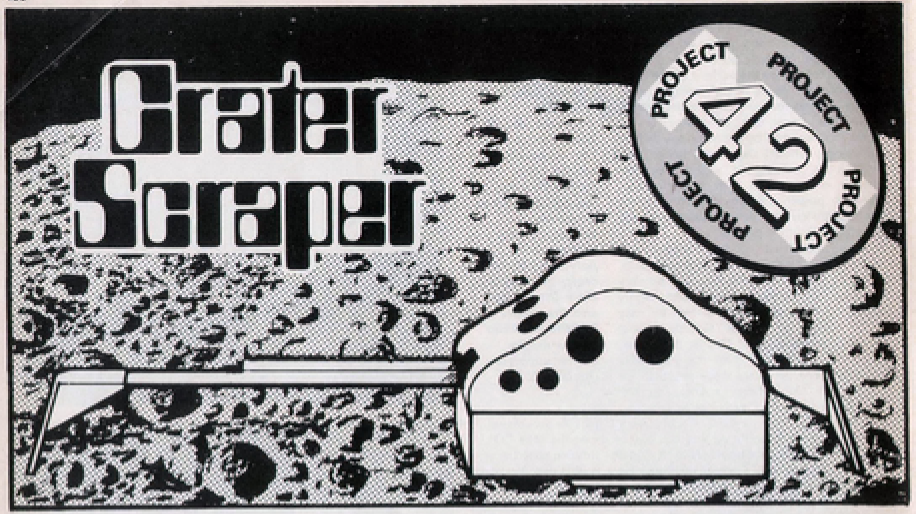
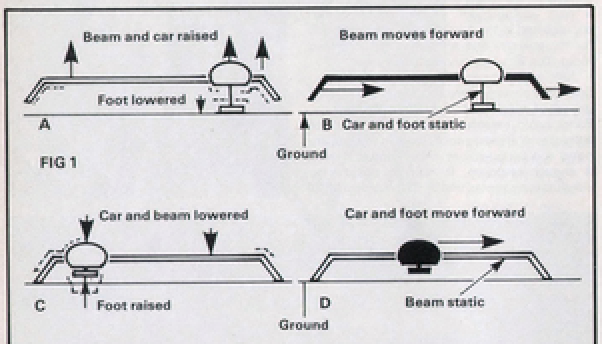
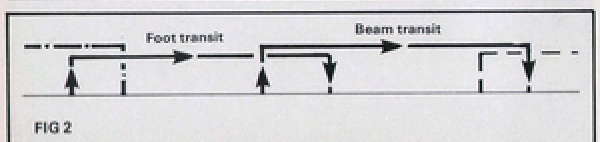
Crater Scraper



The "Space Models" designed by Peter Holland, which appeared in the early *Model Maker* of the 'fifties onwards, were interesting applications of mechanical principles and some are still available today in the Model Maker Plans Service as constructional drawings. This, his latest, "Space Model" makes use of readily available gear and rack sets and there's a radio controlled version too . . . Peter will describe them both.





This machine bears a faint external resemblance to my old M.A.P. Plans Service design "S.L.I.T.H.A.", a friction operated device using one of those dear old ever ready T.G.18 series of electric motors. I still have a few of these motors in old models and they still run on special occasions. There are, however, many small d.c. motors that would power those earlier "Space Models".

The "Crater Scraper" is an earth levelling device or should I say "Moon" levelling?). It has a beam upon which a car travels, and which, upon reaching the far end, shoots the beam forward ahead of itself again as seen in the sequence of **Fig. 1**. Unlike the "S.L.I.T.H.A.", this one has a retractable foot on the car, so that the whole unit is raised when shooting the scraper beam forward. Then raised when the car moves. This results in a form of "walking" action and is illustrated in **Fig. 2**.

Now, in order to give a really positive action and to enable it to support the weight of radio control (should one desire to fit it), a rack and pinion system is used - the one used on the prototype illustrated came from a packet of model experimenters gears from Messrs Proops of 52 Tottenham Court Road, London - though the model could, no doubt, be adapted to suit Ripmax gears and racks. The drive motor is a 3 volt miniature from the same source as the racks, but again, any little'un should do.

Ups and Downs

The foot action is achieved on the free running model by the use of motor torque; **Fig. 3** shows how it is done. Imagine the motor to be fixed as in "A"; the motor pinion simply

turns the gear wheel which carries a pinion to drive the rack. When the motor is reversed to run the rack the other way, the motor exerts a thrust against the mount rather than trying to lift it away. Of course that does it no good, for the poor thing can't get away. Now look at **Fig. 3B**: if there's friction or a load on that gear, the motor pinion, and of course the motor as well, try to behave like a rack and pinion of their own, and the motor crawls around the gear, until it hits a stop.

If the foot is connected to a bellcrank attached to the motor, as seen in **Fig. 4**, then it will be lifted as in "**A**" and forced down so hard, in "**B**", that the car, beam and all, go up ready for "beam shooting". That's how it walks. Now for the details. . .

Construction

The model is made almost entirely from fairly hard balsa, as shown in **Figs. 5** and **6** but select very hard balsa or use spruce for the beam: because there is little ground clearance, sag on the beam could cause the foot to drag in transit. Make sure that the guides prevent undue wobble on the beam without causing too much friction. The beam will slide more freely if the bearing surfaces are rubbed with a soft lead pencil (like drawer runners) - remember, the load on this bit is only its own weight. . . the weight of the car, foot and batteries is taken on the rack driving pinion.

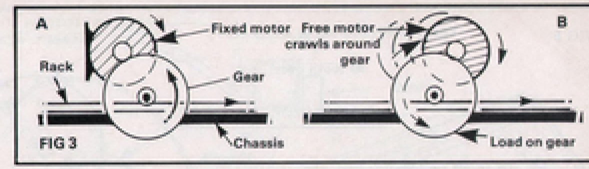
Switchcraft

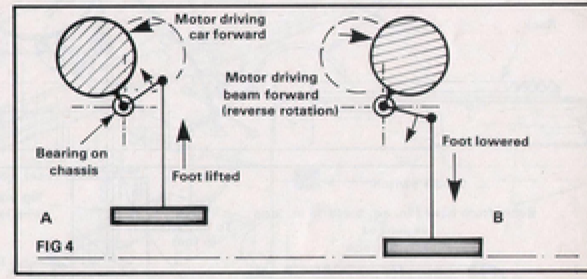
The motor is switched in the opposite direction as the pinion nears each end of the rack. A Radiospares miniature double pole double throw slide switch was used on the prototype, epoxied on its side to the chassis and clunked each way by two panel pins fixed to the beam at the appropriate position. If the action of the switch is a little too stiff for the power and inertia of the motor to actuate, carefully prise open the clips that hold the back plate in place. Remove the innards, and trim the small soft plastic pressure pad down a fraction; this should free the action whilst maintaining enough contact pressure when re-assembled.

Both practical and theoretical circuits are shown in **Fig. 6**, and if, whilst testing, it is found that the motor drives the switch trigger panel pins hard against the switch and stalls, change the battery *or* motor wires over at their connections to make the motor run the other way.

Tuning up

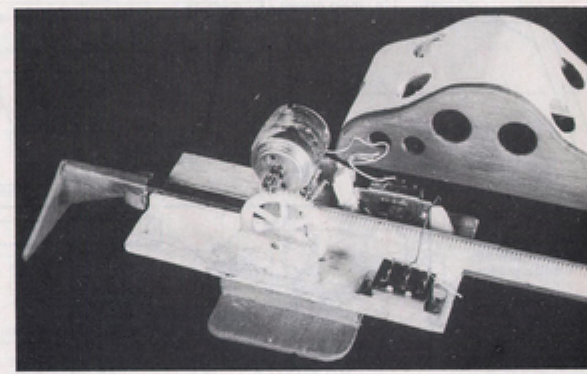
The model should be light enough to balance easily on its foot with both ends of the scraper beam clear of the ground (a hard, level floor is best). There will be a tendency for the car to sink to the ground with the motor switched off, but don't worry, when the torque is there it should lift. If it does not, or if the foot drags, the cure is to apply a little friction to the large gear wheel with a springy wire brake: just a little pressure should suffice without wasting the power from those two H.P. pencell batteries in the foot. Incidentally, the wires were just strapped over the battery ends with plastic insulating tape on the prototype, but a miniature battery clip might be fitted in the foot instead, as a better method of connection. **MM**

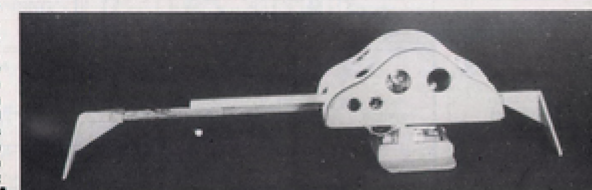




Below, engine room shot shows the motor over in the "foot raised" position; the reversing switch is seen on the far side of the beam rack and the on/off switch at near right.

Bottom, the "Scraper" about to pick up its foot and glide forward along the beam — this is the position from which the radio controlled version steers. Watch the (December) issue for conversion details.





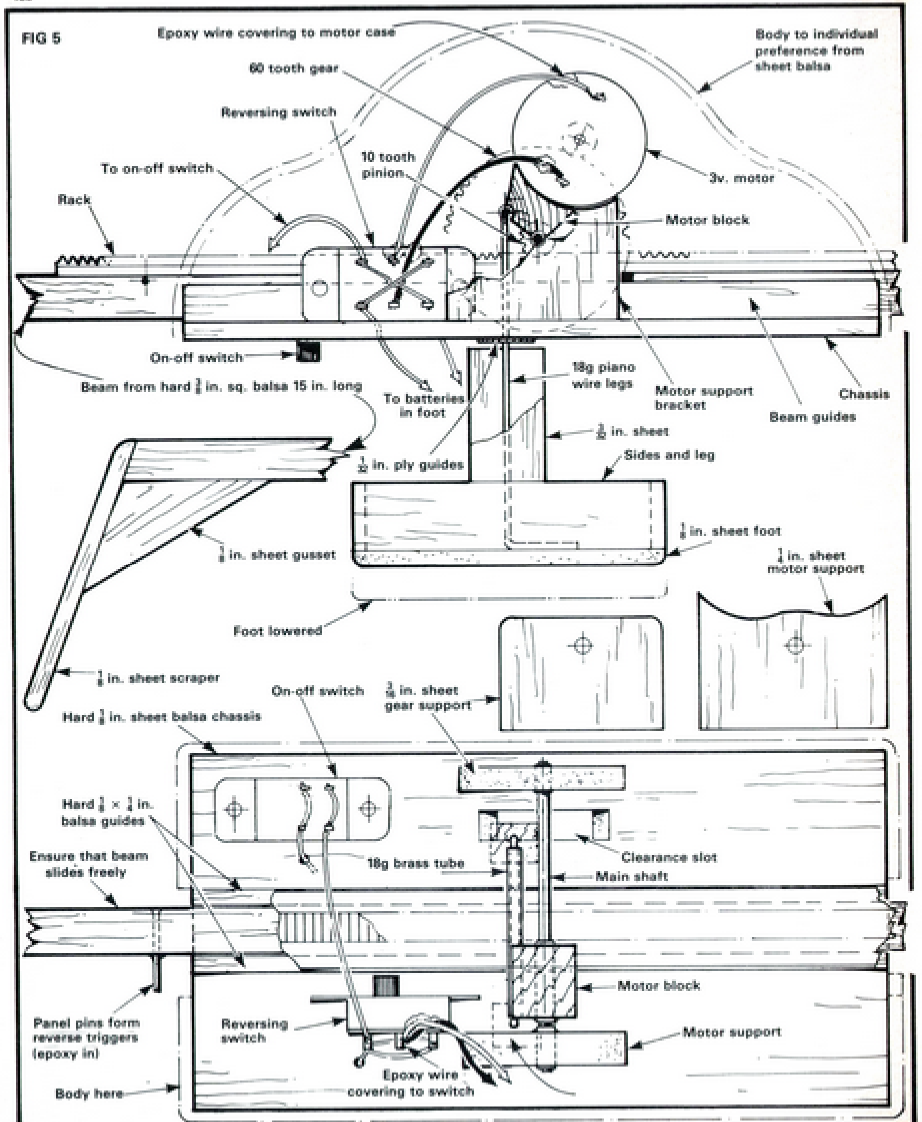
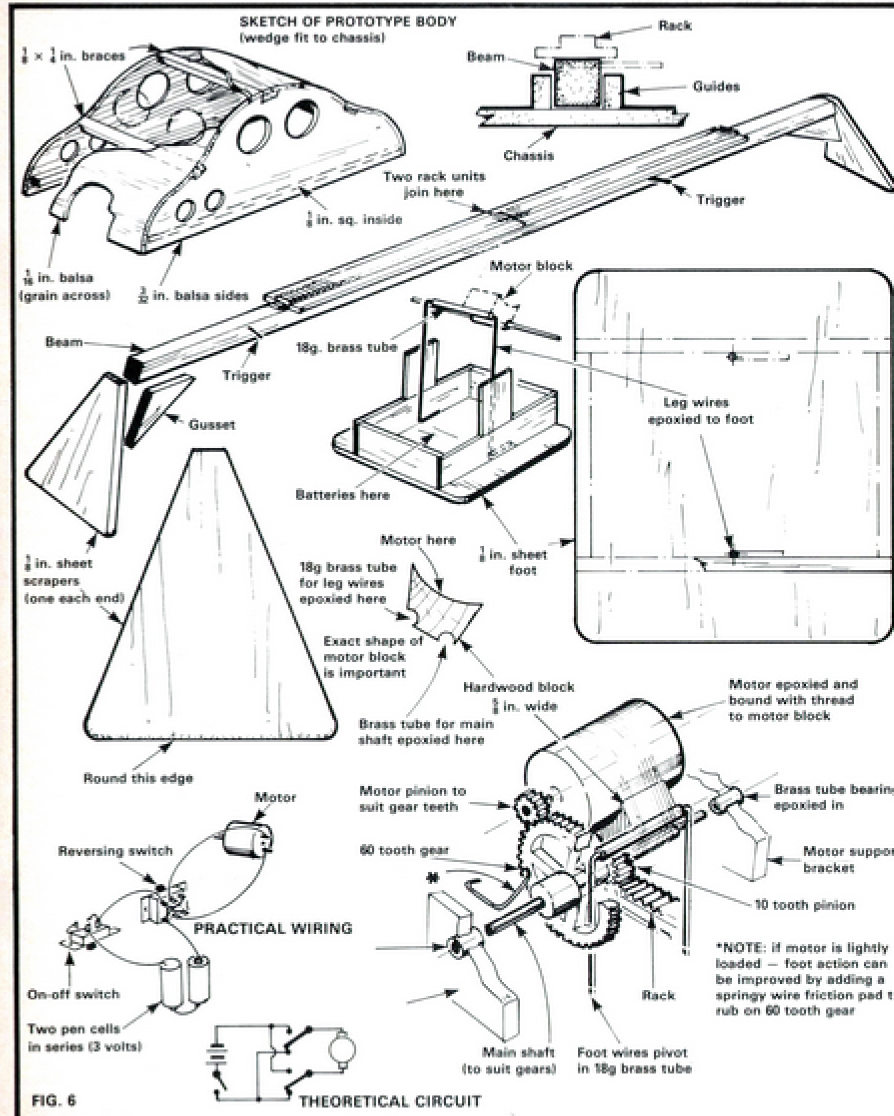
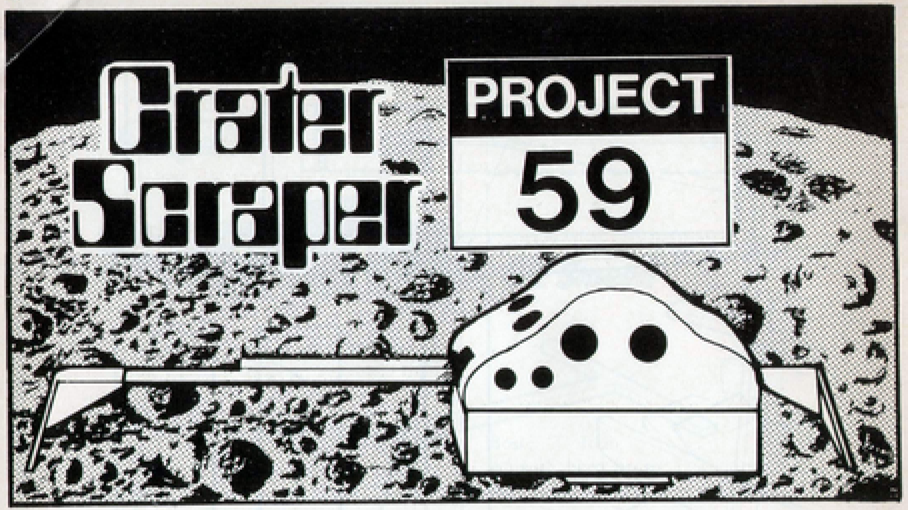


FIG 5
Epoxy wire covering to motor case
Body to individual preference from sheet balsa
60 tooth gear
Reversing switch
10 tooth pinion
To on-off switch
3v. motor
Rack
Motor block
On-off switch
Beam from hard 3/8 in. sq. balsa 15 in. long
To batteries in foot
18g piano wire legs
Motor support bracket
Chassis
Beam guides
3/32 in. sheet
1/32 in. ply guides
Sides and leg
1/8 in. sheet foot
1/8 in. sheet gusset
1/4 in. sheet motor support
Foot lowered
1/8 in. sheet scraper
On-off switch
3/16 in. sheet gear support
Hard 1/8 in. sheet balsa chassis
Hard 1/8 × 3/8 in. balsa guides
18g brass tube
Clearance slot
Ensure that beam slides freely
Main shaft
Motor block
Panel pins form reverse triggers (epoxy in)
Reversing switch
Motor support
Epoxy wire covering to switch
Body here


SKETCH OF PROTOTYPE BODY
(wedge fit to chassis)
1/8 × 1/4 in. braces
Rack
Beam
Guides
Chassis
Two rack units join here
Trigger
1/8 in. sq. inside
1/16 in. balsa (grain across)
3/32 in. balsa sides
Motor block
Beam
18g. brass tube
Trigger
Leg wires epoxied to foot
Gusset
Batteries here
Motor here
3/8 in. sheet scrapers (one each end)
18g brass tube for leg wires epoxied here
1/8 in. sheet foot
Exact shape of motor block is important
Hardwood block 5/8 in. wide
Motor epoxied and bound with thread to motor block
Brass tube for main shaft epoxied here
Round this edge
Motor
Motor pinion to suit gear teeth
Brass tube bearing epoxied in
Reversing switch
60 tooth gear
Motor support bracket
*
10 tooth pinion
PRACTICAL WIRING
*NOTE: if motor is lightly loaded — foot action can be improved by adding a springy wire friction pad to rub on 60 tooth gear
On-off switch
Rack
Two pen cells in series (3 volts)
Main shaft (to suit gears)
Foot wires pivot in 18g brass tube
THEORETICAL CIRCUIT
FIG. 6

Crater Scraper

PROJECT 59



Peter Holland converts his space model (Project 42 from the November 1980 issue) to radio control; this should give even the experts some new techniques to learn!

The free running "Scraper" just asks for that extra something that two function radio control can give. Why let it slide and scrape its lonely way in a straight line until it hits something? The prototype Crater Scraper was designed with radio conversion in mind, although the radio outfit selected for the purpose is sub-miniature.

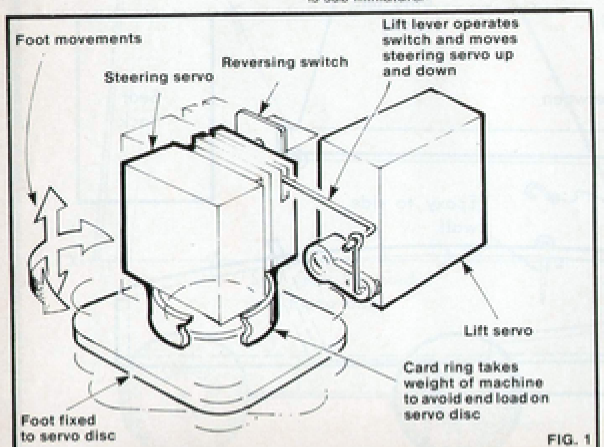


FIG. 1

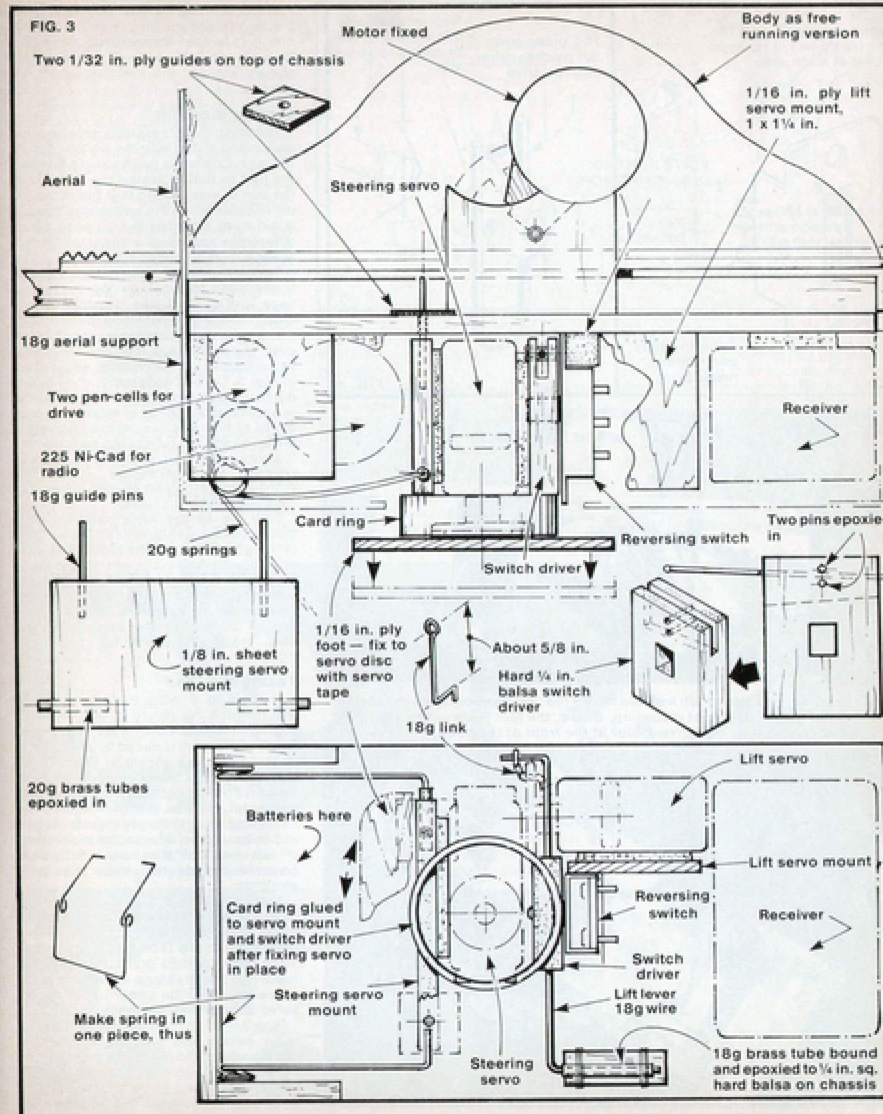
Suppose you've not yet built the model and have larger servos ... There's room for the average receiver and a "225" size Ni-Cad battery (the prototype was also tried successfully with a 100 mA Ni-Cad pack) so two small servos can be purchased, or the cab height and scraper ends deepened to suit. The drawings show the straightforward changes made to the original free-running job.

What does what

Steering is the main control, but because the model has no wheels, it has to pivot on its foot, in a similar manner to a walking dragline excavator. As this model weighs very little, even with radio, and has to be operated on smooth ground, such niceties as over-ride on the steering linkage were omitted. There is no steering linkage — I just stuck a new ply foot to the disc of the steering servo! If the model is prevented from turning, the foot simply skids on the floor and, in any case, it can be made to pick up its foot and try again. It will now be realised that steering is only done with the foot down, either whilst the beam is shooting forward or held at the forward position. This is where the second servo comes in ... its job is to raise and lower the steering servo bodily and at the same time switch the drive motor forward and reverse. All the weight of the model, except that of the foot and steering servo, is carried on a card ring bearing on the top surface of the foot, so as not to end load the servo.

All this is shown in **Fig. 1**. There is now no need for the drive motor to move the

FIG. 3



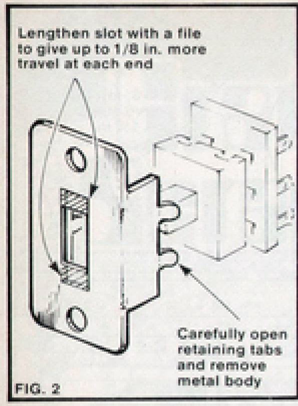


FIG. 2

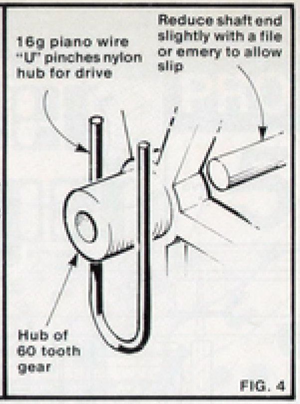
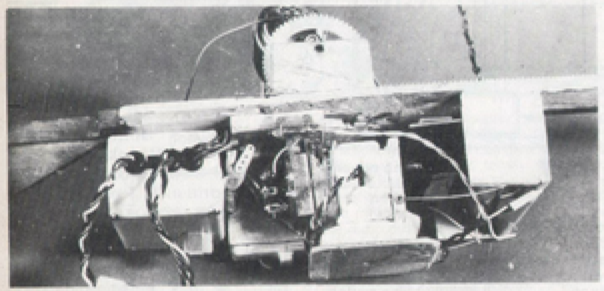
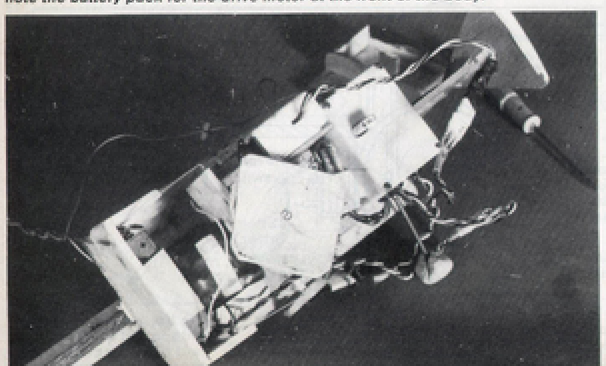


FIG. 4





Above, the complete installation with the foot in the 'up' position. Note the spring balance fitted to the servo foot mounting. Below, the foot is shown rotated 90°; note the battery pack for the drive motor at the front of the body.

foot and operate its reversing switch, so the next step (if you built the free-running one) is to remove the existing foot and its linkage, epoxy the motor to its stop, as shown, and cut the switch free of the chassis.

Getting more lift

The servo that steers is mounted on the switch and slides with the switch "dolly". At first it took some patience in adjusting the foot so that it cleared the floor when the switch was up and that the scrapers did likewise when the switch was down. I could have mounted the steering servo differently and used a separate switch linkage . . . but I prefer simplicity.

Taking the switch apart, I filed the slot in the plate to lengthen the stroke, as seen in **Fig. 2**; it was possible to get nearly ¼ in. more foot lift by this method, without the switch contacts going too far over. The switch was then re-assembled and replaced on the chassis, all as seen in **Fig. 3**. Care is necessary when fixing the balsa switch driver to the switch knob — a piece of polythene or waxed paper is cut to fit first and sandwiched between the wood and the face of the switch while the epoxy sets. This, when torn away, will provide the necessary clearance. Without this temporary spacer, the switch might get glued up solid!

Both the servos were mounted with thin servo tape as shown, and the surface of the wood to which the tape sticks was primed with balsa cement to seal it. I usually put Sellotape on the servos, before taping them in, so that when the time comes for a change, the Sellotape can be peeled off the servos, leaving them clean and ready for their next model.

Taking the load

There is an imbalance in the system, in that the lift servo has to do more work in pushing the foot down than in lifting it. Some of the work is eased by the use of a double spring as shown in **Fig. 3**. This was bent until it balanced about half the weight of the model. To do this, I weighed the model and then, with the lift servo link unhooked, lifted the body slightly whilst it was on the scales, so as to obtain a reading of just over half the first — just over, because the steering servo also gets weighed.

The full vertical travel was set by the use of an adjustable servo arm on the lift servo. World Engines micro-servos were used without lug brackets; other micro-sized servos would probably fit without modifying the drawings shown in **Fig. 3**, except to allow the upper lug of the lift servo to pass through the chassis.

In order to save space, I omitted the radio switch and plugged the Ni-Cad cable socket onto the receiver plug when I needed to "switch on". The drive battery switch does need to be retained even if re-positioned to clear the receiver, for

there is no definite "off" position on the reversing switch.

Slipping the clutch

It became obvious, from driving the thing under radio, that things happen rather too quickly when the beam is on the move — there is not enough time to steer accurately during that time when the foot is down. Now, if the machine is allowed to stand throbbing with its foot down whilst the steering is accurately done, one is not racing with its walking cycle — forever trying to catch up with over- or under-steer.

I had envisaged filing the ends of the rack to allow the drive to slip, but as the gears in the Proops set are a press-fit on the shaft, all I had to do was to make the 60 tooth gear slip a little. Filing the appropriate part of the shaft gently with a fine tooth file reduced its diameter for this purpose . . . the job needs taking in stages, then testing with the gear until it only just fails to grip with the motor running.

The result would have been non-adjustable and eventually there would have been no drive at all, so a piano wire "U" clip was my method of adjustment. It squeezes the hub of the gear into closer contact with the shaft and may be wedged further on to increase the drive. **Fig. 4** shows this detail; the clip should be adjusted so that there is just enough drive to allow the car to move, yet not so much friction at the ends of the cycle to waste the power of the drive batteries.

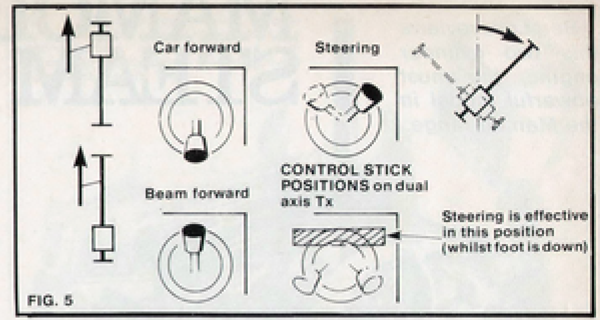


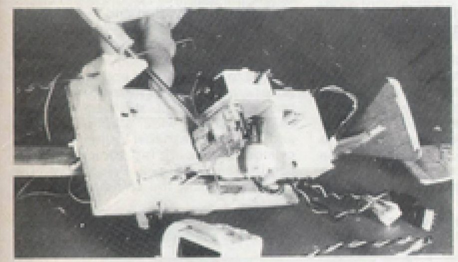
FIG. 5

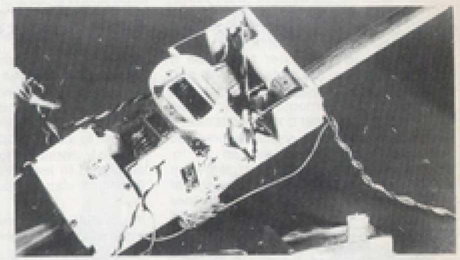
Driving

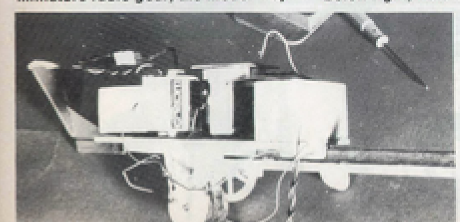
Take a look at **Fig. 5**; this explains the transmitter stick movements for a dual axis stick. Two single-axis sticks can be used, of course, steering on the right and lift on the left.

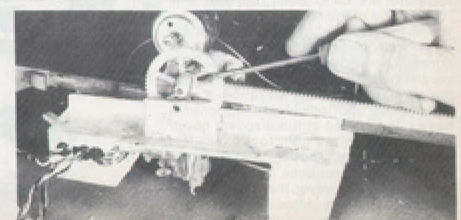
It is possible to make 45° swings either side of centre so that the model makes eight full cycles to execute a "circle" . . . more of an octagon really. However, "squares" may be danced — as it were — by adopting the following procedure. Before making the turn and whilst the car is still travelling with its foot up, "steer in the air" fully in the opposite direction to the intended turn, then lower the foot with the steering still hard over in the "wrong" direction and bring the steering fully the right way; whereupon the whole thing should swing about 90° in one go! It's something else to practise, particularly for those who are not familiar with radio control and who drive this thing towards themselves. But then, it's fascinating mastering the control of an unusual machine.

MM









Above, the screwdriver indicates the servo connecting rod to the switch. Below left, we used World Engines' miniature radio gear; the model may require modification for larger servos. Above right, note the card ring that relieves the end load on the servo shaft. Below right, note the spring clip on the gear shaft to obtain slip at the end of the travel. This should be adjusted to allow just enough grip for the motor to operate the rack.