United States Patent [19]

Reed

[11] **3,734,153**

[45] **May 22, 1973**

[54] **AUTOMATIC CABINET MAKING TOOL**

[76] Inventor: **James C. Reed,** 5750 W. Pierson, Phoenix, Ariz. 85031

[22] Filed: **Dec. 17, 1971**

[21] Appl. No.: **208,760**

[52] **U.S. Cl.**.....**144/326,** 144/137, 144/134 B, 144/309, 83/925 CC, 90/13.8

[51] **Int. Cl.**.....**B27c 5/02,** B27m 3/18

[58] **Field of Search**.....144/134 B, 134 R, 144/137, 144 R, 309 R, 323, 326; 83/71, 72, 57, 39, 925 CC; 90/11.5, 11.42, 13, 13.8

[56] **References Cited**

UNITED STATES PATENTS

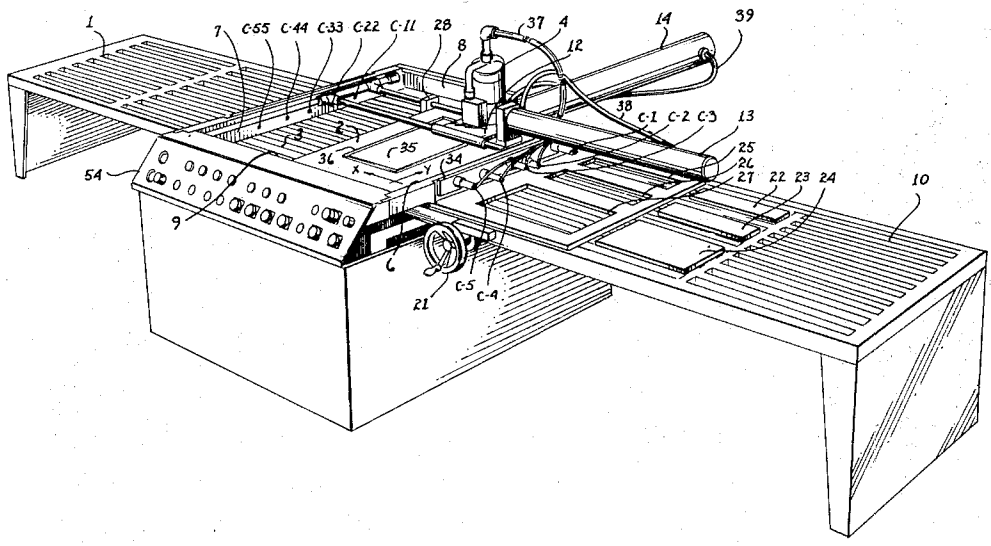
2,261,644	11/1941	Cockrell	144/137
3,693,489	9/1972	Pearl	83/925 CC
3,640,182	2/1972	Vertin	90/13.8
3,434,385	3/1969	Ray	144/144

Primary Examiner—Donald R. Schran
Attorney—William C. Cahill et al.

[57] **ABSTRACT**

Method and apparatus are disclosed for cutting one or more apertures in a cabinet front blank. The cutting operation is performed by a router selectively extending into and out of the cabinet front blank. The movement of the router in the X and Y axes is controlled by air operated mechanisms. A plurality of mechanical switches responsive to movement and position of the router provide feedback signals to a pneumatic control system. The control system also processes command signals from manual controls, which command signals provide direct control over the cutting operation of the router. The number, size and spatial relationship of the apertures may be programmed by the manual controls.

12 Claims, 17 Drawing Figures



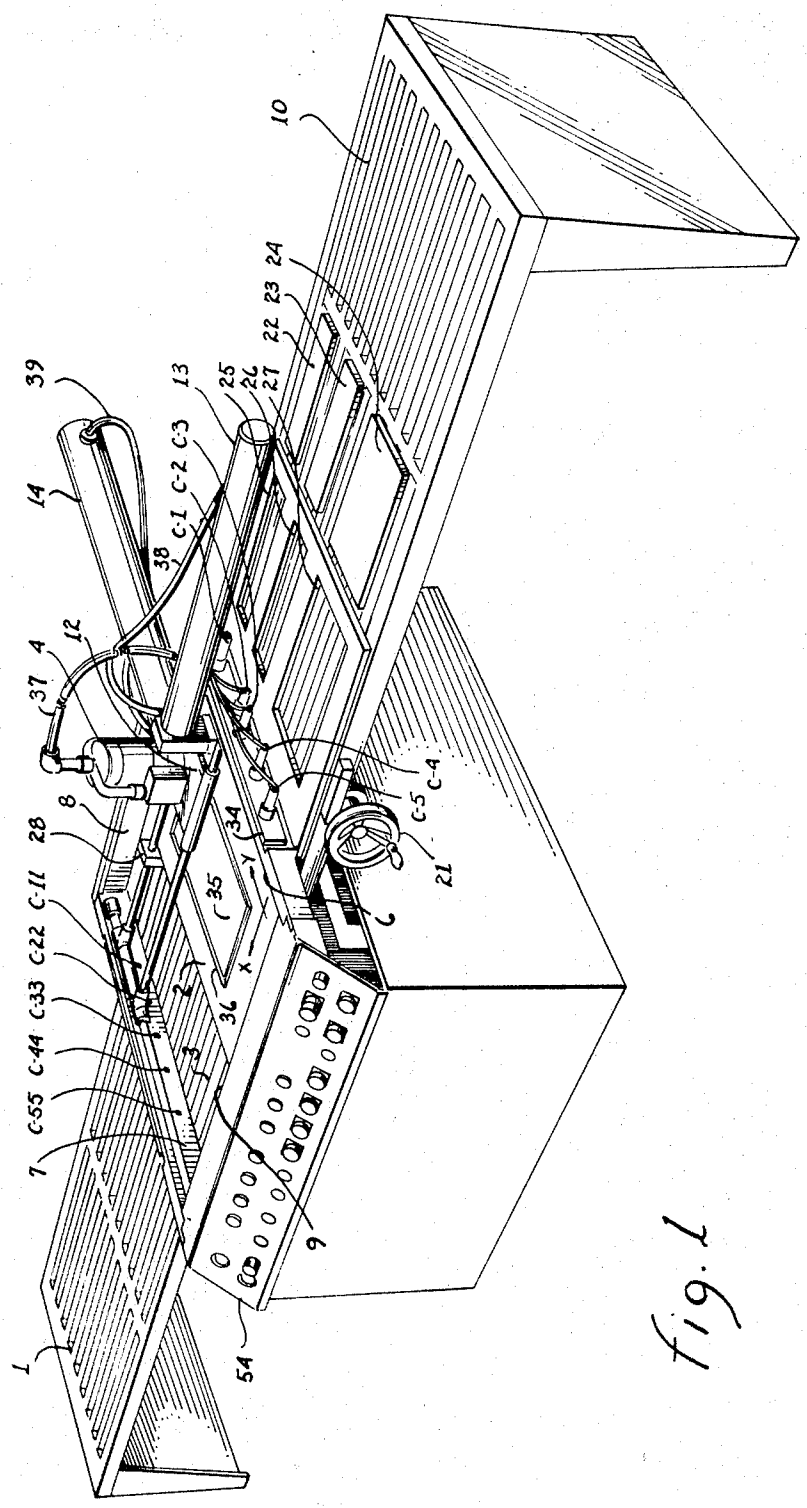

10
24
23
22
21
25
26
27
13
39
14
38
C-1
C-2
C-3
12
4
37
8
28
34
35
C-11
C-22
C-33
C-44
C-55
7
36
9
54
1
C-4
C-5
21
2

fig. 1

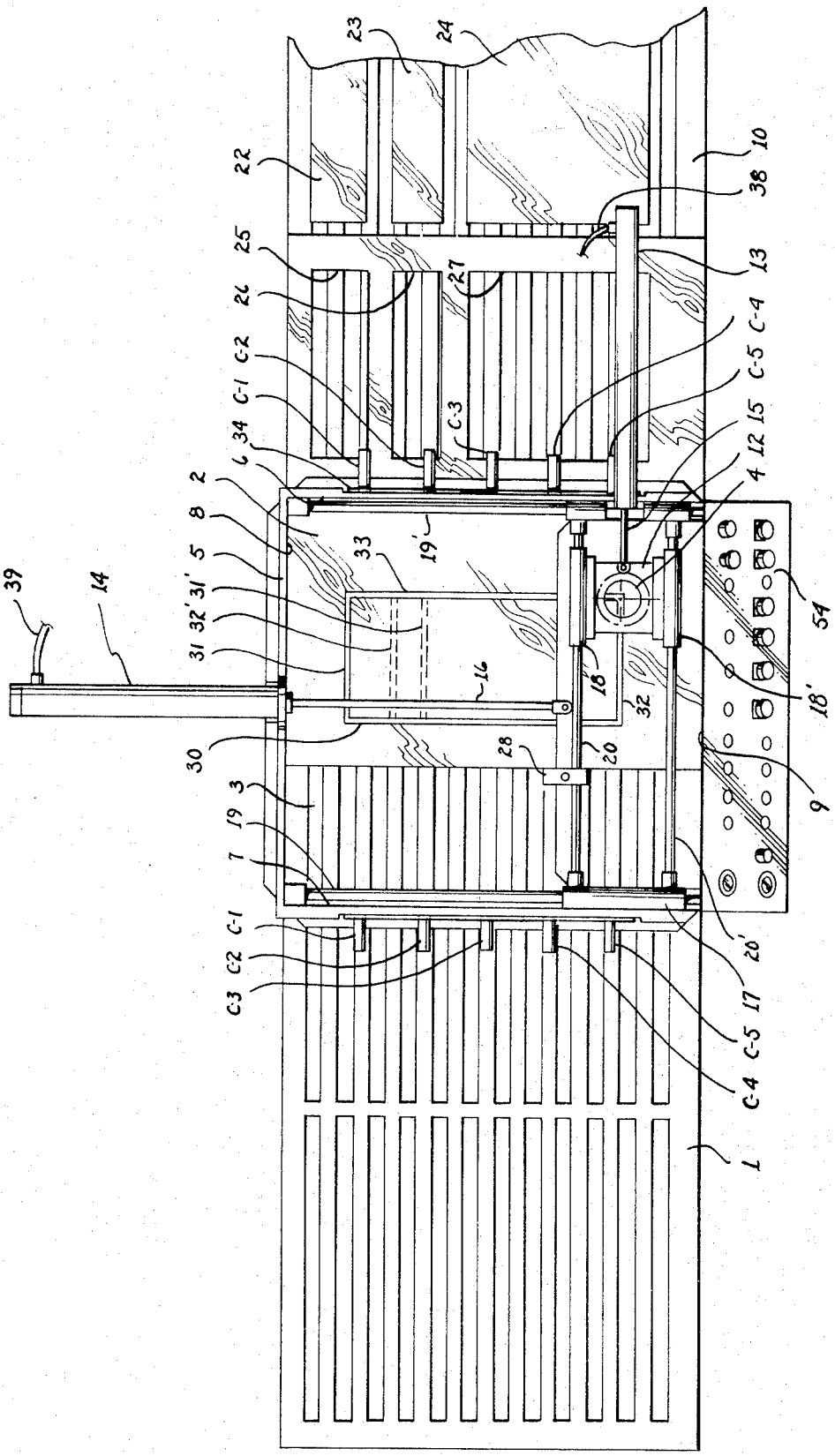

23
24
22
10
38
25
27
13
26
C-4
C-2
C-5
C-1
C-3
15
34
12
4
6
2
8
5
33
19'
39
14
31'
32'
31
54
16
18'
32
30
28
20
9
3
19
7
C-1
C-2
C-3
20'
17
C-5
C-4
1

fig. 2

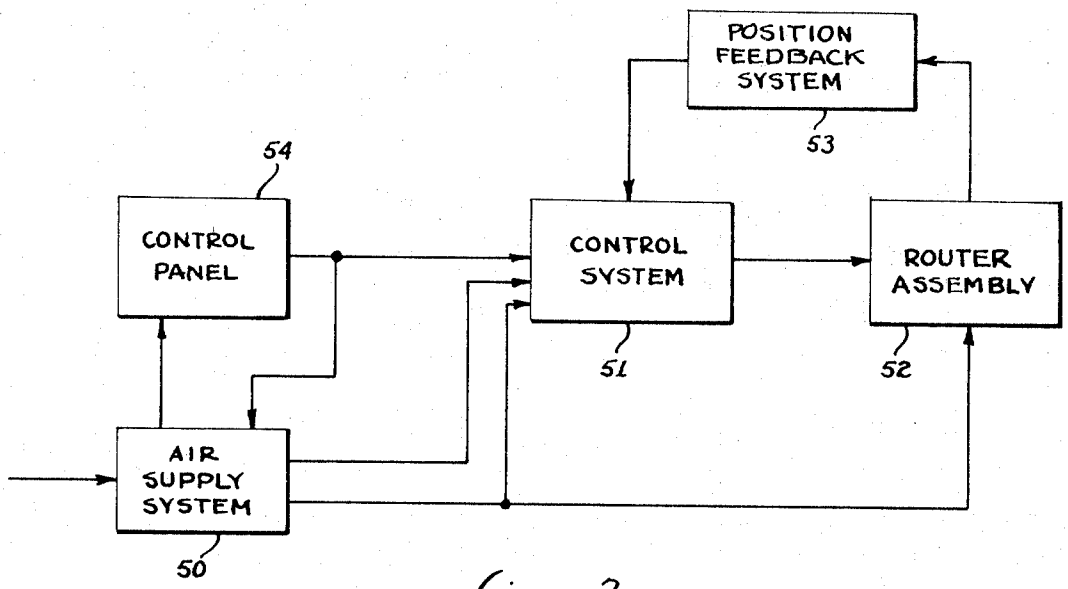

POSITION FEEDBACK SYSTEM
53
54
CONTROL PANEL
CONTROL SYSTEM
ROUTER ASSEMBLY
51
52
AIR SUPPLY SYSTEM
50

fig. 3

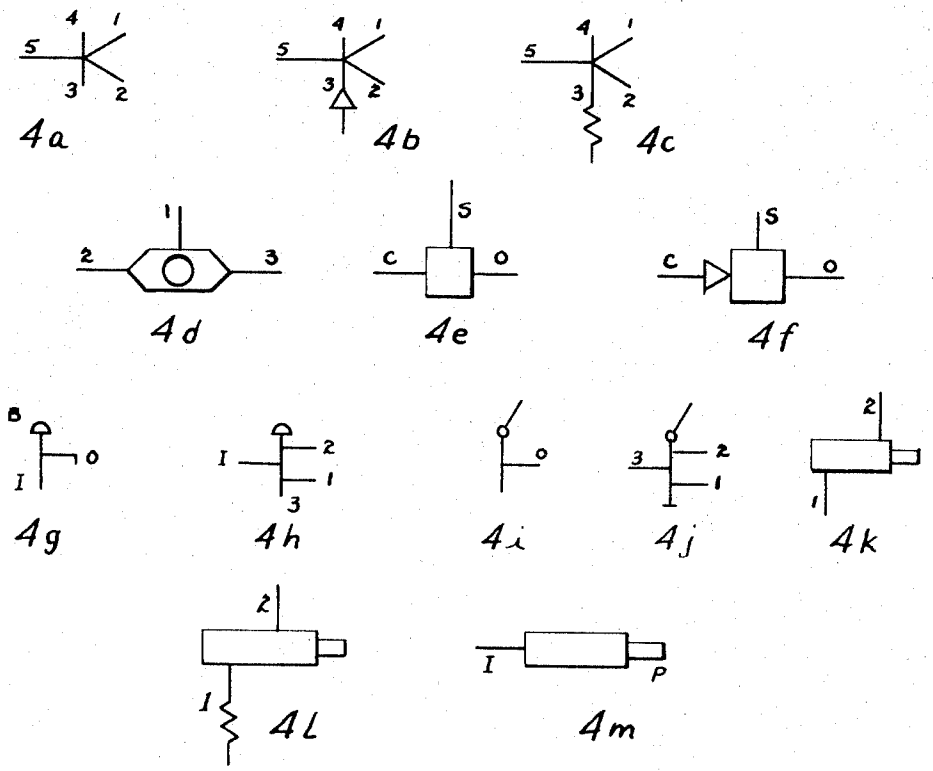

4a
4b
4c
4d
4e
4f
4g
4h
4i
4j
4k
4l
4m

fig. 4

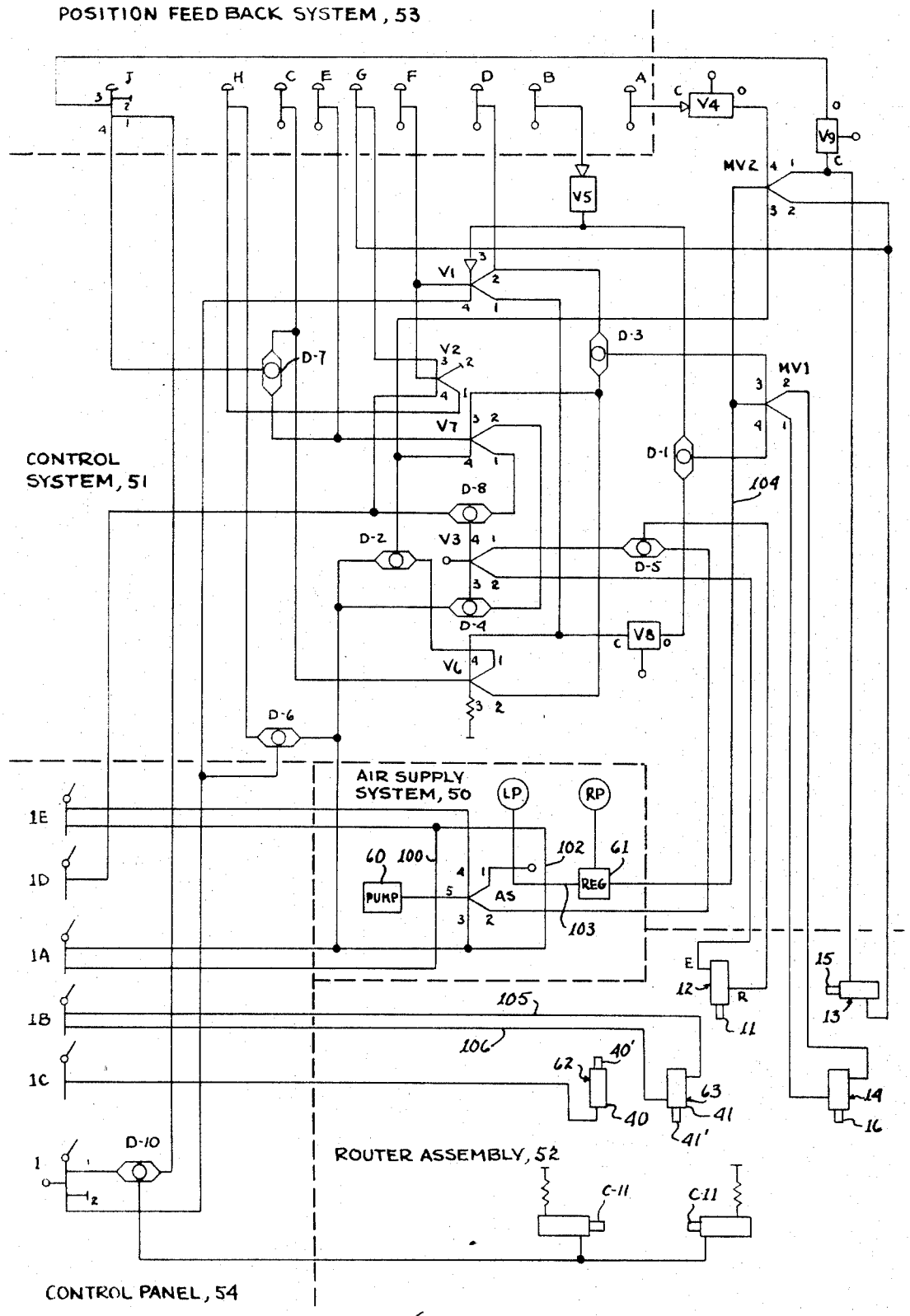

POSITION FEED BACK SYSTEM, 53
CONTROL SYSTEM, 51
AIR SUPPLY SYSTEM, 50
ROUTER ASSEMBLY, 52
CONTROL PANEL, 54
PUMP
REG
AS
LP
RP
V1
V2
V3
V4
V5
V6
V7
V8
V9
MV1
MV2
D-1
D-2
D-3
D-4
D-5
D-6
D-7
D-8
D-10
C-11
1E
1D
1A
1B
1C
100
102
103
104
105
106

fig. 5

AUTOMATIC CABINET MAKING TOOL

The present invention relates to pneumatic control systems for power tools.

Until recently, there were no widely accepted industry standards for cabinets. Consequently, the cabinets were specially made to fit particular size and location requirements. This variety of cabinet sizes required that each of the components of the cabinet be individually measured and cut to size. The cut components were then painstakingly assembled to form the cabinet. During the assembly of the cabinet, further trimming and fitting has been usually necessary. These steps for making a cabinet are not only time consuming, but require the skill of an expert craftsman.

In order to reduce the time and cost of making a cabinet, industry standards were established. New cabinet assembly techniques evolved subsequent to the adoption of these standards. One of these techniques was that of manufacturing the whole front of the cabinet from a single sheet of material. This piece of material is usually referred to as a cabinet front blank. The cabinet front blank may be of any number of different materials, such as plywood, pressboard or composition board. Apertures were cut in the cabinet front blank, which apertures were sized in accordance with the industry standards and corresponded with the placement of cupboards and drawers within the cabinet. The requisite supports, runners, sides, tops and bottoms of the cabinet were cut in accordance with the industry standards and then attached to the apertured cabinet front blank to form a complete cabinet.

The material removed from the cabinet front blank is referred to as a cutout. If the cutout is not marred and is of approximately the same size as the corresponding aperture, it may be used as the front for the drawer, or as the door for the cupboard. When so used, molding is added to the periphery of the cutout to make its outside dimension greater than the inside dimension of the aperture or to cover the space between the edge of the coutout and the aperture. Appropriate handles and hinges are then added to complete the assembly.

The cabinet industry has for some time sought to develop machines which would accurately cut the apertures in the cabinet front blanks and also preserve the utility of the cutouts.

In one of the early attempts at mass producing cabinet front blanks, the machine, programmed to cut a very limited number of apertures, cut these apertures with a rotary power saw. The end of a kerf or cut made by the teeth of a rotary saw blade is an arcuate cut. This arcuate cut by definition is not a vertical straight line cut and one side of the cabinet front blank will be cut further than the other side. For this reason, it is impossible to use a rotary saw to make two cuts defining a corner on each side of the cabinet front blank without having the cuts intersect each other on one side of the cabinet front blank. Therefore, one side of the cabinet front blank must be defaced to sever the cutout from the cabinet front blank. If the corner is to be rounded, the cut from the rotary saw must be stopped short of the corner. A second operation using some other type of tool (such as a coping saw) must be used to complete the cutting of the rounded corner.

In a more practical solution employed in the prior art, a powered router was used to cut the cabinet apertures. The means for guiding the path of the router was through a simple template arrangement. By using templates of various sizes or by using an adjustable template, different sized apertures could be cut out. A major disadvantage of this approach is that a skilled craftsman is required for proper execution. Another disadvantage is that of having to position each template for each aperture, not only with respect to the cabinet front blank but with respect to each of the adjacent apertures. The latter disadvantage inevitably results in certain imperfections in alignment and hence the desirability of the ultimate product.

It is a primary object of the present invention to provide a pre-programmed pneumatically controlled router for cutting apertures in a cabinet front blank.

Another object of the present invention is to provide a pneumatic control system for a router which may be adapted to provide a plurality of different sized apertures within a cabinet front blank.

Another object of the present invention is to provide an X-Y coordinate pneumatic control system for a router.

Another object of the invention is to provide an automatically controlled tool which will prepare an apertured cabinet front blank with a minimum of waste material.

Another object of the present invention is to provide a pneumatically controlled router for cutting apertures within a cabinet front blank which permits the use of a cutout as a drawer front or cupboard door.

Still another object of the invention is to provide programmable automatic pneumatic control system for controlling the path of a router.

These and other objects of the present invention will become apparent to those skilled in the art as the disclosure thereof proceeds.

The present invention teaches a method and the apparatus for cutting one or more apertures in a cabinet front blank. The cutting operation is performed by a router extending into and out of the cabinet front blank. The path followed by the router is controlled by an X-Y coordinate system. The X-Y coordinate system is driven by an air operated mechanism. A plurality of mechanical switches, responsive to movement and position of the router, provide feedback signals to a pneumatic control system. Manual controls provide command signals to the control system. The manual controls program the number, size and spatial relationship of the apertures. After the apertures are cut, the cutouts are removed from the cabinet front blanks. The surfaces and edges of the cutouts are not marred and the cutouts may be used as fronts for the corresponding drawers, and as the door for the corresponding cupboard. When the cutouts are so used, molding is added to the periphery of the cutouts to cover the spaces between the edges of the cutout and the corresponding aperture.

The present invention may be described with more specificity and clarity with reference to the following figures, in which:

FIG. 1 illustrates a perspective view of the apparatus incorporating the teachings of the present invention.

FIG. 2 illustrates a top view of the present invention shown in FIG. 1.

FIG. 3 illustrates a block diagram of the pneumatic control system of the present invention.

FIGS. 4*a*–4*m* illustrate the symbology used in FIG. 5.

FIG. 5 is a detailed illustration of the various elements of the pneumatic control system shown generally in FIG. 3.

FIG. 1 illustrates the relative arrangement of the components of the cabinet making tool of the present invention. A receiving platform 1 is used to position and align the cabinet front blank 2 preparatory to cutting the apertures (25, 26, 27 and 36) therein. The central portion 3 of the cabinet making tool, defined by the framework 5, constitutes the working area for the bit (not shown) of router 4. The framework 5 defines the maximum movement of the router support framework 12 in the X and Y axes. A discharge platform 10 receives the apertured cabinet front blank 2 on completion of the aperture cutting operation. A hand operated crank 21, cooperating with a drive chain and spurs (not shown), may be employed to slide the uncut cabinet front blank 2 from the receiving platform 1 to the central portion 3, and on completion of the apparatus cutting operation, to the discharge platform 10.

For illustrative purposes, FIG. 1 shows a cabinet front blank 2 having a plurality of different sized apertures 25, 26, 27 and 36. Apertures 25 and 26 may serve as the apertures for two shallow drawers. Aperture 27 may serve as the aperture for a deep drawer. Aperture 36 may serve as the aperture for a cupboard. The cutouts 22, 23 and 24 are shown as removed from their respective apertures 25, 26 and 27. Cutout 35 is shown as still positioned within aperture 36 of the cabinet front blank 2. The spaces between the cutout 35 and the edge of aperture 36 represent the basic rectangular path 30, 31, 32 and 33 traced by the router 4.

The downward extension of the bit (not shown) of router 4 may not extend downwardly below the surface of the central portion 3 or else the bit will damage the surface of the central portion 3. To obtain a cut through the cabinet front blank 2 without cutting or marring the surface upon which the cabinet front blank 2 lies, the cabinet front blank 2 must be raised above the surface. The cabinet front blank 2 must be raised to a height at which its lower surface is above the end of the extended bit. Means (not shown) are provided for raising the cabinet front blank 2. The raising means may be mechanical, or air operated.

The router 4 is mounted within the router support framework 12 in such a manner that the router bit (not shown) may extend into or retract out of the cabinet front blank 2. Air hose 37 is shown as representative of the air pressure sources which control the extension and retraction of the router bit. The router support framework 12, as shown in FIG. 2, is moved along the rectangular path represented by paths 31, 30, 32 and 33 by the X-Y coordinate system represented by X axis cylinder 13 and Y axis cylinder 14. Means other than a router may be used to obtain the cuts or incisions on paths 31, 30, 32 and 33.

As shown in FIG. 2, a set of supports 19 and 19' are attached at their ends to each of sides 8 and 9 of framework 5. A pair of sleeves 17 and 17' slidably cooperate with supports 19 and 19' and define the Y axis of the framework 5. Another set of supports 20 and 20' are rigidly attached at their corresponding ends to the set of sleeves 17 and 17'. Thus, supports 20 and 20' slidably move along supports 19 and 19' in the Y axis of framework 5. Another pair of sleeves 18 and 18' slidably cooperate with supports 20 and 20' and define the X axis of the framework 5. The router support framework 12 is disposed between and is attached to sleeves 18 and 18'. By this arrangement, the router support framework 12 moves in the X axis along supports 20 and 20'. The router support framework 12 moves in the Y axis, together with supports 20 and 20', along supports 19 and 19'.

A pair of air operated cylinders 13 and 14 provide the motive force for moving the router support framework 12 in the X and Y axes. Air hoses 38 and 39 represent the means through which the cylinders 13 and 14, respectively, are actuated. X axis cylinder 13, controlling X axis movement, is attached to sleeve 17'. The extremity of plunger 15 of the X axis cylinder 13 is attached to the router support framework 12 and controls the movement of the router support framework 12 in the X axis. Cylinder 14, controlling Y axis movement, is attached to side 8 of framework 5. The extremity of plunger 16 of the Y axis cylinder 14 is attached to support 20 and controls the movement of the router support framework 12, in the Y axis.

A positionable mechanical stop 28 is attached to support 20. Stop 28 limits the movement of sleeve 18 along support 20. The total X axis movement of the router support framework 12 is determined by the total movement of sleeve 18. Thus, stop 28 may be used to set the maximum X axis movement of the router support framework 12 and thereby control the width of the apertures and corresponding cutouts.

A plurality of plunger extendable air cylinders (such as cylinder pairs C-1, C-2, C-3, C-4 and C-5 shown in FIGS. 1 and 2) are attached to sides 6 and 7 of framework 5. The sides 6 and 7 have holes corresponding with the plungers C-11, C-22, C-33, C-44 and C-55 to permit the plungers to extend through the sides 6 and 7. When extended, the plungers C-11, C-22, C-33, C-44 and C-55 prevent sleeves 17 and 17' from moving past them along supports 19 and 19', respectively. In this manner, the air cylinder pairs C-1, C-2, C-3, C-4 and C-5, when selectively actuated, provide limits on the Y axis movement of the router support framework 12.

A plurality of mechanical switches C, D, E, G, H and J (shown in FIG. 5) are located along sides 6, 7, 8 and 9 of framework 5. These switches provide feedback indicative of the position of the router support framework 12. These feedback signals are transmitted to the control system 51.

A pair of mechanical switches A and F (shown in FIG. 5) are located in the router support framework 12. These switches provide feedback signals indicative of whether the router 4 is extended or retracted. These feedback signals are transmitted to the control system 51.

Mechanical switch B (shown in FIG. 5) is located on the router support framework 12. This switch is indicative of the router support framework 12 contacting stop 28. It provides a feedback signal to the control system 51.

A control panel 54 (shown in FIGS. 1 and 2) is adjacent the front of the central portion 3. The control panel 54 includes start/stop switches, switches for programming the size, number and position of the apertures to be cut, and gauges to indicate various air pressures. It may also include lamps indicative of the functions to be or being performed.

The basic functionally distinct portions of the pneumatic control system are shown in block form in FIG.

3. The air supply system **50** receives an air flow input from a pump or other pressurized air source (shown as pump **60** in FIG. **5**). The air supply system **50** provides pressurized air to the control panel **54**, to the control system **51** and to the router assembly **52**. The control panel **54** includes all of the manually actuated switches and pressure gauges. The outputs from the control panel **54** provide input control signals to the air supply system **50** and to the control system **51**. The control system **51** includes all of the pneumatic valves and flip flops required to control each of the phases of operation of the router **4**. The control system **51** receives both a regulated supply of air for actuating the X axis cylinder **13** and Y axis cylinder **14** and a non-regulated supply of air for the system control functions from the air supply system **50**. The operation of the control system **51** is a function of the output from the control panel **54** and the position feedback system **53**. The router assembly **52** includes the router **4**, the stile gauge **62**, clamp **63**, the X axis cylinder **13**, the Y axis cylinder **14**, and when used, the cylinder pairs C-1, C-2, C-3, C-4 and C-5. All of these components, except for the X axis cylinder **13** and the Y axis cylinder **14** are operated from an unregulated air supply from air supply system **50**. Actuation of each of the components of the router assembly **52** is controlled by the control system **51**. The feedback system **53** includes mechanical switches A, B, C, D, E, F, G, H and J. Each of these switches are actuated by its corresponding component in the router assembly **52**. On actuation of one of these switches, a signal is provided to the control system **51**. This signal is in the nature of a feedback signal in that it is indicative of the position of the corresponding component in the router assembly **52**. On receipt of these feedback signals, the control system **51** initiates the succeeding phase of operation of the router assembly **52**.

In describing the pneumatic control system of the present invention, reference will be made primarily to FIG. **5**, supported by the following legend of elements shown in FIGS. **4***a*–**4***m*. Repetition of the operation of the elements in FIGS. **4***a*–**4***m* will not be made unless the requirement for clarity so demands.

FIG. **4***a* represents a pneumatic flip flop. An input on line **5** will be channeled to either output **1** or output **2**. A signal on one of the vents, the latter represented by vents **3** and **4**, directs the input through either output **1** or output **2**, respectively. After the input has been channeled through one of the outputs, the input will continue to flow therethrough until a signal is present at the vent corresponding to the other output.

FIG. **4***b* represents a pneumatic flip flop having vent **3** responsive to an increase in air pressure. An input on line **5** will be channeled to either output **1** or output **2**. A signal on vent **3**, if it is of an air pressure greater than the air pressure previously present, will cause the input to be channeled through output **1**. A signal of constant air pressure or of a drop in air pressure on vent **3** has no effect in switching the output. A signal on vent **4** will cause the input to be channeled through output **2**. A cessation of the signal on vent **4** will not cause the output to switch from output **2** to output **1** despite the presence of a signal of constant air pressure on vent **3**.

FIG. **4***c* represents a pneumatic flip flop having a spring return associated with vent **3**. An input on line **5** will be channeled to either output **1** or output **2**. A signal on vent **4** will direct the input through output **2**. Upon cessation of the signal on vent **4**, the spring return of vent **3** is released and the spring will provide a signal on vent **3** to switch the input through output **1**.

FIG. **4***d* represents a directional valve. An input on either input **2** or input **3** will be directed through output **1**. There is no air flow from input **2** to input **3** or vice-versa.

FIG. **4***e* represents an actuator. An air pressure present on input C switches the actuator to channel an air flow from input I through output O. On cessation of an air pressure on input C, the output air flow is blocked.

FIG. **4***f* represents an actuator responsive to an air pressure change on input C. A pressure change on input C switches the actuator to channel an air flow from input I through output O. On cessation of the air pressure change on input C, the output air flow is blocked.

FIG. **4***g* represents a single output mechanical switch. While button B is depressed, an input air flow through input I will flow through output O.

FIG. **4***h* represents a dual output mechanical switch. An input air flow on input I will be channeled to either output **1** or output **2**. A signal on vent **3** or the depressing of button B directs the input air flow through either output **1** or output **2**, respectively. Once switched, the input air flow will continue to flow through the switched output until a counter signal is present.

FIG. **4***i* represents a single output manual toggle switch. The air flow from input I through output O is determined by the position of the manual switch. In the switch position shown, the air flow from input I through output O is inhibited. When switched, the switch is open and an input air flow through input I will flow through output O.

FIG. **4***j* represents a dual output manual toggle switch. An input air flow on input I will be channeled to either output **1** or output **2**. In the switch position shown, the input air flow from input I is channeled through output **1**. When switched, the input air flow from input I is channeled through output **2**.

FIG. **4***k* represents an air actuated cylinder having a plunger P. An air pressure present on input **1** will extend the plunger P, while an air pressure on input **2** will retract the plunger P.

FIG. **4***l* represents an air actuated cylinder with a spring extended plunger P. An air pressure present on input **2** will retract the plunger P. On cessation of the air pressure at input **2**, the plunger P will extend under force of the spring **1**.

FIG. **4***m* represents an air actuated cylinder having a plunger P. A single input **1** introduces air pressure to extend the plunger P. On cessation of the air pressure, the plunger P may be retracted manually or by other means.

Referring to FIG. **5**, there is shown a detailed schematic of the elements of the pneumatic control system. The elements are segregated by the dotted lines into blocks corresponding to the functional blocks **50, 51, 52, 53** and **54** of FIG. **3**.

Preparatory to operating the pneumatic control system, a pump **60** is energized to provide a source of air pressure to input **5** of flip flop AS. Simultaneously, there will be an air flow through lines **100** and **102** to vent **3** of flip flop AS. An input to vent **3** directs the input to flip flop AS to flow through output **1**. A line pressure gauge LP is connected to the output **1** of flip flop As and indicates the air pressure therein. Output

1 of flip flop AS is connected to and provides air pressure for a plurality of other elements. The AS and indicates the air pressure receiving an air pressure input from output 1 of flip flop AS are indicated by a small circle connected to an input line of the element. Line **103**, connected to the output 1 of flip flop AS, provides air pressure to air pressure regulator **61**. The regulator **61** provides regulated air pressure to the inputs of master valves MV1 and MV 2 through line **104**. A pressure gauge RP is connected to the regulator **61** and indicates the regulated air pressure in line **104**. When pressure gauges LP and RP indicate the appropriate readings, the system may be operated.

A cabinet front blank **2** to be apertured with appropriate sized apertures is placed on the receiving platform **1** (shown in FIGS. **1** and **2**). The cabinet front blank **2** may be moved to the central portion **3** manually or by use of a chain (not shown) operated through crank **21**. To correctly position the cabinet front blank **2** within the central portion **3**, an air operated stile gauge **62** may be energized through manual switch **1C**. The stile gauge **62** is an air operated cylinder **40** vertically oriented within the central portion **3**, such that the plunger **40'**, when extended, extends above the surface of the central portion **3** and contacts the leading edge of the cabinet front blank **2**. At this point, the cabinet front blank **2** may be raised above the surface of the central portion **3** for reasons previously discussed.

Once the cabinet front blank **2** is properly positioned within the central section **3**, clamp **63** is energized to maintain the cabinet front blank **2** rigidly against a side of the framework **5**. The clamp **63** is an air operated cylinder **41** energized through manual switch **1B**. Switch **1B**, when in a first position (as shown), introduces air through line **105** to cylinder **41** to extend the plunger **41'**. The plunger **41'** is connected to means, such as a bar acting against the side of the cabinet front flank **2**, to force the cabinet front blank **2** toward a side of framework **5**. Switch **1B**, when in a second position (not shown) introduces air through line **106** to cylinder **41** to retract plunger **41'**.

The width of the apertures to be cut are determined by mechanical stop **28** (shown in FIGS. **1** and **2**) and it should be adjusted prior to initiating movement of the router support framework **12**.

The initial position for operating the router **4** is shown in FIG. **1**. The router **4** is positioned above the cabinet front blank **2** at one of the corners of the aperture to be cut. In FIG. **1**, the corner of paths **31** and **33** is shown as the initial position.

On initiation of the aperture cutting operation, the router bit extends and engages the cabinet front blank **2**. On engagement, the router bit cuts a hole through the cabinet front blank **2**. The router **4** is designed to extend sufficiently for the router bit to penetrate the raised cabinet front blank **2** but will stop entending short of penetrating the surface of the central portion **3**. When the router bit is fully extended, the router **4** will be displaced by the X-Y coordinate system with respect to the cabinet front blank **2**. The displacement of the router **4** will cause the router bit to make a corresponding cut in the cabinet front blank **2**. The rectangular path followed by the router **4** is represented in FIG. **2** by paths **31, 30, 32** and **33**. When the router **4** has completed its travel along the rectangular path, the router bit will retract and become disengaged from the cabinet front blank **2**.

In the immediately following description, the operation of the control system will be described for cutting one cupboard sized aperture. Subsequently, the variations in number and size of apertures available through programming will be described.

Referring to FIG. **5**, after pump **60** has been turned on and the router support framework **12** has been placed in the initial position above the cabinet front blank **2**, manual switch **1D** is operated to initiate the aperture cutting operation. Operating switch **1D** provides a signal to vent **4** of flip flop **V-2**, switching the input thereto through output **2**. The input to flip flop **V-2** is obtained from mechanical switch F, which switch F is not actuated at this time. Thus, there is no present output from flip flop **V-2**. Simultaneously, switch **1D** supplies a signal to vent **4** of flip flop **V-3**, through directional valve **D-8**, switching the input of valve **V-3** through output **2**. Output **2** of flip flop **V-3** supplies air pressure to the router support framework **12** and extends the router **4** downwardly through the cabinet front blank **2**. As the router **4** extends, the router contacts and depresses mechanical switch A. Switch A actuates actuator **V-4**. Actuator **V-4** provides a signal to vent **4** of master valve **MV-2** to switch the input to **MV-2** through output **2**. Output **2** of master valve **MV-2** provides a regulated air pressure input to the X axis cylinder **13** to extend plunger **15**, causing the router **4** to be moved in the X axis along path **31** (see FIG. **2**).

As the plunger **15** of X axis cylinder **13** extends, the router support platform **12** will move in the X axis to the limit established by mechanical stop **28**. On reaching the stop **28**, mechanical switch B will be depressed. Depressing switch B will actuate actuator **V-5**. The output of actuator **V-5** will provide a signal to vent **3** of flip flop **V-1**, switching the input of flip flop **V-1** through output **1**. The input to flip flop **V-1** is obtained from mechanical switch F. Switch F is not actuated at this time. Thus, there is no present output from flip flop **V-1**. Actuator **V-5** includes a reset feature and which feature will reset actuator **V-5** to a no output state. The output of actuator **V-5**, through directional valve **D-1**, provides a signal to vent **4** of master valve **MV-1**, switching the input of master valve **MV-1** through output **2**. Output **2** of master valve **MV-1** provides an input to the Y axis cylinder **14**, extending plunger **16**. The plunger **16** is connected to the router support framework **12**. As the plunger **16** extends, it moves the router **4** in the Y axis along path **30** (see FIG. **2**).

The plunger **16**, extending in the Y axis, will move the router support framework **12** in the Y axis, and the latter will contact and actuate mechanical switches J, G, H and C. At the moment, switch J has no input and therefore it has no output when actuated by the router support framework **12**. switch G, having an input connected to output **2** of master valve **MV-2**, has an air pressure input. Actuation of switch G provides a signal to vent **3** of flip flop **V-2**, switching the input of flip flop **V-2** through output **1**. The output **1** of flip flop **V-2** is connected to the input of the mechanical switch H. The input to flip flop **V-2** is obtained from mechanical switch F, which switch F is not actuated at this time. Thus, there is no present output from flip flop **V-2**. As the router support framework **12** continues to extend in the Y axis, it will depress mechanical switch H. However, as switch H receives its input from flip flop **V-2**, and as the latter does not presently have an output,

switch H does not have an input at this time. Thus, depressing switch H has no present effect.

As the router support framework **12** continues to extend in the Y axis, it will ultimately contact and depress mechanical switch C. Switch C provides an input to flip flop V-**6**. Output **1** of flip flop V-**6** is normally operative due to the spring return on vent **3**. Output **1** of flip flop V-**6** provides a signal to vent **3** of master valve MV-**2**, through directional coupler D-**2**, switching the output of master valve MV-**2** through output **1**. An output through output **1** of master valve MV-**2** provides an input to the X axis cylinder **13** retracting the plunger **15**. As the plunger **15** retracts, it moves the router support framework **12** in the X axis along path **32** (see FIG. **2**). Simultaneously, output **1** of master valve MV-**2** actuates actuator V-**9**. Actuator V-**9** provides an input to mechanical switch J. A discussion of the effect of an input to switch J will be deferred. The output **1** of flip flop V-**6**, through directional valve D-**2**, also provides a signal to vent **4** of flip flop V-**7**, switching the output of flip flop V-**7** through output **2**. The input to flip flop V-**7** is obtained from mechanical switch E; which switch E is not actuated at this time. Thus, there is no present output from flip flop V-**7**.

As the plunger **15** retracts, the router support framework **12** will ultimately depress mechanical switch D. Depressing mechanical switch D provides, through directional valve D-**3**, an input signal to vent **3** of master valve MV-**1** switching the input to master valve MV-**1** through output **1**. input to the Y axis cylinder **14**, retracting the plunger **16**. As the plunger **16** retracts, it moves the router support framework **12** in the Y axis along path **33** (see FIG. **2**). As the plunger **16** retracts, the router support framework **12** will depress mechanical switches H, G, and J in that order. At the moment none of these switches have an input. Depressing these switches has no present effect.

When the Y axis router **16** is fully retracted, the router support framework **12** will depress mechanical switch E. Depressing of switch E provides an input signal to flip flop V-**7**. Previously, the input to flip flop V-**7** had been directed through output **2**, but at that time there was no input to flip flop V-**7**. An output through output **2** of flip flop V-**7**, via directional valve D-**4**, provides a signal to vent **3** of flip flop V-**3**, switching the input of flip flop V-**3** through output **1**. Output **1** of valve V-**3**, via directional valve D-**5**, provides an input to the router support framework **12**, retracting the router **4**.

When fully retracted, the router **4** will depress mechanical switch F. Depressing switch F provides an input to flip flops V-**1** and V-**2**. Due to previous switching, flip flop V-**1** provides an output through output **1**. An output through output **1** of flip flop V-**1** actuates actuator V-**8**. Actuator V-**8**, via directional valve D-**1**, provides a signal to vent **4** of master valve MV-**1**, switching the input through output **2**. Output **2** of master valve MV-**1** provides an input to the Y axis cylinder **14**, to extend plunger **16**. An output through output **1** of flip flop V-**1** also provides a signal to vent **4** of flip flop V-**6**, switching the input through output **2**. The input to flip flop V-**6** is obtained from mechanical switch C, which switch C is not actuated at this time. Thus, there is no present output from flip flop V-**6**.

The extension of the plunger **16** displaces the router support framework **12** in the Y axis. The path followed is that shown as path **33**, but as the router **4** is not extended, there is no cutting function. Switches J, G, and H are, in turn, depressed by the movement of the router support framework **12**.

Presently, a discussion of the effect of depressing switch J will be deferred. Switch G, which receives an input from output **2** of master valve MV-**2**, has no input as the output of master valve MV-**2** is switched through output **1**. Mechanical switch F, previously depressed by the retracting router **4** provides an input to flip flop V-**2**. The input of flip flop V-**2** is switched through output **1**, due to previous switching, and provides an input to mechanical switch H.

As plunger **16** extends and router support framework **12** depresses switch H, the latter now having an air pressure input. Switch H provides a signal to vent **4** of flip flop V-**1**, via directional valve D-**6**, switching the input through output **2**. An output through output **2** of flip flop V-**1** provides a signal to vent **3** of master valve MV-**1**, via directional valve D-**3**, switching the input of master valve MV-**1** through output **1**. Output **1** of master valve MV-**1** provides an input to the Y axis cylinder, retracting the plunger **16**.

The retraction of plunger **16** displaces the router support framework **12** in the Y axis. The path followed is that shown as path **33**, but as the router **4** is not extended, there is no cutting function. Switches G, and J are in turn, depressed by the movement of the router support framework **12**. Presently, a discussion of the effect of depressing switch J will be deferred. Switch G, which receives an input from output **2** of master valve MV-**2**, has no input as the output of master valve MV-**2** is switched through output **1**.

When plunger **16** is fully retracted, the router support framework **12** will depress switch E. Switch E provides an input to flip flop V-**7**. The input of flip flop V-**7** is switched through output **2** due to previous switching. An output through output **2** of flip flop V-**7** provides a signal to vent **3** of flip flop V-**3**, via directional valve D-**4**, switching the input of flip flop V-**3** through output **1**. An output through output **1** of flip flop V-**3**, via directional valve D-**5**, will command the router **4** to retract. However, as the router **4** is already retracted by a previous operation, this second redundant command will cause the router **4** to depress switch F. Switch F provides an input to valve V-**1**. The latter has the input switched through output **2** by a previous operation. An output from output **2** provides a signal to vent **3** of master valve MV-**1**, via directional valve D-**3**, switching the input of master valve MV-**1** through output **1**. An output through output **1** of master valve MV-**1** commands the plunger **16** to retract. As the plunger **16** is already retracted by a previous operation, this second redundant command will cause the plunger **16** to depress switch E. Depressing switch E commands the router **4** to retract, as discussed above, and the above steps would be repeated. At this point, an impasse is reached and the system has completed one control path.

To illustrate the import and function of the mechanical switches G and H, the operation will be described as if switches G and H were not present.

Referring to the above description at the point where actuator V-**8** provides a signal to vent **4** of master valve MV-**1**, switching the input through output **2** of master valve MV-**1** and causing plunger **16** to extend and displacing the router support framework **12** along path **33**, the following description will illustrate the effect on the movement of the router support framework **12** in the

absence of mechanical switches G and H. As the plunger **16** extends, moving the router support framework **12** past mechanical switch J, it will ultimately contact mechanical switch C. Depressing switch C provides an input to flip flop V-**6**. At this time, the input to flip flop V-**6** is switched through output **2** due to previous switching. The output through output **2** of flip flop V-**6** provides a signal to vent **3** of flip flop V-**7**, switching the input of flip flop V-**7** through output **1**. The output of output **1** of flip flop V-**7** provides a signal to vent **4** of flip flop V-**3**, via directional valve D-**8**. A signal to vent **4** of flip flop V-**3** will switch the input through output **2**. An output through output **2** of flip flop V-**3** provides an input to the router support framework **12**, extending the router **4**. Extension of the router **4** will depress mechanical switch A. Depressing switch A causes the control system to cycle through the whole cutting sequence again, and it will continue to repeat itself until the Air supply is shut off.

The above description is a general description of the operation of the router **4** cutting a standard sized cupboard aperture within a cabinet front blank **2**. For situations requiring different sized apertures, that is, apertures which may be for one or more drawers, or for drawers combined with a cupboard, additional manual input controls must be utilized.

In example, manual toggle switch **1** may be used to actuate a pair of cylinders C-**1**. One cylinder of cylinder pair C-**1** is mounted on a spring centered bar **34**, a part of side **6** of framework **5**. The other cylinder of cylinder pair C-**1** is mounted on side **7** of framework **5**. Each of these cylinder pairs C-**1** includes a plunger C-**11**, which plunger C-**11** extends through an aperture in the bar **34** and side **7** when the cylinder pair C-**1** is actuated. When extended, the plungers C-**11** will contact the router support framework **12** when it moves in the Y axis. Bar **34**, when moved toward side **9**, will actuate mechanical switch C, and when moved toward side **8**, will actuate mechanical switch E. Thus, when the router support framework **12** contacts the plungers C-**11** of cylinder pair C-**1**, a signal from switch C or switch E will be transmitted to the control system **51** as if the router support framework **12** had in fact contacted either switch C or switch E.

In a drawer aperture in combination with a less than full size cupboard aperture were to be cut in the cabinet front blank **2**, switch **1** would be actuated. The output of switch **1**, in the position shown, is through output **2**. As output **2** is blocked, there is no input to cylinder pair C-**1** from switch **1** to retract plungers C-**11**. Therefore, plungers C-**11** remain extended due to the associated spring. When cylinder pair C-**1** is not to be used, switch **1** is switched to its second position to provide an output through output **1**. Output **1** provides an input to cylinder pair C-**1**, via directional valve D-**10**, to retain the plungers C-**11** in the retracted position.

The position of the cylinder pair C-**1** with respect to the sides **6**, **7** of the framework **5** must be established to obtain the desired height of the drawer. As a matter of design, the cylinder pair C-**1** may be positioned on sides **6**, **7** 4 inches from the start position of the extended router **4** to provide paths (like paths **30** and **33**) in the Y axis which are four inches long. Thereby, a drawer aperture having a height of four inches is obtained. The Y axis dimension of the cupboard aperture to be cut would be that of the full size cupboard, less four inches and less the spacing between the drawer and cupboard aperture.

In describing the modifications introduced into the control system by actuation of the cylinder pair C-**1**, a detailed description will be undertaken of those operations not previously discussed. However, for the sake of brevity, those operations previously described in detail will only be described in terms of cause and effect.

In the following discussion, it will be assumed that the cylinder pair C-**1** has been actuated by manual switch **1**. By actuating manual switch **1**-D, the start switch, the router **4** will extend and depress mechanical switch A. Switch A commands plunger **15** to extend, which plunger **15** moves the router support framework **12** in the X axis on path **31**. The router support framework **12** will continue to move in the X axis in path **31** until mechanical switch B is depressed. Depressing switch B commands plunger **16** to extend, which plunger **16** moves the router support framework **12** in the Y axis on path **30**. Movement of the router support framework **12** is the Y axis will cause the router support framework **12** to depress mechanical switch J. The input to switch J is provided by actuator V-**9**. At the present moment, actuator V-**9** has no output as there is no control input to it from output **1** of master valve MV-**2**. Therefore, there is no input to switch J and depressing it will be of no present effect.

As the router support framework **12** continues to move in the Y axis, the router support framework **12** will contact and be restrained from further movement in the Y axis by the extended plungers C-**11** of cylinder pair C-**1**. At this point, the router support framework **12** has moved four inches in the Y axis. One of the cylinders of cylinder pair C-**1** is mounted on the spring centered bar **34**. As the router support framework **12** contacts the plunger C-**11** of the cylinder pair C-**11** mounted on bar **34**, it will cause the bar **34** to move. The movement of the bar **34** toward side **9** will depress switch C. Depressing switch C provides a signal to vent **4** of switch J, via directional valve D-**7**, switching the input through output **2**. At present, there is no input to switch J from actuator V-**9**. The output **2** of switch J is blocked. Perforce, the above-described switching of switch J has no present effect.

Switch C also supplies an input to flip flop V-**6**, the latter being switched through output **1** due to the spring return on vent **3**. The output of flip flop V-**6**, through output **1**, provides a signal to vent **3** of master valve MV-**2**, via directional valve D-**2**, switching the input to master valve MV-**2** through output **1**. The output **1** of master valve MV-**2** provides an input to the X axis cylinder **13**, retracting the plunger **15** to move the router support framework **12** in the X axis. Simultaneously the output from output **1** of master valve MV-**2** actuates actuator V-**9**. The output of actuator V-**9** provides an input to switch J. However, as the output **2** of switch J is blocked, actuation of actuator V-**9** has no present effect.

Retraction of the plunger **15**, moving the router support framework **12** along path **32'** will ultimately depress switch D. Switch D provides a signal to vent **3** of master valve MV-**1**, via directional valve D-**3**, switching the input of valve MV-**1** through output **1**. The output **1** of master valve MV-**1** provides an input to the Y axis cylinder **14**, retracting plunger **16**. The retracting plunger **16** moves the router support framework **12** in the Y axis along path **33** to the initial position. On

reaching the initial position, the router support framework 12 will depress switch E. Depressing switch E provides a signal to vent 4 of switch J switching the output of switch J through output 2. As switch J is already switched to output 2, this has no present effect.

Previously, flip flop V-6, having an output through output 1, provides a signal to vent 4 of flip flop V-7, via directional valve D-2, switching the input of valve V-7 through output 2. Depressing switch E (discussed above) also provides an input to flip flop V-7. As the output of the latter is switched through output 2, a signal to vent 3 of flip flop V-3, via directional valve D-4, switches the input of the latter through output 1. The output 1 of flip flop V-3, via directional valve D-5, provides an input to the router support framework 12, retracting the router 4. Retraction of the router 4 will depress mechanical switch F. Depressing switch F provides an input to flip flop V-1. Flip flop V-1 having an output through output 1, actuates actuator V-8. Actuator V-8 provides a signal to vent 4 of master valve MV-1, via directional valve D-1, switching the input of master valve MV-1 through output 2. The output 2 of master valve MV-1 provides an input to the Y axis cylinder 14, extending the plunger 16 in the Y axis along path 33.

Extending plunder 16, moving the router support framework 12 along path 33 will now depress the mechanical switch J, switching the output of the latter through output 1. Switch J presently has an input from actuator V-9. An output through output 1 of switch J will, via directional valve D-10, provide a command to the cylinder pair C-1 to retract the plungers C-11. Retraction of plungers C-11 allows the router support framework 12 to extend, in the Y axis, beyond the plungers C-11. Switches G and H will be depressed but as they have no input, depressing them has no present effect upon the system.

Finally, the router support framework 12 will depress switch C. Depressing switch C provides a signal to vent 4 of switch J, switching the input of the latter through output 2. In the absence of an output through output 1 of switch J, the plungers C-11 of the cylinder pair C-1 will extend under the force of the spring within the cylinder pair C-1. Actuation of switch C also provides an input to flip flop V-6. The output of flip flop V-6 is switched through output 2 and provides a signal to vent 3 of master valve MV-1, switching the input to master valve MV-1 through output 1. The output 1 of master valve MV-1 provides an input to the Y axis cylinder 14, retracting plunger 16 along path 33.

Upon retraction of the plunger 16, the router support framework 12 will contact the extended plungers C-11 and displace bar 34. The displaced movable bar 34 depresses switch E. Switch E provides an input to flip flop V-7. The depressed switch C, discussed above, provides an input to flip flop V-6. Flip flop V-6 has the input switched through output 2 by a previous operation. An output through output 2 of flip flop V-6 will also provide a signal to vent 3 of flip flop V-7, switching the input of flip flop V-7 through output 1. The output 1 of flip flop V-7, via directional valve D-8, provides a signal to vent 4 of flip flop V-3, switching the input of the latter through output 2. The output 2 of flip flop V-3 provides an input to the router support framework 12, extending the router 4. The extending router 4 will depress switch A.

Simultaneously, switch E provides a signal to vent 4 of switch J, via directional valve D-7, switching the input of switch J, through output 2. As the inputs to the switches J are already switched through output 2, depressing switch E has no present effect thereon.

Router 4 depressing switch A will initiate movement of the router support framework 12 along the rectangular path 31', 30, 32 and 33. The operational functions performed during travel along paths 31', 30, 32, and 33 are the same as those functions previously described with respect to travel along paths 31, 30, 32 and 33.

Additional air operated cylinder pairs C-2, C-3, C-4 and C-5, as shown in FIGS. 1 and 2, may be used to provide additional varieties of pre-programmed aperture combinations. These cylinder pairs would be actuated by one or more switches similar to manual switch 1. The basic function of these further manually actuated cylinder pairs would be similar to the two aperture cutting operations described above. Similarly, additional mechanical switches operating as mechanical switch J may be added to control the extension and retraction of the plungers C-22, C-33, C-44 and C-55 of cylinder pairs C-2, C-3, C-4 and C-5. Again, the operation of these mechanical switches would be similar to that described with respect to mechanical switch J.

Manual switch 1-*e* is an emergency switch and has an input air supply from the main air pressure pump 60. On actuation of switch 1-*e*, the output provides a signal to vent 4 of flip flop AS, switching the output of flip flop AS through output 2. An output through output 2 of flip flip AS, via directional valve D-5, provides an input to the router support framework 12 to retract the router 4. The switching of the output of valve AS for output 1 to output 2 simultaneously cuts off the air supply to all of the remaining switches and flip flops in the system. Thus, the router 4 is retracted and the system is inoperative.

Manual switch 1-*a* acts as a reset switch. The input to switch 1-*a* is connected to the pump 60. An output from switch 1-*a* provides a signal to vent 3 of flip flop AS, switching the output of flip flop AS from output 2 to output 1. Thereby an air supply is reapplied to all of the remaining switches and flip flops. The output of output 1 of flip flop AS also provides an input to the regulator 61, the latter providing an input to master valves MV-1 and MV-2.

I claim:

1. A system for automatically forming apertures in sheet material while recovering the cutout portions removed from said apertures, said system comprising in combination:

a. cutting means for forming said apertures, said cutting means having a rotatable bit selectively positioned within the plane of said sheet material and translatable into and out of the plane of said sheet material;

b. translation means for positioning the bit of said cutting means within the plane of said sheet material;

c. first drive means for controllably actuating said translation means;

d. second drive means for controllably translating the bit of said cutting means into and out of the plane of said sheet material;

e. detection means for generating feedback signals indicative of the location of said cutting means;

f. a plurality of input controls for selectively determining the number and shape of said apertures;

g. control means responsive to said plurality of input controls and to said feedback signals generated by said detection means for actuating said first and second drive means.

2. The system as set forth in claim **1** wherein said translation means comprises a mechanical X-Y coordinate system for translating said cutting means in the X and Y axes.

3. The system as set forth in claim **2** wherein said cutting means comprises a router.

4. The system as set forth in claim **3** wherein said detection means comprises a first plurality of switches responsive to the location of the bit within the plane of said sheet material, and

a second plurality of switches responsive to the location of the bit within and without the plane of said sheet material.

5. The system as set forth in claim **2** wherein said first and second drive means comprise pneumatically operated plungers for operating said mechanical X-Y coordinate system.

6. The system as set forth in claim **5** wherein said detection means comprises a plurality of mechanical switches responsive to the location of said cutting means.

7. The system as set forth in claim **6** wherein said control means comprises a plurality of pneumatically operated flip flops, valves and actuators.

8. The system as set forth in claim **7** wherein said input controls comprise a plurality of manually operated switches for introducing pneumatic inputs to said control means.

9. The system as set forth in claim **3** wherein said plurality of input controls include means for altering the maximum movement of said router in the X axis.

10. The system as set forth in claim **9** wherein said plurality of input controls include means for altering the maximum movement of said router in the Y axis.

11. The system as set forth in claim **10,** including:

a receiving platform for receiving said sheet material prior to forming said apertures;

a central portion for retaining said sheet material while forming said apertures; and

a discharge platform for receiving said sheet material subsequent to forming said apertures.

12. A method for automatically forming apertures in sheet material while recovering the cutout portions removed from said apertures, said method comprising the steps of:

a. forming said apertures with cutting means, said cutting means having a rotatable bit selectively positioned within the plane of said sheet material and translatable into and out of the plane of said sheet material;

b. positioning the bit of said cutting means with translation means within the plane of said sheet material;

c. actuating said translation means with a first drive means;

d. translating the bit of said cutting means into and out of the plane of said sheet material with a second drive means;

e. generating feedback signals with detection means indicative of the location of the bit of said cutting means;

f. determining the number and shape of said apertures with a plurality of input controls; and

g. actuating said first and second drive means with control means responsive to said plurality of input controls and said feedback signals generated by said detection means.

* * * * *