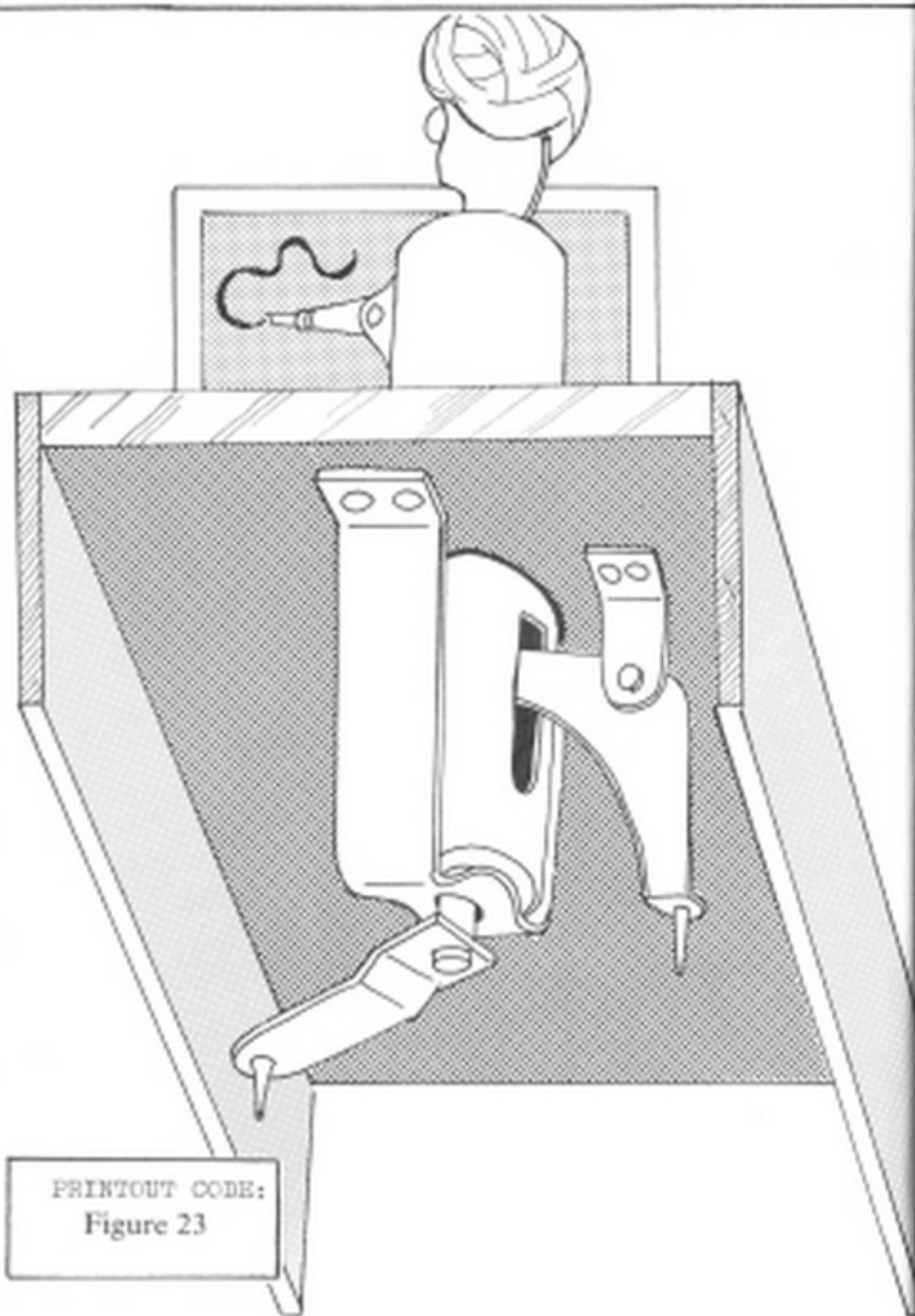


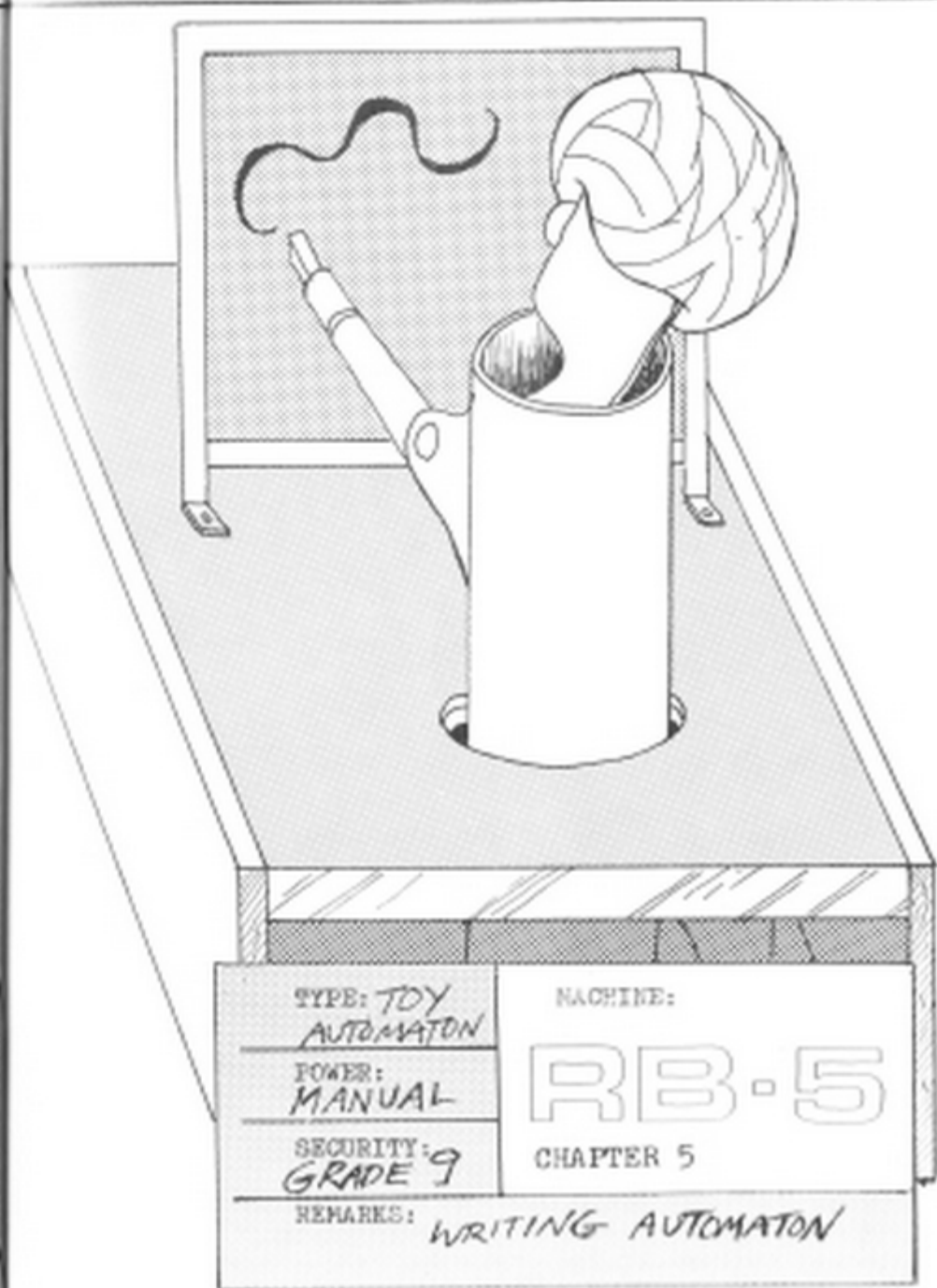
MAKE YOUR OWN ROBOTS

RICHARD CUMMINGS





PRINTOUT CODE:
Figure 23



RB-5

RB-5 is a simple but workable writing automaton. It can be built in a day or two with ordinary household tools and inexpensive materials.

HOW IT WORKS

Study Figures 23, 24, and 25. (The mechanism in Figure 24 is more elaborate than necessary. It includes a means of "automatically" driving the machine with strips of 35 mm film (*N*) pulled by hand or by hand crank. This part of the machine can be left out, as we shall see.)

As shown in Figure 23, the basic mechanism centers on a tubular body thrusting up through a hole in the platform. Installed in the body (refer to Figure 24, *B*) is the head-arm piece (*A*) with a felt-tipped pen at its arm end (*C*). This head-arm piece is connected inside the tube at point *K* with a lift rod (*J*). *J* is attached to the vertical stylus arm (*D*). The stylus arm exits from the tube through a slit and swivels on a machine bolt that attaches it to the vertical action brace (*F*). When moving vertically—up and down—this stylus arm influences

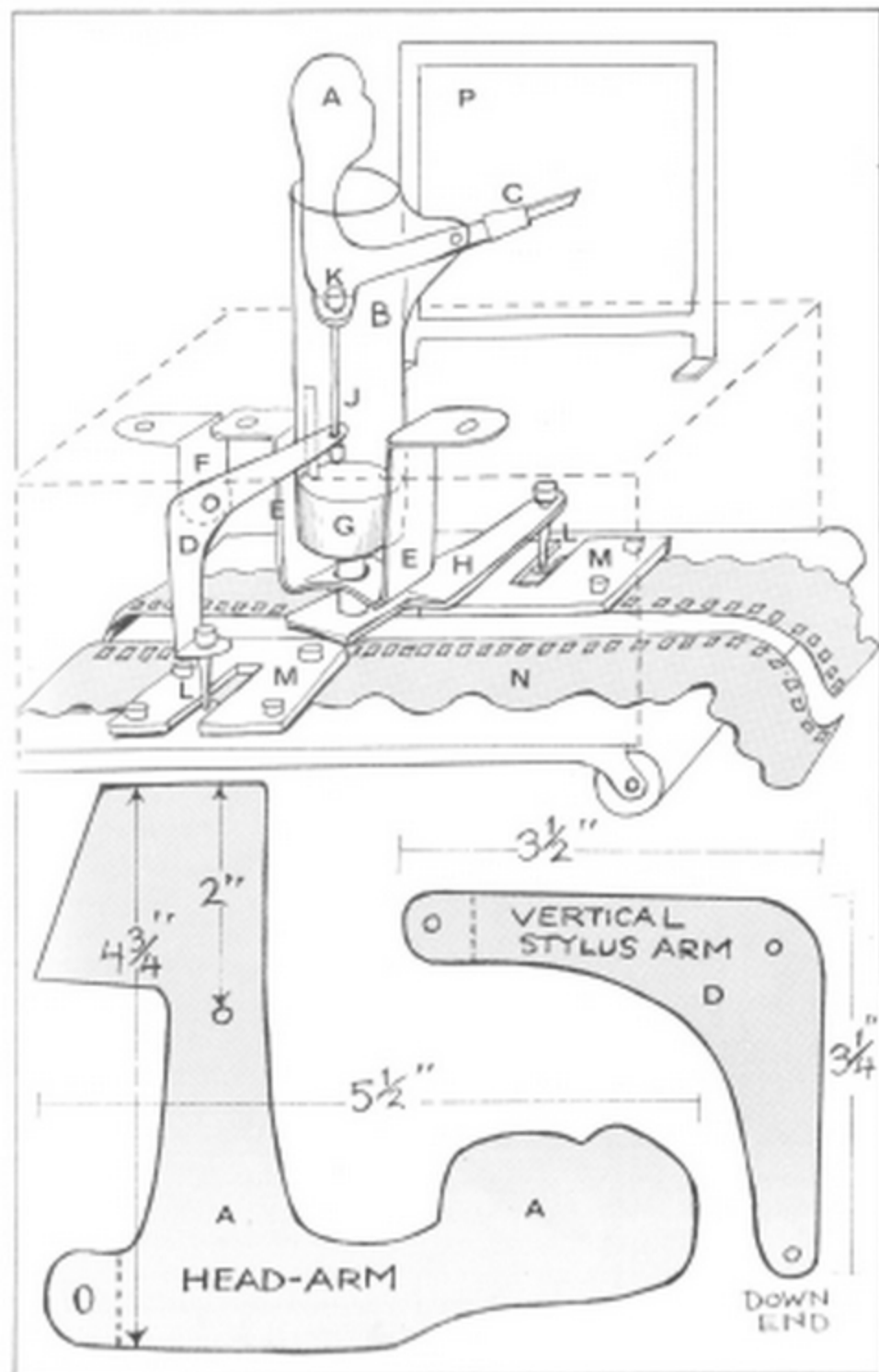


Figure 24

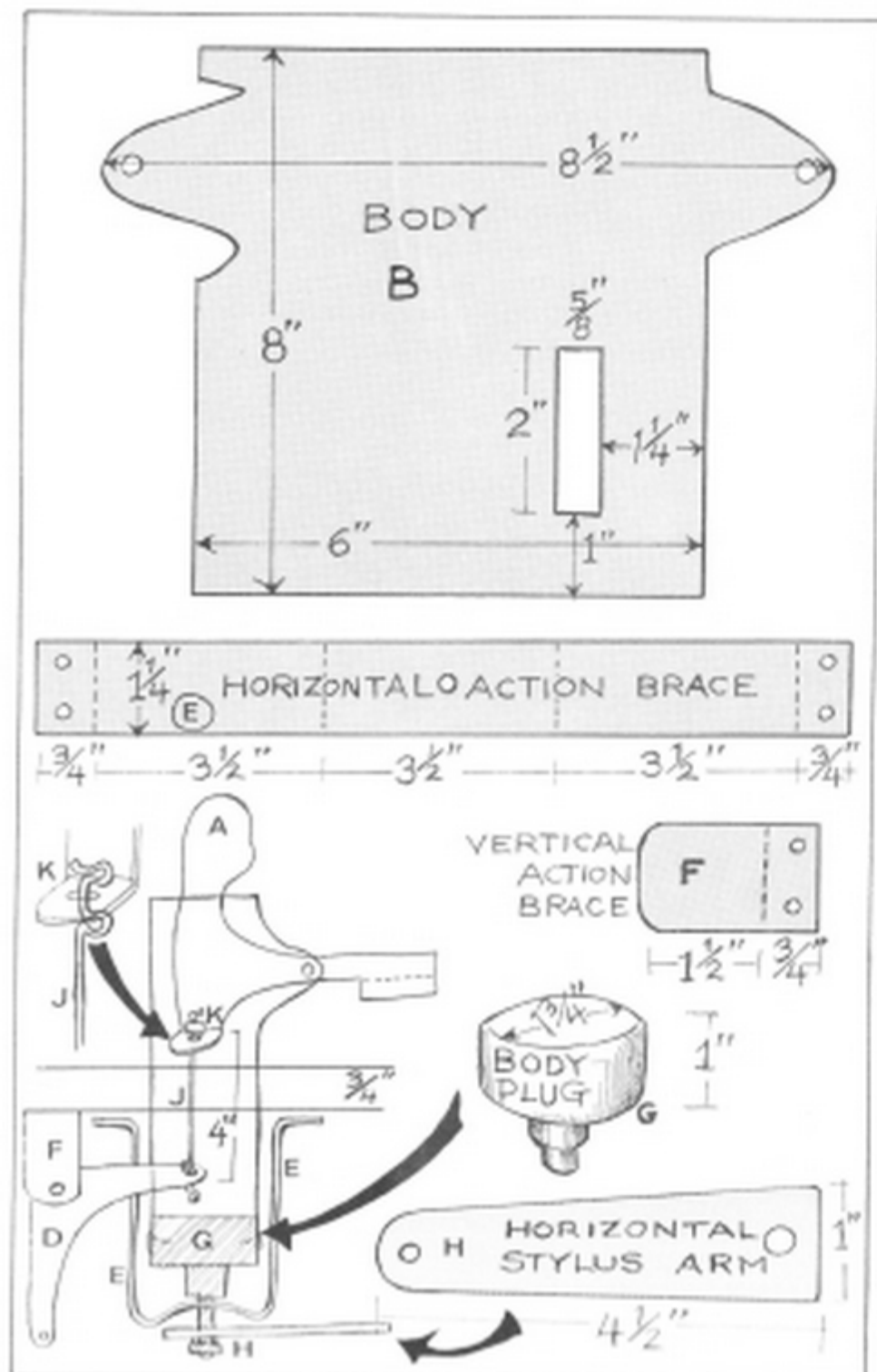


Figure 25

the vertical movement of the pen and directs all pen strokes in an up-and-down direction.

Horizontal, or side-to-side, movements of the pen are determined by a twisting motion of the entire tubular body, left and right. The lower end of the tube is filled with the body plug (G). The weight of the tube is carried on the horizontal action brace (E). Attached to a dowel at the bottom of the body plug is the horizontal stylus arm (H). When this arm is moved left or right by hand or by the film mechanism, it imparts a twist upward to the robot body. This moves the pen (C) left and right, and influences all pen strokes in a left and right direction.

Thus, by a combination of vertical and horizontal movements, the pen can be made to write or draw on the easel (P). Straight up-and-down and side-to-side strokes are easy; circles take a more practiced coordination of the two directions of movement. The stylus arms are most easily moved by hand. They can be made to move with the film mechanism (Figure 24, L, M, N), but direct manual manipulation is much easier to achieve and perfect.

MATERIALS AND TOOLS

- 1 24" x 13" sheet of light aluminum, the type used for roof flashing
 - 2 slabs 1/4" plywood, 5" x 10"
 - 1 slab 1/4" plywood, 5" x 12"
 - 1 slab 1" lumber, 10" x 12"
 - 1 1" length of 1 1/4" closet pole or dowel
 - 1 pair small jewelry box hinges
 - 6 small machine bolts and nuts
 - 3 1" machine bolts with nuts
 - 1 4" length coathanger wire
 - 1 felt pen, permanent ink
 - 1 sheet emery paper
- assorted hardware, scrap wood, cloth, epoxy glue, rubber bands

Tools: hammer, pliers, wrenches, tin snips, drills, metal punch, wire cutters, carpet tacks or brads

MAKING THE PARTS

First, prepare the aluminum parts by drawing them on paper. Follow the shapes and dimensions indicated in Figures 24 and 25 (*A, B, D, E, F, and H*). Carefully cut out the paper templates, arrange them on the sheet aluminum, and draw their outlines with a fine felt-tipped pen. Keep the dimensions as faithful to the originals as possible. Use light emery paper to sand the edges smooth; then use a hand or leather punch, or a drill, to make the various holes.

Next, prepare the body plug (*G*). Note that it actually has three parts: three sizes of dowel, one fitted into the other and glued. This enables it to rest on the horizontal action brace (*E*) and to twist or swivel so as to horizontally influence the movement of the pen above.

Prepare the lift rod (*J*) from a length of medium-gauge wire or wire from a coathanger. Use needle-nosed pliers to prepare both ends of the wire, as shown in Figure 25 (*K*) so that it will exert force at point *K*, whether pulled upward or downward by the vertical stylus arm (*D*).

Prepare the box platform by drilling a 2" hole in the top slab. This will receive the automaton's body. Glue and nail the two lighter plywood panels in place to support the platform, as shown in Figure 23.

ASSEMBLING

Attach the lift rod (*J*) to the head-arm piece at point *K* (refer to close-up detail of this in Figure 25). Next, bend the body sheet into its tubular form and slide it into the 2" hole in the platform. From this point on, you will have to work with the tubular body in position in the slab hole, because once the lift rod is attached to the stylus arm, you will not be able to insert the body through the hole.

Attach the lower end of the lift rod (*J*) to the vertical stylus arm (*D*) so that the stylus arm thrusts out through the slot in the tube. Close the tubular body by bringing the two "arms" together at the top to hold the pen arm of the head piece. Insert a bolt and nut for the pen arm to swivel on.

Complete the closure of the body by inserting the body plug (*G*) at the bottom of the tube, and by driving several carpet tacks or brads through the bottom sides of the tube into the body plug. Epoxy glue will also help seal the bottom of the tube.

The tube is now seated in the hole in the platform, with the lift rod (*J*) installed inside and the vertical stylus arm (*D*) sticking out of the slot opening in the lower body. This vertical stylus arm may now be attached to the vertical action brace (*F*) that is attached to the underside of the platform with screws or bolts, as shown in Figures 23 and 24.

Next, bend the horizontal action brace (Figure 25, *E*) on the four broken lines to form the bracket shape shown in Figure 24. Drill out a center hole, then install it up against the middle dowel of the body plug (*G*) so that it supports the bottom of the tubular body. Screw or bolt it to the underside of the platform slab, as shown in Figures 23 and 24.

The horizontal stylus arm (Figure 25, *H*) can now be attached to the lower dowel of the body plug (*G*) by compression of a screw in the end of the dowel or with epoxy glue. It must be firmly and permanently attached. When the arm is moved, the tubular body will be twisted, imparting a left-right direction to the pen above.

You are now ready to install a felt-tipped pen at the end of the arm (Figure 24, *C*). Wrap the aluminum tab around the pen and, if necessary, secure it with a length of surgical tape.

Next, install the easel (*P*) on the platform in the position shown in Figures 24 and 26. Glue, tape, or tack a sheet of absorbent paper (not slick or coated) to the easel. The easel's legs should be secured with small jewelry box hinges, that will allow the easel to lean toward the automaton body and pen. A light spring or rubber bands should be attached to the front of the easel to cause it to lean toward the pen. The amount of tension in the spring or rubber bands will have to be adjusted with practice. If there is too little tension, the pen will not make marks on the paper; if there is too much tension, the pen will not be able to move.

You are now ready to make your automaton draw and write.

WRITING AND DRAWING

Place your hands inside the box under the platform, (refer to Figure 26) and grasp the vertical stylus arm (*D*) with the fingers of your left hand. Grasp the horizontal stylus arm (*H*) with your right hand. By moving your left hand slightly up and down, you will cause the pen to move up and down on the surface of the easel paper. By moving your right hand slightly left or right, you can make the pen move side to side on the paper. By carefully coordinating both movements, you can cause the pen to make angular or circular movements.

Operating the automaton is something like learning to ride a bicycle. Most of the difficulties come at the beginning. In the end, you will be operating instinctively and by "feel" rather than by direct thought. Drawing *A* at bottom of Figure 26 was our very first scrawl with our machine—an attempt to draw a house. As you can see by the fourth drawing (*D*), we were able to manage a heavily scribbled caricature of Groucho Marx. Writing is more difficult, but after a dozen attempts, we managed the first legible word (*B*). After a few more attempts, I made the machine write my name (*C*).

From the beginning, you might want to practice with the easel facing away from you and the automaton pointing its pen toward you, as shown at the top of Figure 26. This will require you to write backwards. But if the ink is of the permanent type and will soak through the paper, you will find that writing backwards is not much more difficult than the other way around. The purpose of learning to draw and write backwards is to enable you to stage the impressive illusion suggested at the top of Figure 26, which was inspired, in part, by the Chess Player, the famous pseudo-automaton shown in Figure 27. It is referred to as a *pseudo-automaton* because the mechanism doesn't operate completely of itself and requires human intervention. As you can see in Figure 26, our operator is dressed as a swami or Eastern mindreader. A pair of false arms and hands appear to grasp the box at either side, while the operator's actual arms (*X*) are thrust into the back of the box. The hands grasping the two operating arms are concealed from the audience. An assistant or members of the audience may ask the automaton swami to answer questions. While the swami goes into a trance, the automaton slowly scribbles replies in words

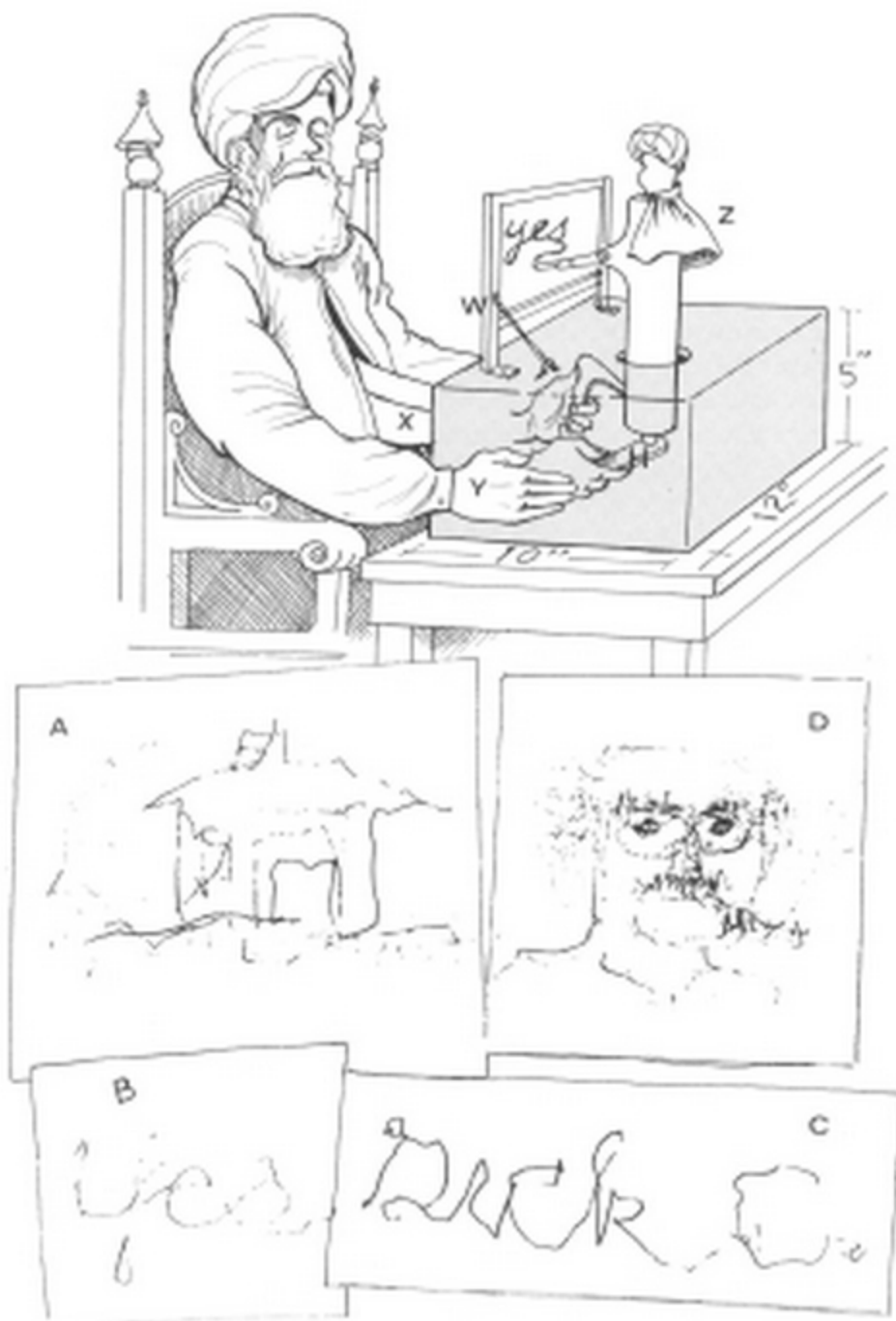


Figure 26

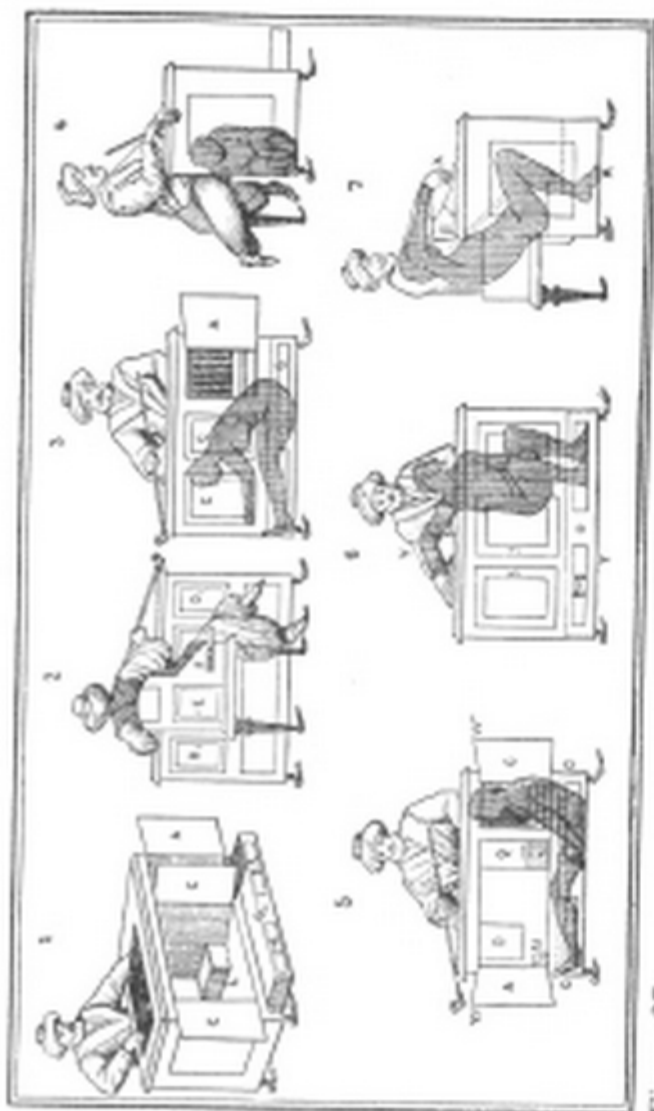


Figure 27

or in crude pictures. Questions that can be answered with a simple yes or no will, of course, be easier to answer.

IMPROVEMENTS

The appearance of the rather plain little aluminum figure can be improved by adding a tiny turban and cape. The cape partially conceals the movements of its head-arm piece as it scribbles.

As suggested in Figure 24, the basic mechanism may be elaborated with the addition of a stylus (*L* and *L*) to the vertical and horizontal operating arms as well as two flat pressure plates (*M* and *M*) to hold down two film strips but with scissors in wavelike configurations. As these film strips are drawn through the bottom of the machine by hand or by hand crank, their serrated edges push the stylus arms forward and back, and convey these eccentric movements upward through the mechanism to the head-arm and from there to the pen. The pen then writes in accordance with the eccentricities along the film edges.

How can you design the wavelike serrations on the film edges? Operate the system in reverse. While uncut film is drawn through the plates at an even rate, the pen above is manipulated by hand to produce the required drawing or writing. These movements are conveyed downward through the mechanism to the sharpened styluses, which scratch out a pattern on the film. The scratched outline is then cut out with scissors. When the film is run through again, its wavelike serrations will move the styluses and cause the pen to reproduce the original drawing.

Such a mechanism is not an easy project, but it has been done in the past. Perhaps you are the determined and patient inventor who will accomplish it again.