of the chassis, so that the rear end of each trunnion is $1\frac{3}{4}$in. away from the rear of the chassis, and the face of each trunnion is $\frac{3}{8}$in. inside the chassis edge. The rear wheels are fitted to the rear axle as shown in Figs. 8(b) and 9.

SCANNING SYSTEM

We now come to the eye scanning system. This is built 'backwards'; in other words, the last gears in the chain are fitted first, and the affixing of the motor comes last. Refer to Figs. 10(a), (b) and (c) as necessary when fitting the parts concerned. A $\frac{3}{16}$in. hole is drilled through the chassis 3in. from the chassis front and approximately $3\frac{5}{8}$in. distant from the vertical main drive shaft. The exact position for the hole is found by holding one of the 10-tooth gear wheels so that it meshes with the large gear wheel under the chassis, and then marking the position where its axle must pass through the chassis. The 10-tooth gear wheel is temporarily bolted onto a $5\frac{1}{2}$in. length of axle, and passed from the underside of the chassis up to the top. The 30-tooth gear wheel is temporarily bolted to the axle.

Another 10-tooth gear wheel is held against the

Close-up view of the mechanics above the chassis. The scan motor worm gear may be observed as it meshes with the 36-tooth matching gear. The 10-tooth gear beneath the latter is obscured, but its position can be deduced from the position of the 30-tooth gear with which it meshes. The long shaft on which the 30-tooth gear is fitted also carries the 10-tooth gear under the chassis and the 10-tooth gear above the chassis which rotates the eye unit at the top. The eye unit was removed for this photograph



30-tooth wheel, and the position that its axle must take up is marked on the top of the chassis. A $\frac{5}{32}$in. hole is drilled at this point, but only part-way through the chassis. The second shaft is 2½in. long, and a bracket is made up to support it from a Meccano perforated strip 3½in. long (part no. 3). The strip is bent first through 90° with two holes to one side of the bend and the remaining five to the other side of the bend. It is then bent through 90° again, so that there are two holes between the other end of the strip and the second bend, leaving three holes between the bends. The bends go in opposite directions, as illustrated in Fig. 10(b). A small washer with internal diameter of $\frac{5}{32}$in. is soldered at one of the holes at the end of the bracket to reduce the diameter of the hole to that required by the axle. This bracket is now screwed to the chassis so that the small $\frac{5}{32}$in. hole through the washer is directly above the hole just drilled in the chassis. The 36-tooth gear which is part of the worm set is now temporarily bolted to the axle which passes through the bracket and into the corresponding chassis hole, and the worm gear is bolted to the spindle of the motor. The motor is now positioned so that the worm gear meshes with the 36-tooth gear wheel, the axis of the motor being parallel to the long side of the chassis. The motor is then screwed to the chassis by means of the bracket supplied.

EYE UNIT

The bracket holding the eye unit pivot is now made up out of a 9½in. length of Meccano perforated strip (part no. 1a), this being bent so that the two feet each have two holes, the uprights each have five holes, and the top section has five holes. See Fig. 10(c). The middle hole at the top is enlarged to ¼in. diameter to take the threaded part of a 3.5mm. jack plug, which is then soldered in place. The bracket is now screwed to the chassis with the spindle of the jack plug directly over the vertical main front wheel drive spindle, and with the top of the bracket parallel to the short sides of the chassis. A 1½in. length of Meccano perforated strip (part no. 6a) is bolted to the top section of the bracket so that the hole at the other end is over the hole in the chassis which takes the axle having the 10-tooth gear and which meshes with the large gear on the front wheel unit. The strip is loosely bolted in place. A washer with an inside diameter of $\frac{5}{32}$in. is soldered at the end hole of the strip to take the axle which will later pass through it.

The construction of the first part of the eye unit now takes place, and Fig. 11 should be consulted. The second large gear wheel (part no. 27b) is taken, and on the side opposite the bush is bolted another double bent strip (part no. 45). This has its central hole enlarged to ¼in. to take a 3.5mm. jack socket, which is fixed in place. This unit will eventually carry the photoelectric cell. It will be seen that the jack socket fits over the jack plug on the large bracket, and the eye is therefore free to rotate about the same axis as the front wheel unit. At the same time, the jack plug and socket allow electrical connection to be made to the photoelectric cell whilst the eye unit rotates. This idea was borrowed from 'In Your Workshop' in the September 1969 issue*. An alternative method of arranging the eye would be for the eye to look straight down the axis of rotation of the unit, and for a mirror to be set at 45° on the unit. Again, the eye would look along the direction in which the robot was moving, but the former method is preferred because it allows a lower overall height for the model. For those interested in the mirror approach, a diagram showing the method is given in Fig. 12.

(The photocell and tube assembly of Fig. 11 need not be constructed and wired at this stage. Further details on the assembly will be given in Part 4).

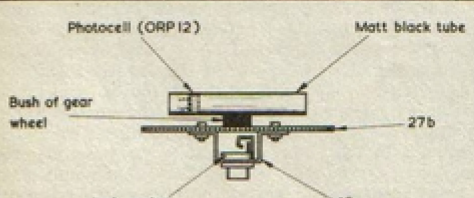


Fig. 11. Illustrating how the photocell assembly is constructed. The numbers are Meccano part numbers

* The jack plug and socket scheme was a 'reader's hint' submitted by B. Richardson.—Editor.

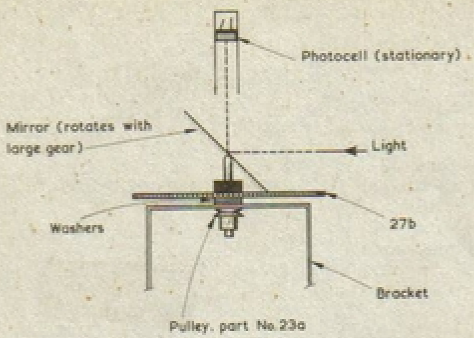


Fig. 12. A possible alternative method of operating the eye assembly

The eye unit is placed on the large bracket by way of the jack plug and socket, and the long axle is passed through the perforated strip (part no. 6a) at the top, and the chassis. Two 10-tooth gear wheels are bolted to the axle; one at the bottom underneath the chassis, meshing with the large gear of the front wheel drive unit, and the other at the top, above the perforated strip and meshing with the large gear wheel on the eye unit. The position of the perforated strip is then finally adjusted so that the top 10-tooth wheel meshes comfortably with the large gear wheel on the eye unit, and it is then bolted firmly down.

After this, all the gears are permanently assembled. First, the 10-tooth wheel at the top is removed, and the long axle is pushed down until its top is below the perforated strip. A spacing nut (see Fig. 10(c)) and the 30-tooth wheel are threaded on. The axle is then pushed up again, and all the gears bolted firmly on. Finally, the 10-tooth wheel at the top is put back on again. The gears on the short shaft are bolted in position as in Fig. 10(b). The scanning system can now be tried out with a 6 volt d.c. supply for smooth running, and it should be checked that both the front wheel drive unit and the eye unit turn together in unison.

This concludes the details of the main mechanical construction. In the next article details of the basic reflex circuitry will be given.

(To be continued)

BOOK REVIEWS

RADIO CONTROL

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THE PROPO BOOK by "Radio Modeller" Staff.
118 pages, $5\frac{3}{4} \times 8\frac{1}{2}$in. Published by Radio Control Publishing Co. Ltd. Price £1.25.

The purpose of this book is to introduce aeromodellers to the present sophisticated method of flying a model aircraft by radio control. 'Propo', as proportional control is abbreviated to, gives a finesse of control not found in any other system. As one moves the control stick on the transmitter, so the corresponding control in the aircraft follows in a similar manner. A small movement in transmitter control gives a similar movement in receiver response in the aircraft, i.e. the system gives proportional control in the aircraft to that set up on the transmitter.

This system has become so popular, that it may very soon become the only one to be used in future, and it has become widely adopted by the manufacturers of R/C equipment for the aeromodeller, as the system of choice. Complete propo R/C systems are quite expensive and if one purchases one, it is essential it be installed correctly in the model and used properly, if calamity and disaster is to be avoided!

This book covers all aspects of choosing propo-gear, installing it and maintaining it. Valuable information is given on linking systems from the equipment to the control surfaces. Pre-flight checks, fault finding and much else is adequately covered. A most useful feature in the book, is a series of full size diagrams of fourteen of the most popular servos in present use, giving all dimensions needed for planning and installing in the model.

For someone wanting to make the change from single channel, with its restricted control, to the precision of 'propo' control, this book is essential reading.

★ ★ ★

LOW COST PROPORTIONAL. By W. P. Holland.
118 pages, $5\frac{3}{4} \times 8\frac{1}{2}$in. Published by Radio Control Publishing Co. Ltd. Price £1.05.

If you are one of those who has had some experience of single channel radio control and wants to progress to the advantages of proportional control but who prefers the interest and experience – and the saving in expense – of building your own equipment to buying and assembling ready made propo systems, in your models, "Low Cost Proportional", in the RM Book Series, will tell you how to go about it. This publication really does cover its subject matter thoroughly. It starts off by explaining the advantages of proportional control; then deals with elementary pulse systems and methods of pulsing the radio carrier; goes on to deal with motorised actuators and explains the now well known "Galloping Ghost" system. The electronic side of the system is as adequately covered as the mechanical and the book is thoroughly practical as well as giving the necessary theoretical coverage. This is a book which can be recommended to the radio constructor of radio control equipment with every confidence.