



We all know that a rubber band can provide a driving force when stretched in a linear or twisted manner. The Great Egg Race showed how its stored power could do surprising things.

What then, if the rubber is used in the form of a balloon? Inflate the balloon and the rubber is stretched to form a convenient accumulator for compressed air. A most useful side-effect is that the air is returned at fairly constant pressure, whereas that same amount of rubber would have provided an initially high force, reducing to a very low level as it returned to its

Creeping Robot Activated Balloon

Low pressure pneumatics operates this ingenious device, designed by Peter Holland



Fig. 1 WALKING BEAM

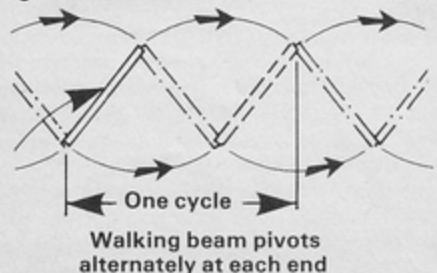
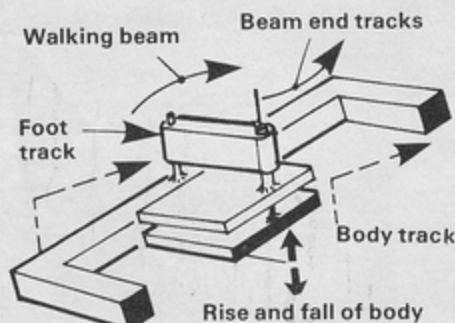


Fig. 2 RISE AND FALL/WALKING BEAM



original length. Those crafty bits of gearing and fusee units that were used in the Egg Race to provide a constant level of power output are unnecessary in this field of low pressure pneumatics.

The reason for this is that, although the rubber of the balloon is stretched to provide an initially high force, the volume of air upon which it acts is also greater, so the output pressure per cubic inch used varies only slightly.

Test pieces

Several applications of mechanical conversion of the power of an inflated balloon

Fig. 3 WALKING CYCLE

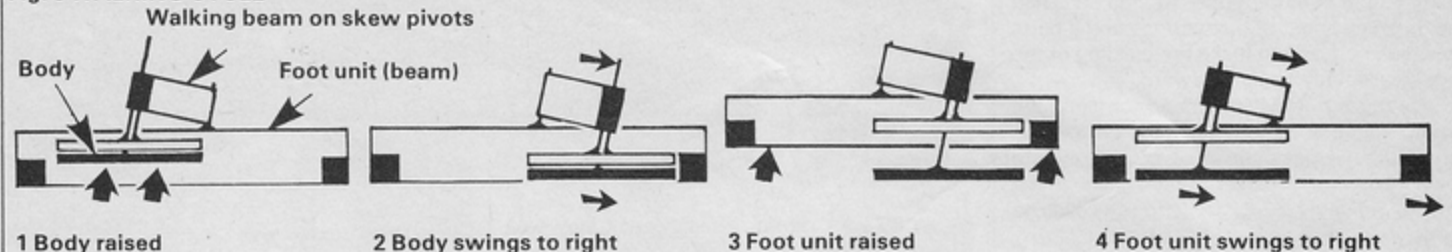
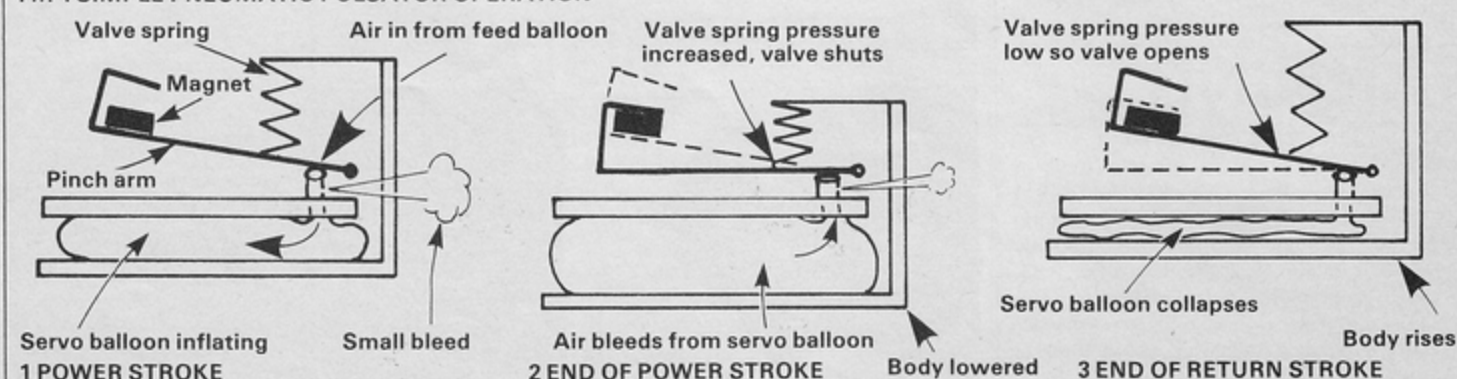
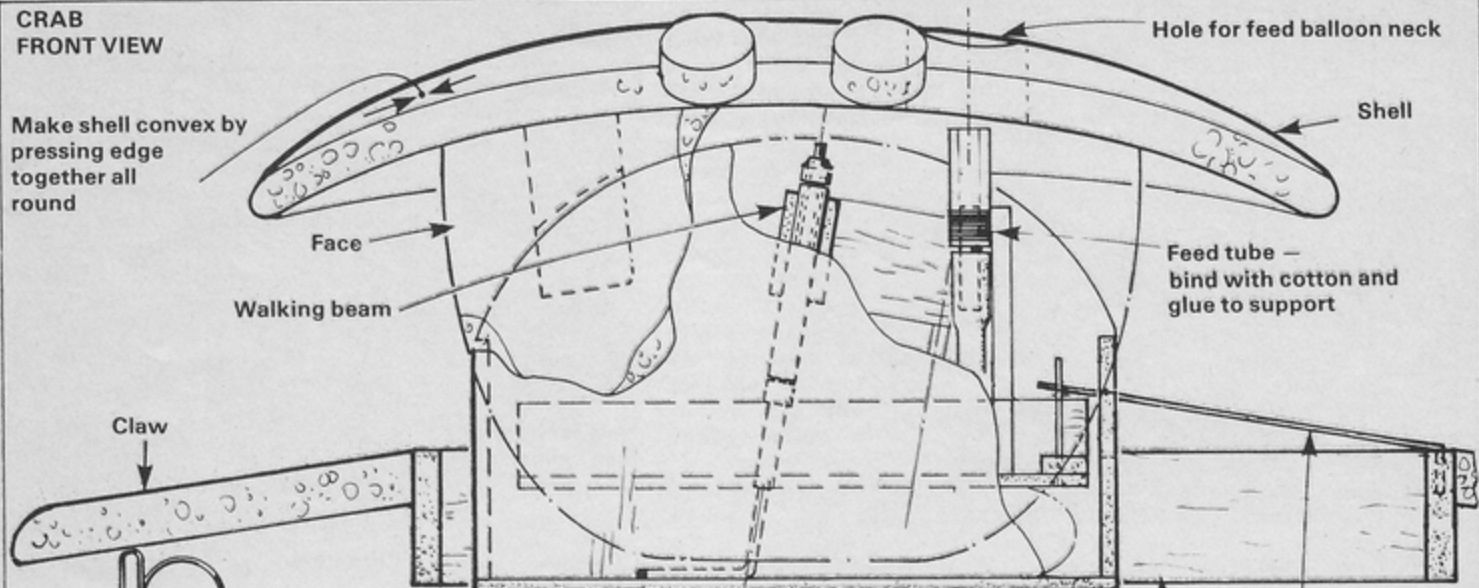


Fig. 4 SIMPLE PNEUMATIC PULSATOR OPERATION

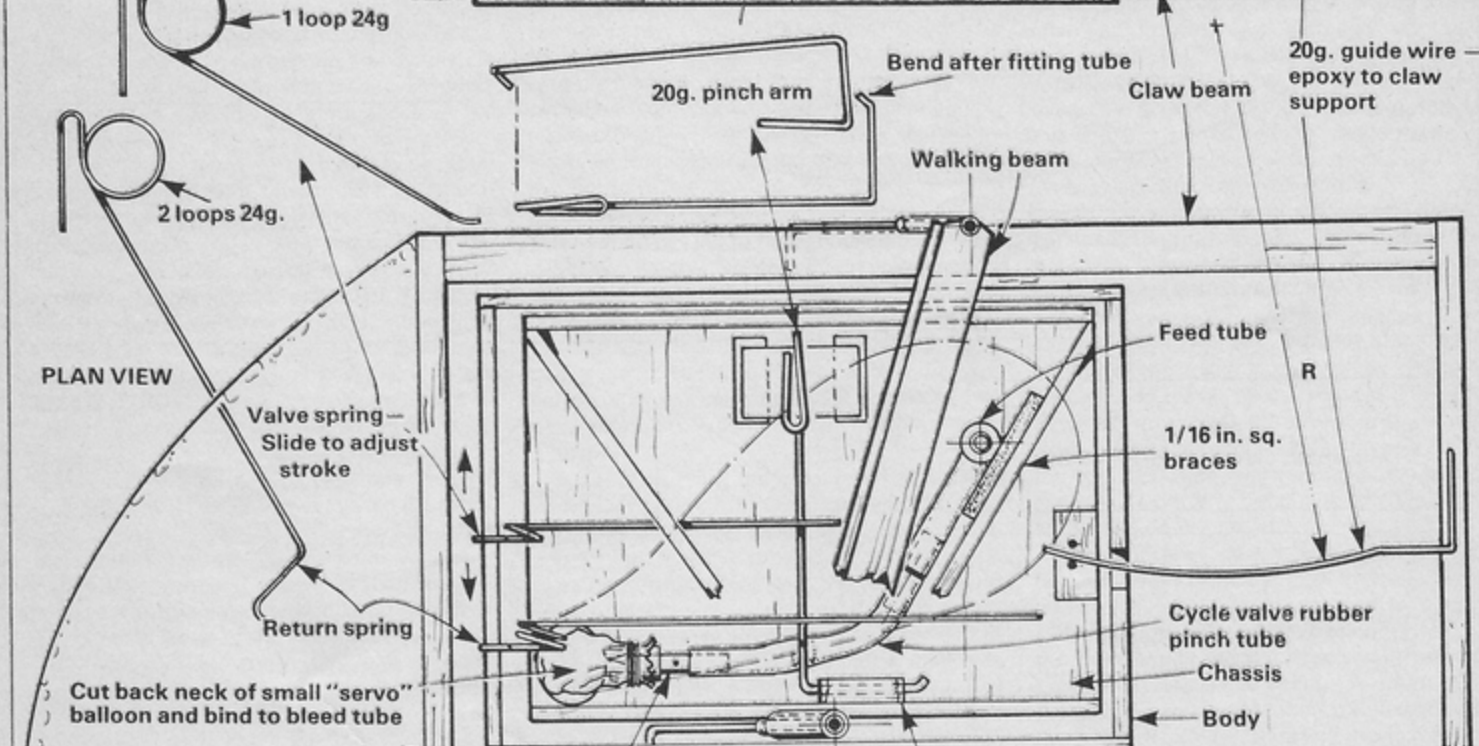


CRAB
FRONT VIEW

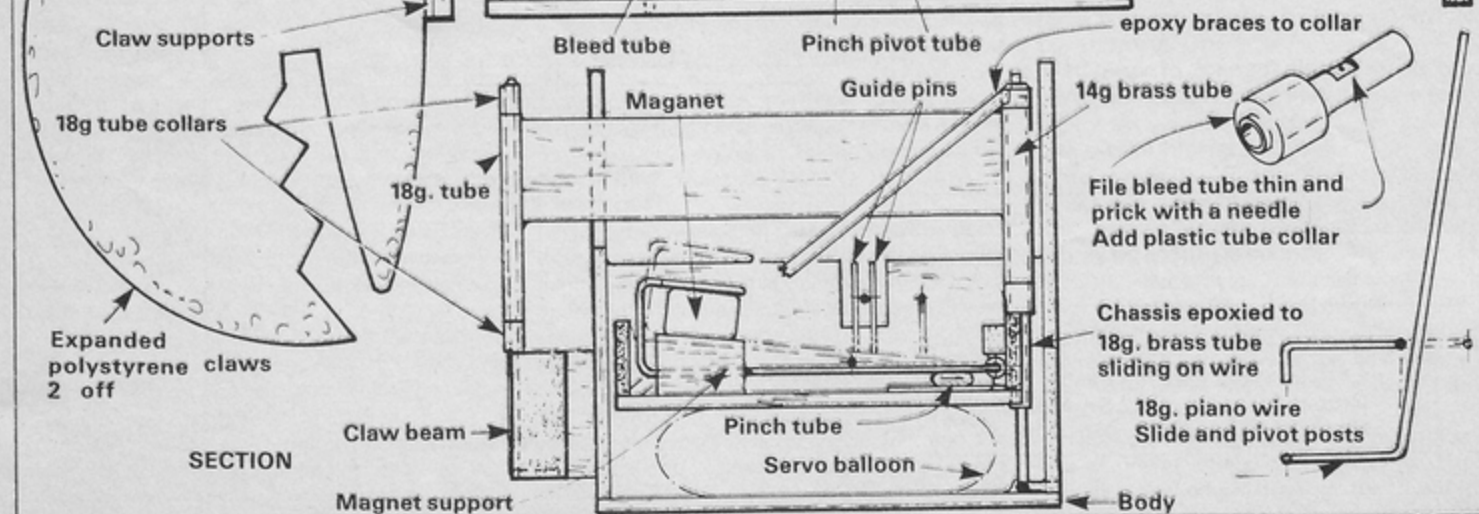
Make shell convex by
pressing edge
together all
round



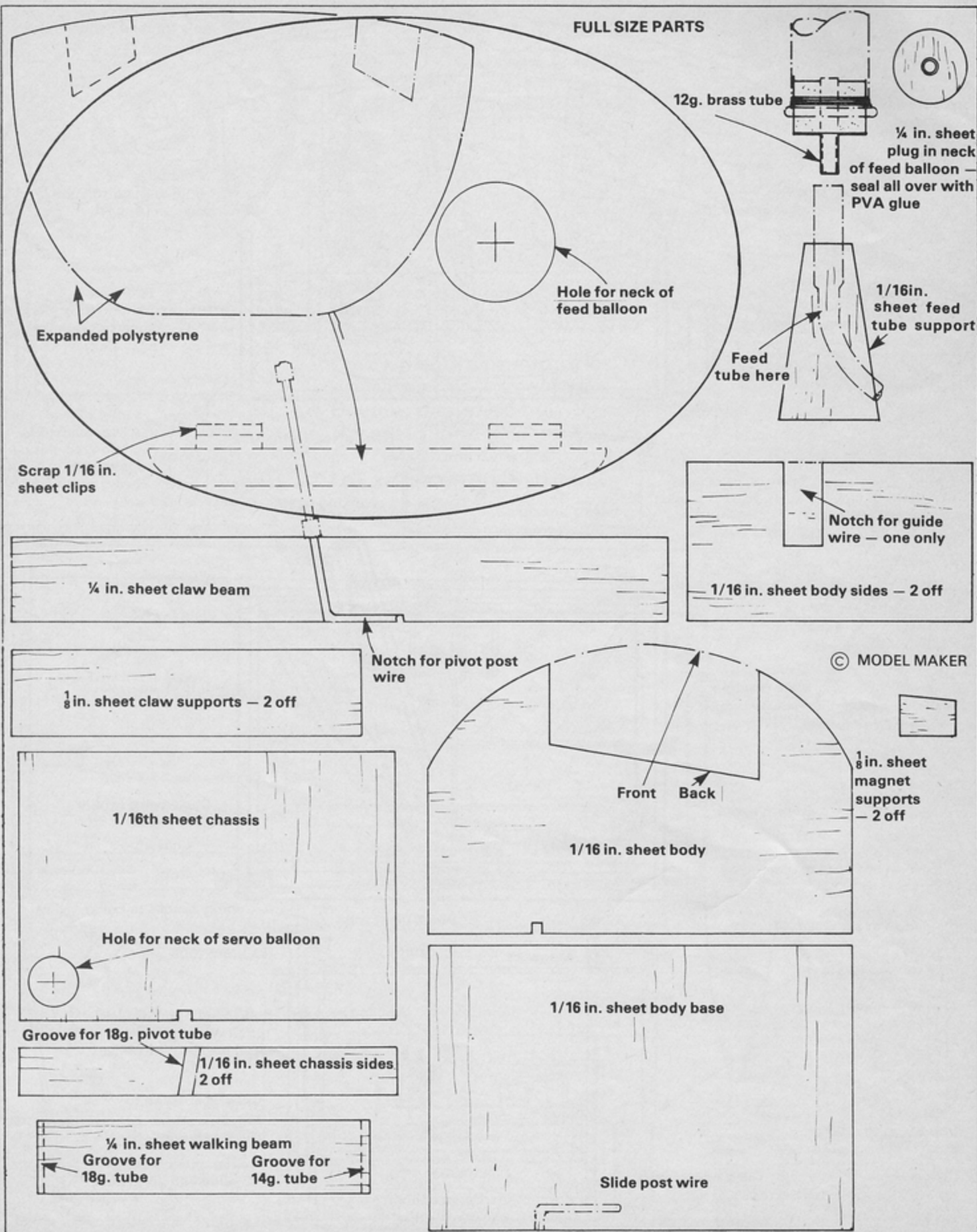
PLAN VIEW

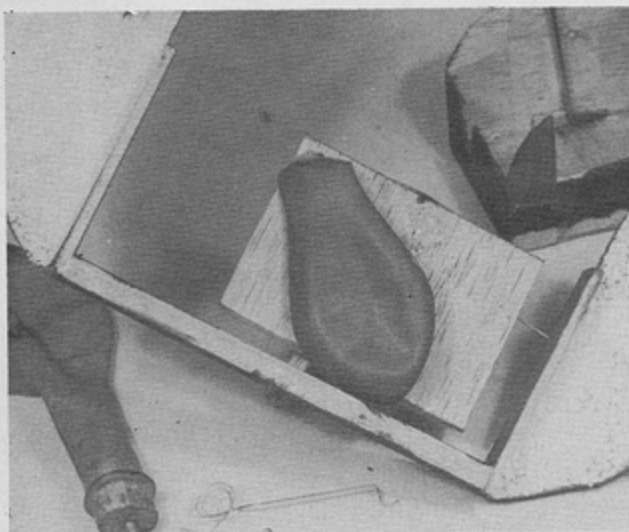


SECTION



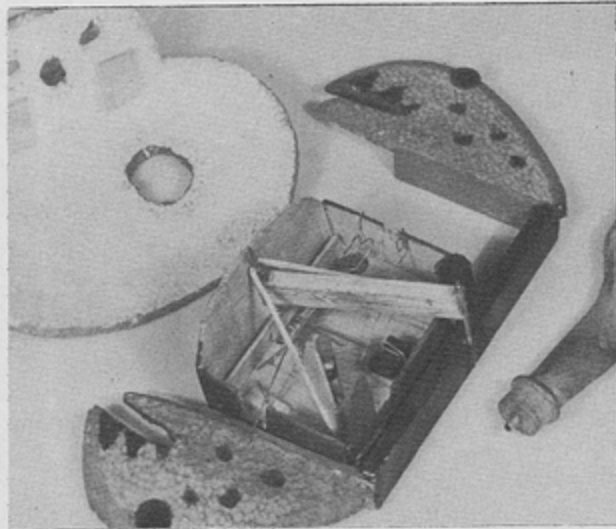
FULL SIZE PARTS





Left, the basic frame with supply balloon fitted. The claws are made from expanded polystyrene and coloured with water colour paints.

Right, the complete mechanism. It will require considerable patience to find the correct tension for the springs before a satisfactory performance is obtained.



have been tried by the designer and although the available power is quite low, the duration/effort ratio can be arranged to suit the user's needs. Diaphragms, bellows and piston engines have been built and these and other devices will be described in future issues.

The "Crab"

This is a fun machine that walks, or rather creeps, sideways on a smooth level surface. It is driven by a simple pneumatic pulser taking its power from the stored energy in a toy balloon. The walking action is provided by an interesting application of a "walking beam". Fig. 1 shows the general principle — imagine a foot at each end of the beam; turn it counter-clockwise about its left foot and the right foot will advance, then turn it clockwise about its right foot and its left foot will advance.

Clearly if it is to get anywhere without the use of wheels and brakes, first one foot will have to lift as it moves forward, then the other. Fig. 2 shows how a "U" shaped and a rectangular foot can be made to walk in a stable manner, using gravity as the means of moving the respective feet forwards. The skew pivots at each end of the walking beam are the trick here. All that is necessary is to raise and lower the base of the rectangular foot to make the whole device walk. In Fig. 4 the rectangular foot is called the "body". It shows the walking cycle clearly.

Rise and fall

How is the rise and fall to be accomplished? The simple pulser shown in Fig. 4 does the job. It was found that by alternately filling a small "servo" balloon and allowing it to collapse, there was enough effort to raise several ounces of model. Air is admitted via a piece of cycle valve rubber and shut off by pinching it. The air in the servo balloon is allowed to leak away via a very small bleed hole in the supply pipe, to complete the cycle.

Opening and closing the pinch valve is effected by attaching a valve spring to the moving part of the device. When the servo balloon is fully inflated the spring pressure forces the valve shut, then when the servo balloon collapses the spring is exerting less force, so the valve rubber recovers its original open shape and admits more air. In the course

of experiments it was found that a state could be reached when the valve would only partly open or partly close, due to instant feedback in the system. To overcome this, a piece of ceramic magnet (taken from a small magnetic cupboard catch) was used. Half a magnet, easily broken, is enough. The wire pinch bar sticks alternately to the top and bottom of the magnet to give a positive "click-clack" action.

Making the "Crab"

It seemed natural to "dress the crab" — as it were! — so the walking or creeping action could be utilised effectively. The working drawings of parts and assembly are shown overleaf and should be self-explanatory. Basic construction is from balsa and expanded polystyrene, but there are a few points that need careful attention.

The pivots

A beam carrying the claw feet has a piano wire pivot post set at 9° to the vertical. One end of the walking beam has a brass tube epoxied to it. This tube should be a good working fit on the wire with the very minimum of slop or end play — scraps of tube soldered to the wire prevent the latter. The other end of the beam carries a larger brass tube which fits snugly over another tube which slides up and down the slide wire fixed to the body. Tube collars prevent end float between the two tubes. The innermost of these tubes is epoxied to the chassis piece which carries the valve gear.

When setting up the basic mechanism, ensure that the "claw" supports, which are the outer feet, rest evenly on the ground when the body is half extended.

Pinch bar

The piano wire pinch bar is carried in a brass tube epoxied to the chassis side. There is quite a lot of pressure on this point so do not try to operate it until the epoxy is well cured. If the valve rubber pinch tube does not close fully, pack it up with a piece of wire or a pin, directly under and parallel to the pinch wire.

Setting up

With the supply balloon connected, and the servo balloon collapsed, the valve spring should be bent until the valve opens, then closes when the chassis rises far enough to

allow the claw feet to swing fully to the right. At this point the valve should click shut and not open until the body has "slithered" right up to the leading claw. This takes some time for the bleed hole to release all the air in the servo balloon. It gives the "Crab" a distinct limp, but this is just what is needed, for a short power stroke ensures that a minimum quantity of air leaks away before the valve shuts.

Half the fun of making this model lies in the patient setting up of the valve timing so that the body traverses the space between the claws fully and that there is no wastage of air by excessive raising of the chassis in the walking cycle. The amount of rise and fall (or stroke) of the pulser is adjusted by sliding the valve spring closer to the magnet end of the pinch bar (to shorten the stroke) or towards the pinch tube to lengthen it. If the chassis stalls at the top, bend the valve spring down but if it stalls at the bottom, bend it up, then re-set the stroke as just described.

With the shell added, the body is a little heavier, so err on the side of an earlier power stroke. If the valve does not open far enough, slide the pinch tube just a fraction further from the hinge end of the pinch bar and increase the pressure of the valve spring. A return spring hastens the collapse of the servo balloon, and its pressure can be adjusted to augment the force provided by the valve spring in forcing the chassis down.

The prototype "Crab" runs (it should be said "creeps") for about 15 minutes on one balloon-full of air and travels about 10 feet in the process! Different versions will vary in performance; the duration depends on the size of the tiny bleed hole and the stroke needed. The distance travelled depends on the length of "step" and the amount of air conserved by efficient valve timing. There are other variables such as the angle of the skew pivots and the volume of the servo balloon — all interesting in their selection to achieve the best efficiency. Do not inflate the supply balloon to its maximum size — this weakens it.

There are more efficient variants such as the use of proper inlet and outlet valves, but the simple inlet/bleed method of the "Crab" is a good starting point.