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Abilgaard et al.

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[45] **Sept. 4, 1973**

[54] **METHOD AND APPARATUS FOR BINDING BOOKS**

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[22] Filed: **Apr. 15, 1971**

[21] Appl. No.: **134,359**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 799,045, Feb. 13, 1969, Pat. No. 3,596,929, Continuation-in-part of Ser. No. 875,126, Nov. 10, 1969, Pat. No. 3,608,117.

[52] **U.S. Cl.** ..... **281/25,** 11/1 R, 281/21

[51] **Int. Cl.** **B42b 1/00,** B42c 19/00

[58] **Field of Search** ..... 11/1 R, 1 M, 1 B; 281/21, 25

[56] **References Cited**

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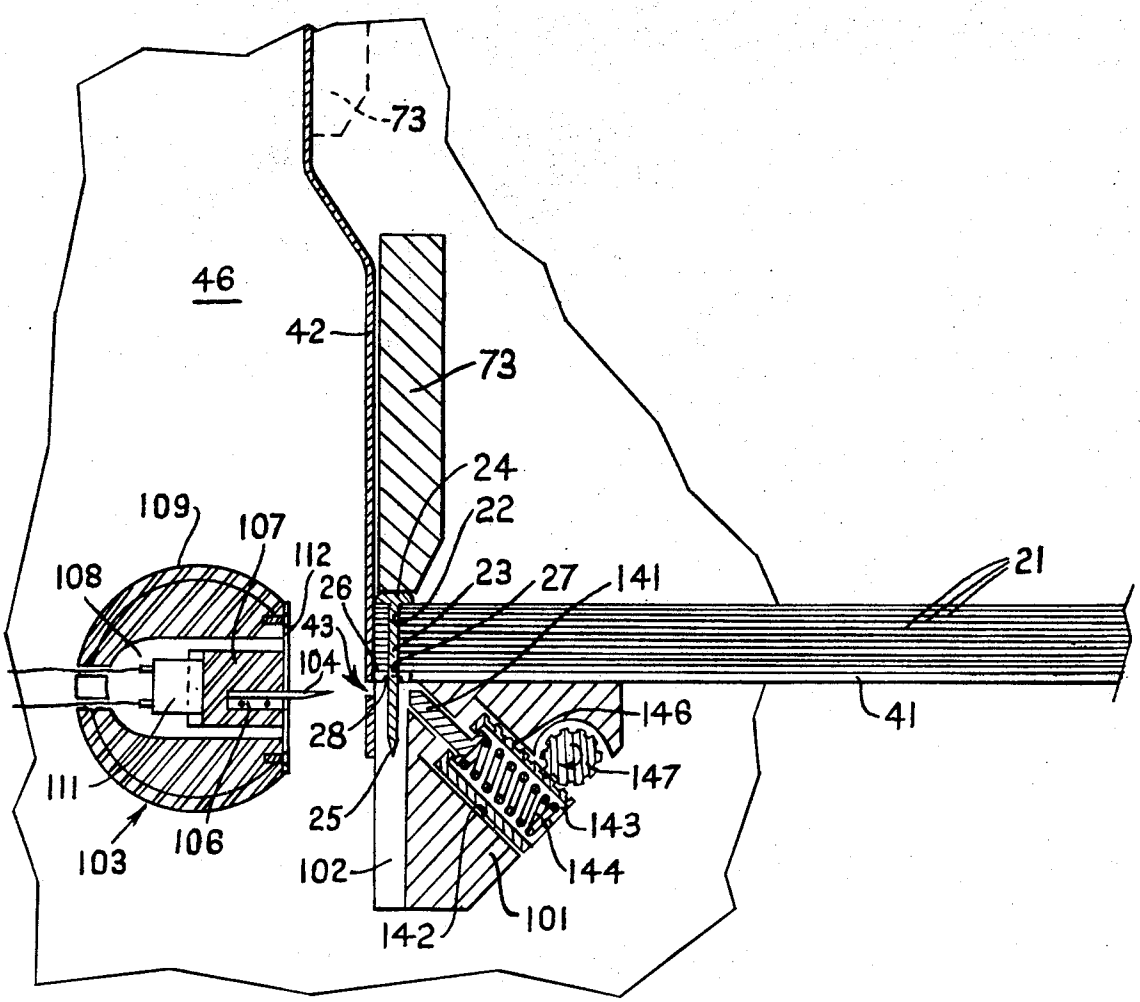
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Primary Examiner—Lawrence Charles
Attorney—Julian Caplan

[57] **ABSTRACT**

A machine is provided for first punching holes in sheets and then binding the sheets to form a book. Used with the machine are two thermo-plastic strips, a first having longitudinally spaced, upstanding studs and the second having holes corresponding in spacing to the studs and preferable formed with counterbores on one surface. The machine has a punch to punch the sheets. Punched sheets are placed on a platen on top of the second strip and the studs of the first strip are inserted through the holes in the paper and the holes in the second strip. A pressure foot is mechanically moved to apply pressure on the first strip to compress the paper between the two strips with predetermined force and this pressure is maintained until completion of the binding. Excess stud length protruding below the second strip is cut off a short distance below the second strip by heated knives. The knives are then moved upward, deforming the stud stubs into the counterbores in the second strip to form heads. Upon withdrawal of the knives, cooling and forming fingers are forced against the heads to shape and cool same. When the heads have hardened, the fingers are withdrawn and the pressure foot withdrawn.

18 Claims, 15 Drawing Figures



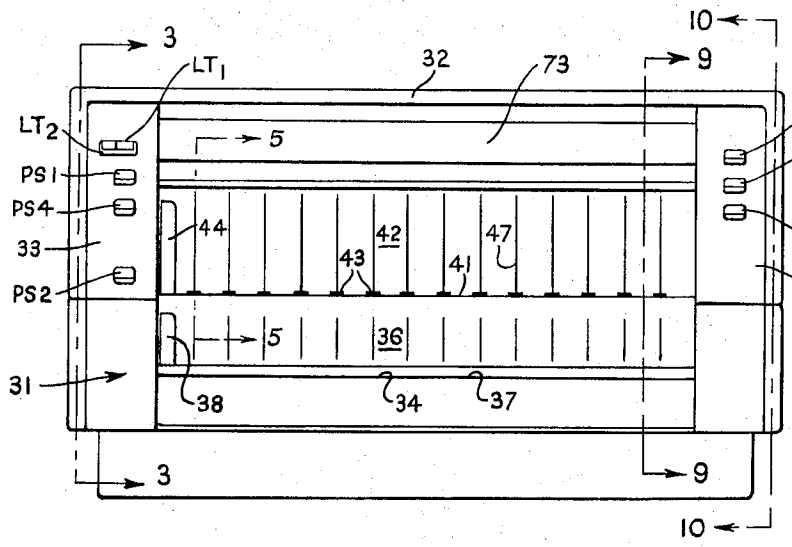


FIG. 1

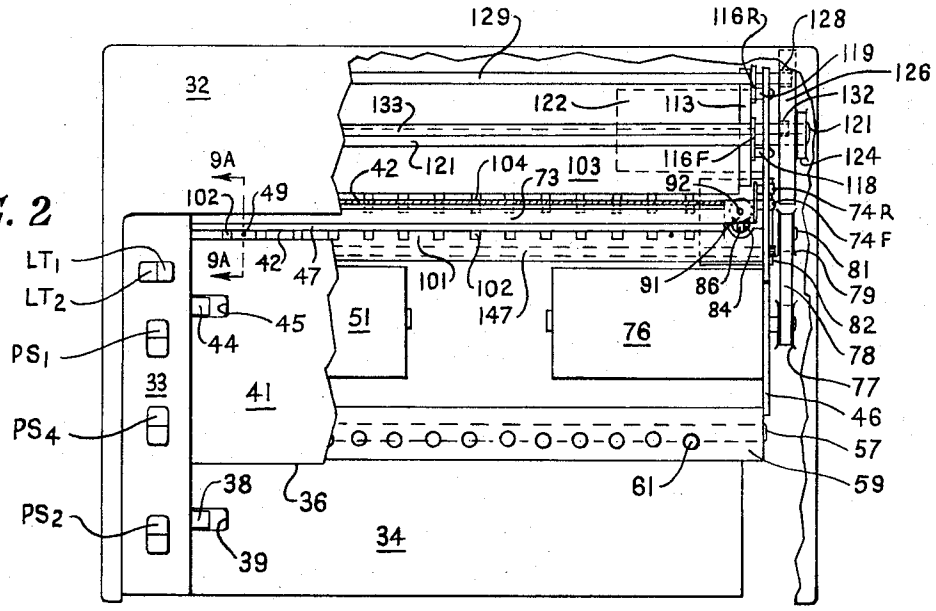


FIG. 2

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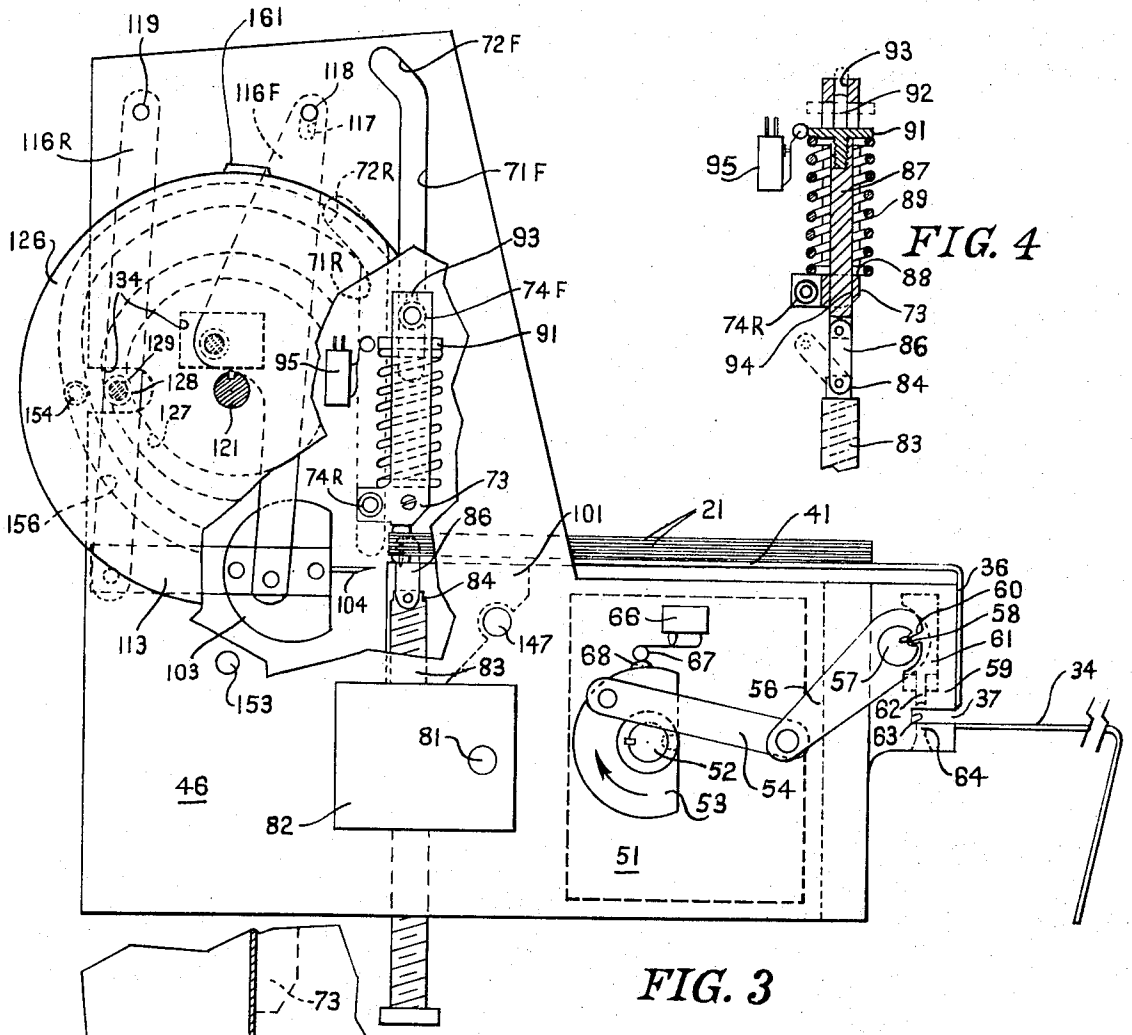


FIG. 3

FIG. 4

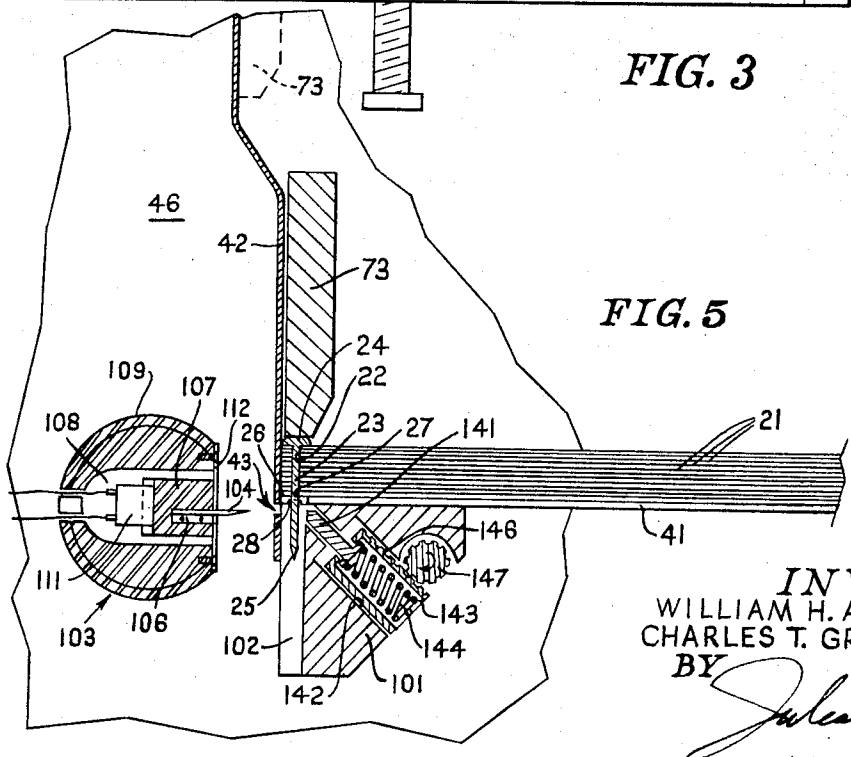


FIG. 5

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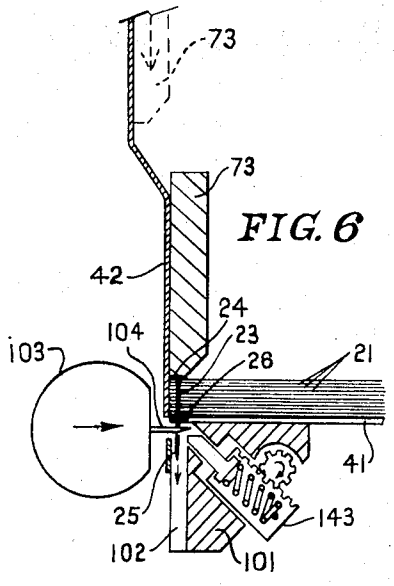


FIG. 6

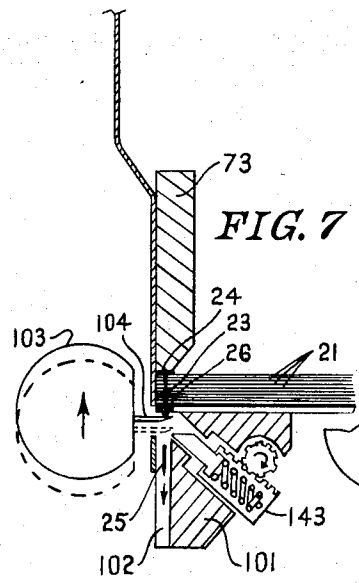


FIG. 7

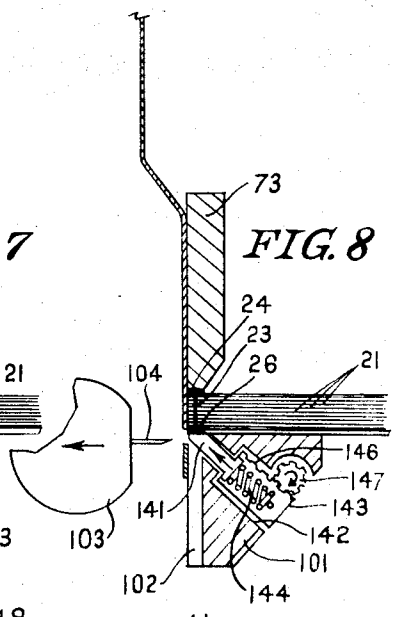


FIG. 8

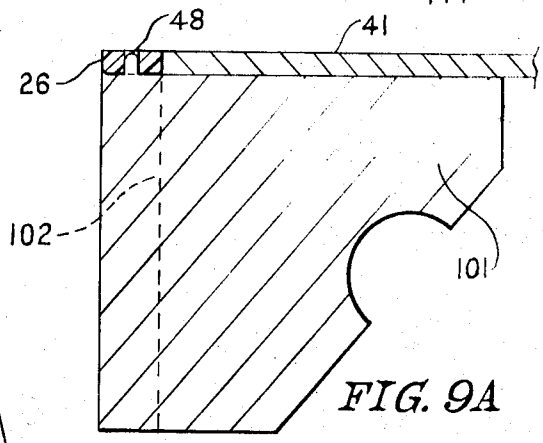


FIG. 9A

FIG. 9

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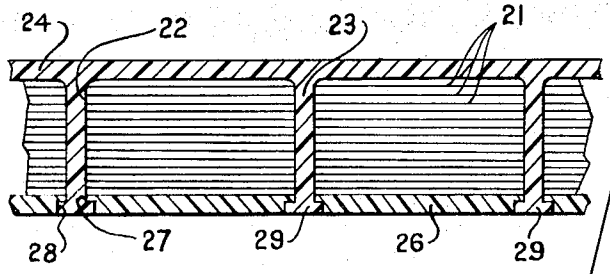


FIG. 11

FIG. 10

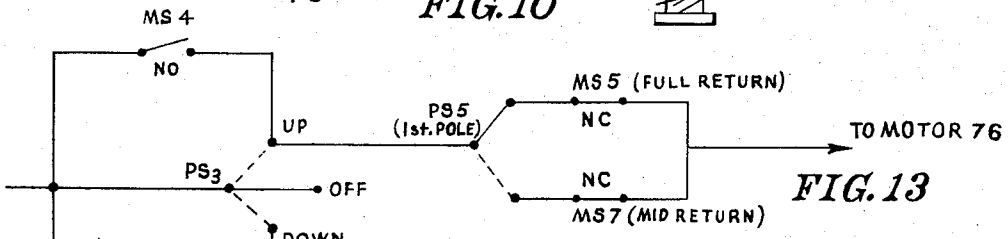


FIG. 13

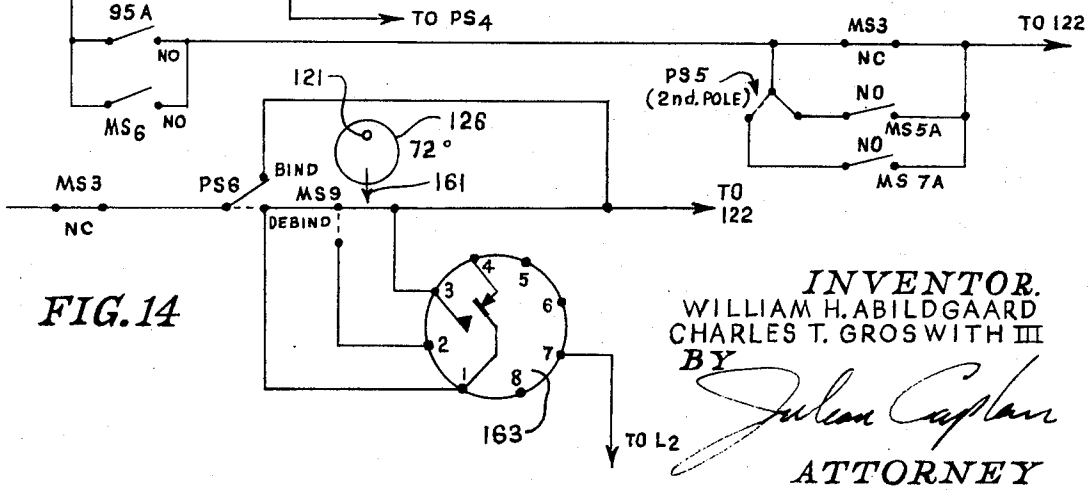


FIG. 14

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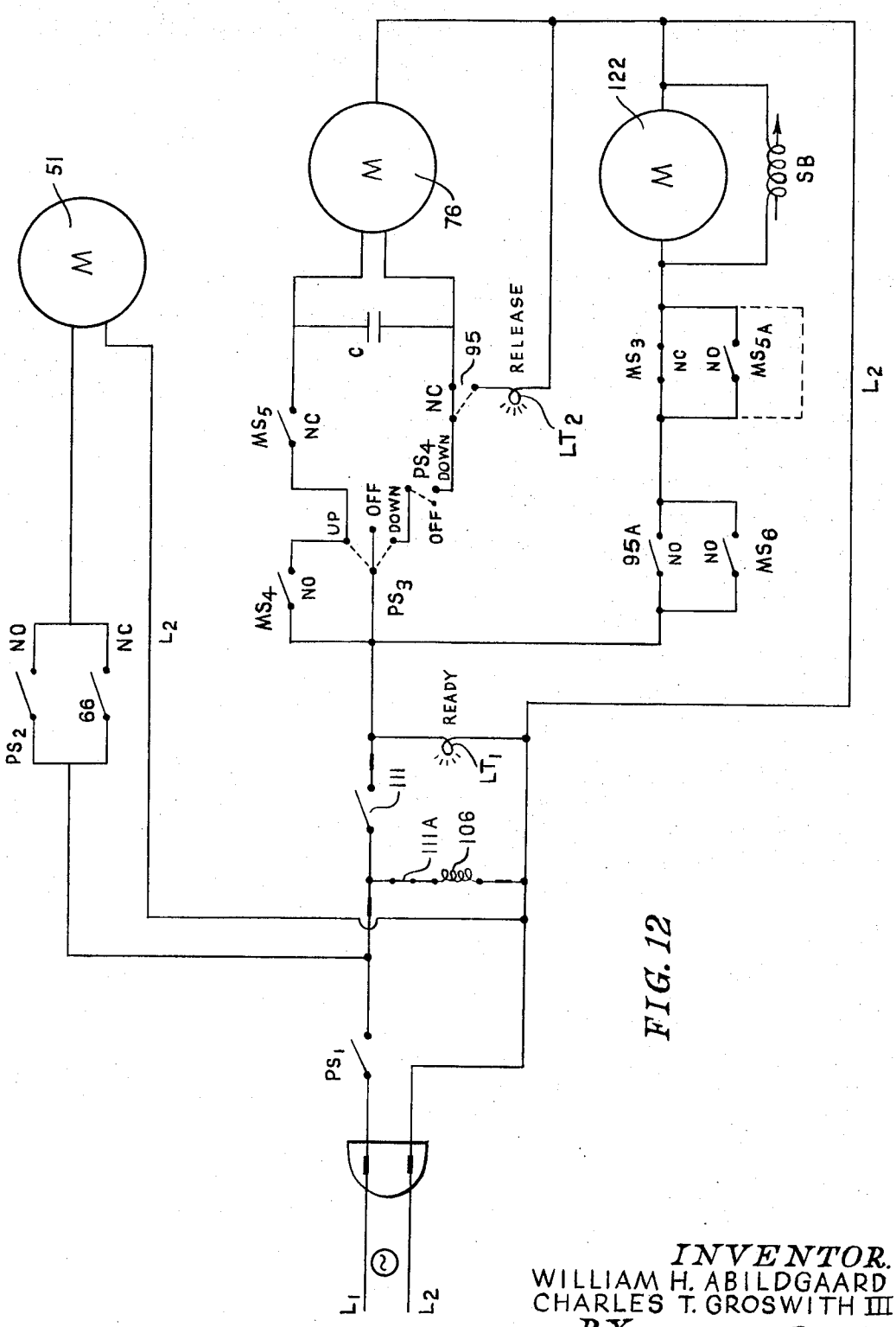


FIG. 12

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METHOD AND APPARATUS FOR BINDING BOOKS

This application is a continuation-in-part of copending applications Ser. No. 799,045, filed Feb. 13, 1969, now U.S. Pat. No. 3,596,929 and Ser. No. 875,126, filed Nov. 10, 1969, now U.S. Pat. No. 3,608,117. In the latter copending application, joint inventor Dalny Travaglio was not a party to that portion of the subject matter which is common to this application.

This invention relates to a new and improved apparatus and method for binding apertured sheets to produce a book.

A feature of the present invention is the fact that it provides a machine of a size suitable for use in a business office which both punches and binds sheets together, using two plastic strips, one having spaced studs which project through the holes in the sheets and the other being formed with holes to receive the ends of the studs. When the two strips are pressed together with the apertured sheets to be bound interposed and with the studs fitting through the apertures in the sheets, a ladder-like arrangement of the strips is obtained. The excess lengths of the studs are sheared off, leaving the stubs of the studs in softened condition. The stubs are pressed with fingers which form heads and cool the same, permanently binding the sheets together between the strips.

A feature of the invention is the fact that it accepts a wide variety of types of sheet material. Thus ordinary paper which has been punched or drilled adjacent one of its margins may be used or the machine may punch the paper as a preliminary to the binding operation. On the other hand, looseleaf, previously-punched paper may be used. It is sometimes desirable to re-bind books or to bind assembled pluralities of books, pamphlets, catalogs and the like. For this operation, the material is punched or drilled adjacent one margin thereof, in a separate machine. The versatility of the apparatus, as far as the variety of material accepted, is one of the features of the invention.

Another feature of the invention is the fact that a range in thickness of books is accommodated. The studs of the first strip heretofore mentioned are of extended length so as to fit through a relatively thick book. However, the apparatus shears off the excess length of the studs where less than the maximum length is required. The effectiveness of the binding operation is relatively independent of the thickness of the book involved. The apparatus will accept a variety of sizes of sheets, within limits.

Another feature of the apparatus is the fact that the sheets are tightly pressed together and then locked in place in compressed condition.

Still another feature of the invention is the provision of a mechanism, preferably motor operated, which applies predetermined pressure to press the pages of the book together.

Another feature of the mechanism is the fact that the foot which applies the pressure is so guided that at its extreme open position it is displaced rearwardly, permitting insertion of plastic strips even at the extreme thickest limit of the books being handled.

Another feature of the invention is the provision of a cam system which mechanically and electrically times the cutting of the studs, the pressing of the studs into rough shapes for heads and then presses the heads into the final form and cools them so that the plastic sets into a permanent binding.

Another feature of the invention is the fact that a timing cycle is achieved which shears the excess stud lengths and then presses the still soft stud ends to form heads.

Another feature of the invention is the fact that the apparatus is easily operated by relatively untrained personnel. Little physical effort is required to operate the machine and the operation is rapid.

Another important feature of the invention is the provision of electrical means within the circuitry of the machine which enables the same mechanical elements to be used to de-bind books which have previously been bound on the machine. It will be understood that it sometimes happens that it is desirable to remove the binding in order to make changes in the material on the sheets. The present invention has an alternate electrical circuit which may be actuated by the operator which overheats the rivet-heads, softening them and enabling the strips to be pulled apart, thereby effectively debinding the book.

Other objects of the present invention will become apparent upon reading the following specification and referring to the accompanying drawings in which similar characters of reference represent corresponding parts in each of the several views.

In the drawings:

FIG. 1 is a front elevation of the machine.

FIG. 2 is a top plan thereof broken away to reveal internal construction.

FIG. 3 is a side elevation with the casing removed and partially broken away to reveal internal construction.

FIG. 4 is a fragmentary sectional view of a portion of FIG. 3.

FIG. 5 is a fragmentary sectional view taken substantially along the line 5—5 of FIG. 1 and showing the parts at the beginning of the cycle of operation.

FIGS. 6, 7 and 8 are fragmentary views of portions of the structure of FIG. 5 showing the parts at different positions in the cycle of operation.

FIG. 9 is a sectional view taken substantially along the line 9—9 of FIG. 1 with portions broken away to conserve space.

FIG. 9A is an enlarged sectional view taken substantially along the line 9A—9A of FIG. 2.

FIG. 10 is a view similar to FIG. 3 from the opposite side.

FIG. 11 is an enlarged, fragmentary view through the bound book.

FIG. 12 is a circuit diagram of the machine.

FIG. 13 is a fragmentary circuit diagram showing alternate means for interrupting retractive movement of the pressure foot at a position intermediate the limits of its movement.

FIG. 14 is a fragmentary circuit diagram showing alternate means for debinding a book.

A. BINDING MATERIALS

The apparatus hereinafter described is used to bind together either temporarily or permanently and to debind pluralities of sheets of paper or the like which are designated in the accompanying drawings generally by reference numeral 21. Cover sheets (not shown) for the front and back of the book may also be used. Each sheet is formed with a series of spaced apertures 22 along one margin thereof, the spacing between the apertures corresponding to the spacing of studs 23 of first

strip 24, hereinafter described. The apertures 22 are preferably round and made by means of a paper punch which is a part of the apparatus herein described, or they may be notches or other shapes. Occasionally, it is desirable to bind pre-punched pages or to re-bind a book such as a paper bound book. Thereupon the apertures 22 of such sheets may be drilled or otherwise formed by separate apparatus. The dimensions of the sheets 21 which are accepted by the apparatus hereinafter described are subject to considerable variation, the apparatus being made large enough to accommodate a range of sizes. The thickness of the book which is to be bound is likewise subject to variation between a very few sheets and a thickness which is within the limits of the lengths of the studs 23 of the strip 24.

First strip 24 is preferably rectangular to cross-section being about ¼ inch wide and 1/16 inch thick. The length is approximately equal to that of the sheets 21. Spaced along the center of one surface of the strip 24 are integral studs 23 preferably round and formed with points 25 at their outer ends. The studs 23 are preferably between 3/32 inch and ⅛ inch in diameter and may be in length up to about 3 inches.

The second strip 26 also is approximately ¼ inch in width and 1/16 inch in thickness and is formed with a series of holes 27 spaced in distances corresponding to the spacing of the studs 23. Preferably, a counterbore 28 is formed in each hole 27 along one surface of the strip 26.

The strips 24, 26 are preferably molded or otherwise formed of a thermo plastic material. One suitable plastic is a rigid polyvinyl chloride. Other suitable thermoplastics are high-impact polystyrene and acrylonitrile butodiene styrene (ABS).

B. CASING OF MACHINE

The apparatus of the present invention is preferably incorporated in a machine similar in general appearance to standard office machines and having incorporated therein certain electrical circuits and mechanical mechanisms, hereinafter described in detail, consisting generally of:

C - punch.
D - pressure foot actuation
E - knife activation
F - forming and cooling fingers
G - electrical circuitry

In the following description, each of these sections of the machine will be described as well as the method of operation for binding and de-binding books.

Casing 31 has a top 32 at the rear, and on either side downwardly-forwardly slanting side panels 33 on which various controls and indicators are mounted. Disposed horizontally between the side panels 33 at the lowermost level is punch platen 34 and at the rear edge thereof is a punch backstop 36 having an opening 37 at its lower edge which accepts papers to be punched in the punch mechanism C. On the left side as viewed in FIGS. 1 and 2 is a horizontally, transversely movable punch side guide 38 which controls the positioning of the left edge of paper placed on platen 34. Guide 38 moves in a horizontal elongated slot 39, the means for moving the guide in and out not being herein explained or illustrated in detail.

At a level above platen 34 is binding platen 41 which is also horizontally disposed and which has a backstop 42 at its rear edge, said backstop being flexibly mounted at its top so that its lower edge may move rearwardly and forwardly within slight limits to accommodate different widths of strips 26, as hereinafter explained. A series of openings 43 are formed in the bottom edge of backstop 42 for the outward extension of cutting knives as hereinafter explained. On the left edge of platen 41 is a side guide 44 moving in a slot 45 and actuated and having a purpose similar to guide 38 and slot 39.

Interiorly of the casing 31 on either side are vertical side plates 46 suitably rigidly interconnected by means not herein illustrated and in which most of the shafts hereinafter described are journalled and to which many of the actuating mechanisms are suitably pivotally mounted.

C. PUNCH

Where the sheets 21 are not prepunched, it is necessary to form apertures 22 therein and a suitable mechanism by which this is accomplished is shown on the right-hand side of FIGS. 3 and 9. Sheets 21 are placed on platen 34 and their left-hand edges are moved against guide 38 and their rearward edges are pushed through slot 37. The height of slot 37 determines the thickness of pages which may be punched and prevents overloading of the punch.

The punch mechanism is preferably driven by its own motor 51 to the shaft 52 of which is connected a check 53. Connecting rod 54 is pivoted on cheek 53 and the opposite punch shaft 57. Longitudinal notch 58 is formed on shaft 57.

Shaft 57 also extends through punch cross frame 59 which is a block of steel in which are formed vertical bores and which reciprocate punch cylinders 61 having tongues 60 which fit into slots 58. Thus, when shaft 57 oscillates, the punch cylinder 61 reciprocates in frame 59.

The number and spacing of cylinders 61 corresponds to the number and spacing of the apertures 22 to be formed in sheets 21. Accordingly at the lower end of each cylinder 61, is a punch foot 62 normally retracted above punch throat 63 formed in frame 59 and reciprocating downwardly below the throat 63 to engage with female punch die 64 formed in frame 59. The throat 63 is in alignment with opening 37 and its back edge limits the rearward movement of the sheets 21 positioned on platen 34. The distance between the back end of throat 63 and the path of punches 62 determines the distance between the edge of the sheet and the hole 22 punched therein. A micro-switch 66, here shown mounted on the end of motor 51, is contacted by a contactor 67 on the edge of check 63.

A single complete revolution of motor shaft 52 with keyed cheek 53 drives crank arm 56 through approximately 60° and back, forcing punches 62 down and lifting them back up. Microswitch 66 stops motor 51 after one complete 360° rotation when contactor 67 strikes lobe 68 on cheek 53.

D. PRESSURE FOOT MECHANISM

At the commencement of the operation, second strips 26 are placed in the machine on bridge 101 (hereinafter described in detail) in a space shown at the rear edge of platen 41 and immediately forward at the bottom edge of backstop 42. As has previously been mentioned, the lower edge of backstop 42 may flex slightly to accommodate different widths of strips 26. Strips 26 are formed with counterbores 28 which are preferably positioned facing downwardly. The left edge of strip 26 is aligned with guide 44. Etched guidelines

47 on backstop 42 allow rapid visual alignment of second strip 26, the holes 27 in said strip 26 being centered on said guidelines. As an optional feature, a small locating hole 49 may be formed in each strip 26 and a matching pin 48 provided to fit into same to properly align strip 26 without using guide 44. Pin 48 may be recessed into bridge 101 (hereinafter described).

Where it is necessary to do so, the sheets 21 are punched with apertures 22 at predetermined intervals along the back edge in the punch mechanism hereinbefore described. Sheets thus or otherwise punched, are placed on platen 41 and their left edges are aligned with guide 44 thus aligning apertures 22 and holes 27 with guidelines 47 on backstop 42.

Thereupon, strip 24 is applied with the studs 23 inserted through holes 22 and 27. To properly bind the sheets 21 between the strips 24, 26 it is desirable to force the strip 24 downwardly against the sheets and the strip 26 with a predetermined pressure. The mechanism whereby this is accomplished is described in this section of this Specification and is best shown in FIGS. 3 and 4.

Formed in each side plate 46 are front and rear vertical slots 71F, 71R, respectively, each of which has a rearwardly angularly directed offset 72F, 72R. Extending between side plates 46 is transverse pressure foot 73, each end of which is provided with a front and rear follower roller 74F, 74R which is guided by slot 71F and 72F and by slots 71R and 72R, respectively. The shapes of the slots guide the pressure foot 73 so that in its lower movement it reciprocates vertically to a downward position shown in FIGS. 5–8 in solid lines, but in its upward position the pressure foot 73 is rearwardly offset as shown in dotted lines in FIGS. 5 and 6.

Reciprocation of pressure foot 73 is accomplished by mechanism which is actuated by pressure foot motor 76 having a pulley 77 connected by belt 78 to pulley 79 on pressure foot cross shaft 81. On either side of the machine is a screw jack 82 turned by shaft 81 and having a non-rotatable but vertically movable screws 83 vertically disposed on either side of the machine. The upper end 84 of each screw 83 is bifurcated and the lower end of link 86 is pivotally mounted between the bifurcations to oscillate in a longitudinal vertical plane. The upper end of each link 86 is pivoted to spring stem 87 which slides in a cut-out slot 88 through guide hole 94 formed in each end of pressure foot 73. Surrounding stem 87 and within the cutout 88 is a compression spring 89, the lower end of which bears against the bottom of cutout 88 and the upper end of which bears against cap 91 which is fixed to stem 87. An extension 92 on cap 91 slides in a guide hole 93 formed in the pressure foot 73 above opening 88.

When screw 83 is retracted vertically so that the pressure foot 73 is forced downwardly on strip 24 and compresses the sheets 21 against strip 26, further downward movement of screw 83 causes cap 91 to compress spring 89, thereby applying pressure to the sheets. To control the amount of pressure applied, microswitch 95 is connected to pressure foot 73 and is engaged by cap 91 when it has moved to the desired lower limit shown in FIG. 4. Closing of switch 95 stops motor 76 and holds the foot 73 in its full line position shown in FIG. 5 until the additional operations shown in FIGS. 6–8 have been completed. Thereupon, by means hereinafter described in detail, the motor 76 is reversed, causing the pressure foot 73 to be elevated either to its full upward position shown in the dotted lines of FIGS. 5 and 6 or to some intermediate position.

E. CUTTING KNIFE

After the strips 26, 24 and sheets 21 have been placed on the platen 41 supported by bridge 101 and the pressure foot 73 moved down against the strip 24 with predetermined pressure as hereinbefore explained, the mechanism hereinafter described cuts off the excess lengths of studs 23, forms a rough head on the bottom of the stubs of studs 23 and then forces the material from the rough head into the counterbore 28 and cools the same, forming head 29 flush with the bottom surface of strip 26, locking the strip 26 to strip 24, whereupon pressure foot 73 is lifted and the bound book removed.

Extending transversely between plates 46 is bridge 101 located immediately below platen 41 extending rearwardly thereof to a position immediately below backstop 42. The rear edge of bridge 101 is formed with vertical slots 102 corresponding in number and spacing to the studs 23 of strips 24. Thus, when the pressure foot 73 is in downward position, the pointed ends 25 of studs 23 project into slots 102.

Mounted behind backstop 42 is knife assembly 103 which extends transversely of the machine and moves forwardly and rearwardly and also slightly upwardly as hereinafter explained. Projecting from assembly 103 are knife blades 104 which are horizontally disposed along the length of assembly 103 and correspond in number and spacing to the studs 23. Blades 23 are preferably coated with Teflon or plated with Chromium or otherwise treated to prevent the plastic of studs 23 sticking thereto. Interiorly of assembly 103, as best shown in FIG. 5, is an electric cartridge heater 106 in heat transferring relation to blades 104. The rear ends of the blades and heater are captured within transverse horizontal aluminum channel 107 which is held in place by standoffs 108 and surrounded by an insulation box 109, the front of which is closed by face plate 112 through which the blades 104 project. Thermostats 111 and 111A are positioned in proximity to channel 107 and function to control the heat of cartridge 106 and to electrically unlock other parts of the machine.

Assembly 103 is supported at either side of the machine by generally horizontally disposed knife support arm 113 which moves inside plate 46. Directing attention to FIGS. 3 and 9, arm 113 is pivoted to the lower ends of front and rear knife support links 116F and 116R, respectively, said links being immediately inside plate 46. Link 116F is formed with a slot 117 near its upper end to receive pivot 118 fixed to plate 46 and to permit upward movement of link 116F; whereas link 116R is pivoted by means of pivot 119 to plate 46 without provision for upward movement.

Extending transversely horizontally is cam shaft 121, the ends of which are journalled in plates 46, driven by motor 122 by means of pulleys 123 and belt 124. Mounted on the outside of plates 46 on opposite ends of shaft 121 are identical cam bodies 126. On the inward face of each body 126 is a knife horizontal movement control cam groove 127 which controls the inward and the outward movement of assembly 103 from the retracted position of FIG. 5 to the projected position of FIG. 6 and then to the return position of FIG. 8. For such purpose, a follower roller 128 mounted on opposite ends of shaft 129 and located outside plates 46 fits into each groove 127 and also through holes in

link 116R. The shaft 129 which extends across the machine insures that the links 116R oscillate in unison.

Also formed in cam body 126 is cam 131 and on the working face thereof rides knife raising roller 132 which is mounted on cross shaft 133 which extends transversely across the machine. Shaft 133 passes through a hole in link 116F and thus controls upward movement of link 116F. To permit movement of shafts 129 and 133, cutouts 134 are formed in plate 46.

The effect of the shape of cams 127 and 131 is shown in FIGS. 5–8. Under the influence of the shape of cam 127, roller 128 swings link 116R in a counter-clockwise direction from the position of FIG. 3 or 5 to the position of FIG. 6. During this movement, link 116F is in lower position so that the upper end of slot 117 rests on pin 118. Link 116F also swings in counterclockwise position along with link 116R.

Completion of this movment is shown in FIG. 6. Under the influence of shape of cam 131, follower 132 raises link 116F within the limits of slot 117, causing the assembly 103 to be elevated from the dotted line position of FIG. 7 to the solid line position of FIG. 7. The notches 43 in the lower end of backstop 42 provide clearance for the blades 104 in upward position. Retractive movement of assembly 103 from the raised position of FIG. 7 to initial position is controlled by the shape of cams 127 and 131, preferably first downward and then rearward.

The movement from FIG. 5 to FIG. 6 cuts off the studs 23 slightly below the bottom surface of strip 26, the cutoff ends 25 dropping down through slots 102. The upward movement to the position of FIG. 7 heats the stubs of studs 23 remaining below strip 26 and the mass of material is formed in an irregular shaped head, being partially moved into the counterbores 28 in the bottom of strip 26. In some instances the irregularly shaped heads are satisfactory and the heads may be air cooled to harden to hold the book bound together. Where more perfectly formed heads 29 and/or more rapid cooling are desired, then cooling fingers 141, next described, may be installed.

F. FORMING AND COOLING FINGERS

The plastic masses of stub material are optionally but preferably formed with neat heads 29 which are finished smooth and fill the counterbores 28. At the same time, the plastic material is cooled so that strips 24 and 26 are securely bound together.

Directing attention particularly to FIGS. 5 and 8, cooling fingers 141 corresponding in spacing and number to the studs 23, reciprocate in inclined recesses 142 in bridge 101. Each finger 141 is received in a hollow thimble 143 which reciprocates in recess 142 and contains a spring 144 which biases the finger 141 to extended position. However, the force of spring 144 is sufficiently small so that if finger 141 encounters an obstruction, the spring 144 will compress, preventing damage. The upper portion of the exterior of thimble 143 is formed with a rack 146 which meshes with a splined transverse horizontal shaft 147, the ends of which extend outside plates 46. On the outside of plate 46 is a rack 151 which meshes with the end of shaft 147 and is pivoted at its upper end to bell crank 152 which is pivoted to plate 46 by pivot 153. The upper end of bell crank 152 carries a roller follower 154 which fits into the groove 156 of cam body 126. The shape of cam groove 156 is such that fingers 141 are in the retracted positions of FIGS. 5–7 until the assembly 103 has begun its retractive movement. Thereupon, the bell crank 152 is turned in counter-clockwise direction causing rack 151 to reciprocate and to rotate shaft 147. Rotation of shaft 147 in a clockwise direction projects the thimble 143 upwardly and to the left from the positions of FIGS. 5 and 7 to the position of FIG. 8. The ends of fingers 141 are bevelled so that they are parallel to the bottom of strip 26. The projection of fingers 141 moves the plastic stubs on the ends of studs 23 into the counterbores 28 in strip 26 and form neat heads 29 similar to rivet heads which fill flush with the bottom of strip 26 (See FIG. 11). Preferably the fingers 141 are of aluminum or other heat-conductive material which draws the heat from the plastic and causes the plastic to harden. After the heads have had time to harden, the fingers 141 begin to withdraw and the pressure foot 73 is elevated either to the full-up position shown in dotted lines in FIG. 5 or to an intermediate position under the control of the operator. The completed book rivetted construction is best shown in fragmentary cross section in FIG. 11.

G. ELECTRICAL CIRCUITRY

Referring now to the wiring diagram FIG. 12, to start the machine, the operator closes main panel switch PS1 which enables the punch motor 51 to be operated. Upon closing of panel switch PS2, motor 51 is driven to turn punch shaft 57 to lower punches 62. When motor 51 makes one complete revolution of 360°, contactor 67 contacts lobe 68 on cheek 53, tripping switch 66 and stopping motor 51. As has hereinbefore been explained, at times sheets 21 are prepunched, in which case it is unnecessary to close the switch PS2.

Closing of switch PS1 on panel 33 causes current to pass through the cartridge heater 106. When the heat generated by heater 106 is up to the desired minimum range (e.g. 350° F.), thermostat switch 111 closes and light LT1 is illuminated. Companion to thermostat switch 111 is thermostat switch 111A which opens at the maximum desired temperature of the knives 104 (e.g. 400° F.) and which closes before the lower limit of the closing temperature of switch 111 is reached. When switch 111 is closed, "ready" light LT1 is illuminated on panel 33 and the binding cycle can be started. Hence thermostat switch 111 is a locking device which prevents the binding cycle from being activated until the knife blades have reached a certain prescribed minimum temperature; while thermostat switch 111A is a controlling device which fluctuates on and off and maintains a relatively constant cartridge heater temperature.

To bind a book both panel switches PS3 and PS4 are pushed from the "off" (intermediate) position shown in wiring diagram FIG. 12 to "down." PS4 is preferably on the other side of the machine from PS3; thus both hands of the operator must be occupied in closing switches PS3 and PS4, thereby preventing the fingers from being jammed in the mechanism. The closing of switches PS3 and PS4 energizes motor 76 to move bar 73 in a down direction. When switch 95 is actuated by pressure bar 73 reaching an obstacle and the springs 89 being compressed, motor 76 is stopped and LT2 is illuminated. Release of switches PS3 and PS4 allows "RELEASE" lite LT2 to go out.

In normal operation, the pressure bar 73 (controlled by motor 76) remains down for a prolonged period of time. If there is some reason for removing the work from the machine prior to the completion of the cycle,

under the control of the operator PS3 may be moved to "up" position, which reverses motor **76.** In normal operation, however, a lobe **161** on the periphery of cam body **126** contacts micro-switch MS4 (as shown in the mechanical drawings) and since MS5 is then also closed, the motor **76** is reversed. MS5 is normally closed but is located so that it is physically opened when the pressure bar **73** reaches its upper position.

Motor **122** which turns cam **126** (and has solenoid brake SB1 in its circuit) controls movement of assembly **103** and fingers **141.** It is normally energized when micro-switch **95A** (which is physically a companion to **95**) is closed, i.e., when the pressure bar **73** is down and spring **89** compressed to the desired degree to apply the desired compressive force to strip **24.**

MS3, **4** and **6** are controlled by lobe **161** on cam body **126** which has a 10° arcuate length between 350° and 360° of the cycle of rotation of body **126.** When cam body **126** has reached its 350° position and the pressure bar **73** has previously been clamped down, binding motor **122** is stopped because switch MS3 is cammed open by lobe **161.** Simultaneously, MS6 is cammed closed by lobe **161,** overriding micro-switch **95A** which is dependent upon the position of pressure bar spring **89.** Simultaneously, MS4 is cammed closed, starting the pressure bar motor **76** in a direction to raise the pressure bar **73.** The pressure bar **73** continues to move upward until it reaches the top of its movement whereupon it opens switch MS5 and stops motor **76** and also closes MS5A to restart motor **122.** When cam **126** is turning from 350° to 360°, MS6 overrides switch **94A,** and when the cam **126** has reached 360°, MS6 rolls off lobe **161** and functions to stop motor **122.** Thus, switch MS6 is cammed closed at 350° and cammed open at 360°.

Restarting the motor **122** causes the cam **126** to travel from 350° position to 360° position at which time the pressure bar **73** is up. At 360°, MS4 rolls off cam lobe **161** and is reopened and MS6 also rolls off the cam lobe **161** and stops motor **122.**

As viewed in FIG. **13,** double pole panel switch PS5 may be used to control whether the pressure bar **73** is moved to full "up" position (dotted line position of FIGS. **5** and **6**) or stopped automatically at intermediate position. Where only small stacks of sheets **21** are being compressed and the studs **23** are short, it is unnecessary to fully retract the pressure bar **73** to dotted line position and time is saved. As shown in FIG. **13,** one pole of PS **5** in the solid line position controls motor **76** in the same fashion as in FIG. **12.** When this pole is in dotted line position, a switch MS7, which is physically located to be contacted by pressure bar **73** when it reaches a partially up position, stops motor **76.** The other pole of PS5 controls binding motor **122.** Thus, when MS3 is opened when the lobe **161** reaches 350°, either switch MS5A or MS7A restarts motor **122** after pressure bar **73** reaches its intermediate "up" or full "up" position. The switches **5** and **5A** and **7** and **7A** are companion switches which are opened and closed simultaneously by movement of the pressure bar **73.**

Directing attention to FIG. **14,** it is sometimes necessary to remove the heads from the studs **23,** or in other words, to "de-bind" the book. This function is optional. The de-binding is accomplished by a time delay dwell of the hot knives **104** at the top of their strokes (solid line position of FIG. 7). PS6 when manually moved from full line to dotted line position controls the de-binding function. MS9 is controlled by a lobe **161** on cam body **126** at 72° of its cycle of rotation. At 72° the blades **104** are at the top of their movement. When MS9 is opened by lobe **161,** motor **122** is stopped and simultaneously power is applied to terminals **2** and **7** of an electric time delay relay **163,** which may be of the type designated Syracuse electric time delay relay TDR115A153. Upon passage of a preset time delay, such as ten to fifteen seconds, the output terminals transfer from contacts **1** and **4** to contacts **1** and **3,** restarting motor **122.** Reset of timer **163** is accomplished by removal of the input power which is done when the binding motor **122** starts and the cam **126** moves past 72°.

Since the heads **29** on the ends of studs **23** within the counter-bores **28** have been melted beyond their ability to retain the strips in place, when the book is removed from the machine it is merely necessary to pull the strip **26** away from the book to break the bind and permit the book to be disassembled. When it is necessary to rebind, the entire operation is repeated, using new strips **24** and **26.**

H. OPERATION

In normal operation of the machine, switch PS1 is closed by the operator. Where it is necessary to operate the punch, sheets **21** are placed on platen **34** and their left edges brought into contact with side guide **38** (which has been adjusted for the width of sheets **21**) and the rear edges pushed through opening **37** to the back of throat **63.** Thereupon, PS2 is closed causing motor **51** to turn one complete revolution until cam lobe **68** throws micro-switch **66,** causing motor **51** to stop with punch **61** in the "up" position. Where the throat **63** will not accommodate the full load of sheets to be bound, the punching operation is repeated as frequently as is required. Further, it will be understood, the sheets may be formed with holes **22** by other punching means.

Second strip **26** is placed with the counterbores **28** facing downward in the space between the rear edge of platen **41** and the bottom of backstop **42.** The backstop will flex rearwardly slightly if the strips **26** are of extra width. Holes **27** in second strip **26** are aligned with guidelines **47** marked on backstop **42.** Guide **44** is adjusted for the width of sheets **21** and used to align the holes **22** in sheets **21** with the holes **27** in second strip **26.** Thereupon, the sheets **21** are placed on the platen **41** with holes **22** aligned with the holes **27** in strips **26** by guide **44.** Strip **24** is then installed, the studs **23** fitting through the apertures **22** in sheets **21** and also through the holes **27** in strip **26.** It will be understood that at this point the pressure bar **73** is either in full-up (dotted line) position or partially up (a position not shown but heretofore described). When full up, bar **73** is displaced rearward, permitting strips **24** with long studs **23** to be used without bar **73** interfering. However, where short studs are used, bar **73** need be elevated only to intermediate position.

The closing of PS1 has energized heater **106** and when its temperature reaches the desired range, thermostat **111** is closed causing light LT1 to illuminate and indicating to the operator that it is possible to proceed with the binding operation.

The operator then moves PS **3** to "down" position causing motor **76** to start. Preferably, there are two companion switches PS3 and PS4 which must be moved simultaneously in the down movement of motor

76 before the motor 76 will start. This is a safety precaution and it is optional. Pressure bar 73 moves down from up position to the down position shown in FIG. 5. When the bottom of the pressure bar encounters strip 24 it forces downwardly and presses the sheets 21 against the strip 26 which is held in place by the metal of the bridge 101 between the slots 102. The pressure is controlled by switch 95 and when the spring has been compressed to the position of FIG. 4, motor 76 is stopped, by reason of switch 95 being moved from normally closed solid line position to dotted line position.

Movement of switch 95 simultaneously causes movement of switch 95A and this causes motor 122 to turn cam body 126 through 350°. As the cam body 126 turns, it first causes links 116F and 116R to move in counter-clockwise direction as viewed in FIG. 3 and this causes the assembly 103 to move from the retracted position of FIG. 5 to the position of FIG. 6. The hot knives 104 cut the studs 23 a distance slightly below the undersurface of strip 26, the excess lengths 25 dropping down slots 102. Cam 131 then causes the link 116F to be raised to the limit of the length of slot 117 and this raises blade 104 to the position of FIG. 7 (solid line) (an event which occurs preferably in about 72° of rotation of cam body 126). The movement of the hot knife blades 104 deforms the stub ends of studs 23 which extend below strip 26, forcing the material into the counterbores 28. Thereupon, the cam 131 lowers the assembly 103 from the solid line position of FIG. 7 to the dotted line position, and then begins to retract it from the dotted line position of FIG. 7 to the position of FIG. 8 which is the same, insofar as assembly 103 is concerned, as FIG. 5. As the blades 104 retract, cam 156 causes movement of bell crank 152 and thus the rack 151 rotates shaft 147 to cause the fingers 141 to move from the retracted position of FIG. 7 to projected position of FIG. 8. Fingers 141 form neat heads on the ends of the studs 23, completely filling the counterbores 28 level with the undersurface of strip 26 and also withdraw heat from the plastic which causes it to solidify. Thereupon, the fingers 141 retract as the cam body 126 continues to turn.

When body 126 has reached 350° of travel, switch MS3 is opened by cam lobe 161 and motor 122 is stopped. MS4 is closed by the same lobe 161 causing motor 76 to be turned in "up" direction. When pressure bar 73 travels to its up position, MS5 is opened, which stops motor 76 and simultaneously MS5A is closed to restart motor 122. At 350°, MS6 is also closed by lobe 161 which overrides switch 95A. Upon closing of MS5A, the motor 122 turns from 350° to 360°, at which time the switches MS4 and MS6 roll off the cam lobe 161, thereby stopping motor 122 and the cycle is ready for repetition.

As has heretofore been explained, the circuit shown in FIG. 13 may be used to stop the pressure bar 73 at an intermediate up position in order to speed up the binding cycle where short stacks of sheets 21 and short stud lengths 23 are employed. Further, as shown in FIG. 14 and in the description thereof, the same apparatus may be used to de-bind the studs on the bound books.

What is claimed is:

1. Apparatus for binding apertured sheets together using a first strip, a plurality of studs projecting from and spaced longitudinally relative to said first strip and a second strip formed with holes spaced longitudinally of said second strip at intervals complementary to said studs, said apparatus comprising a frame having second strip locating means shaped to receive said second strip, a binding platen adjacent said locating means to support said apertured sheets with their apertures aligned with said holes, a pressure bar movably slidable on said frame formed to engage said first strip and to press said strips toward each other with said studs extending through said apertures and said holes and projecting beyond said second strip, cooperating means on said frame and said pressure bar to move said pressure bar toward said first-mentioned means to bring said strips together with said studs projecting through said holes, said cooperating means including a spring flexible when said pressure bar applies a predetermined pressure on said strips to limit said pressure and to maintain said pressure constant for the remainder of the cycle of operation of said apparatus, and cutting means mounted on said frame and movable to cut off the ends of said studs projecting through said second strip.

2. Apparatus according to claim 1 in which said cooperating means comprises a pressure bar motor mounted on said frame, means articulately connecting said motor and said pressure bar, and cooperating guide means on said frame and said pressure bar, said motor forcing said pressure bar in a direction perpendicular to said platen to compress said strips toward each other.

3. Apparatus according to claim 2 in which said guide means comprises at least one slot having an angularly disposed upper end and said pressure bar has a guide roller fitting in said slot, said slot and guide roller displacing said pressure bar at the upper end of its movement out of said direction perpendicular to said platen.

4. Apparatus according to claim 2 in which said motor advances said pressure bar through a resiliently-biased lost motion connection which flexes as pressure of said pressure bar on said strips increases, and which further comprises a switch actuated by flexure of said connection a pre-selected distance, said switch de-energizing said motor after such flexure through said predetermined distance to regulate the maximum pressure of said pressure bar on said strips.

5. Apparatus according to claim 2 which further comprises a first reversing switch contacted by said pressure bar at the limit of the retractive movement of said bar, a second reversing switch contacted by said bar at an intermediate position of the retractive movement of said bar, an electric circuit, said motor being energized in either direction by said circuit, a manual switch selectively connecting either said first or said second reversing switch into said circuit, said circuit terminating energization of said pressure bar motor in a retractive direction either at a fully retracted position or an intermediate position.

6. Apparatus according to claim 1 which further comprises a punching platen on said frame, a plurality of punches, a punch motor, and means connecting said punch motor for reciprocation of said punches.

7. Apparatus according to claim 1 in which said second strip is formed with at least one second hole spaced offset relative to said first-mentioned holes, and which further comprises a locating pin projecting from said second strip locating means dimensioned to fit into said second hole and to further locate said second strip laterally of said apparatus.

8. Apparatus for binding apertured sheets together using a first strip, a plurality of studs projecting from and spaced longitudinally relative to said first strip and a second strip formed with holes spaced longitudinally of said second strip at intervals complementary to said studs, said apparatus comprising a frame having second strip locating means shaped to receive said second strip, a binding platen adjacent said locating means to support said apertured sheets with their apertures aligned with said holes, a pressure bar movably slidable on said frame formed to engage said first strip and to press said strips toward each other with said studs extending through said apertures and said holes and projecting beyond said second strip, cooperating means on said frame and said pressure bar to move said pressure bar toward said first-mentioned means to bring said strips together with said studs projecting through said holes, cutting means mounted on said frame and movable to cut off the ends of said studs projecting through said second strip, and a plurality of heading means mounted on said frame and actuating means for advancing said heading means against the stub ends of studs cut off by said cutting means to form heads on said ends securing said studs and said strips in assembled position and for retracting said heading means.

9. Apparatus according to claim 8 which further comprises heating means on said cutting means to heat and make plastic said ends, whereby said heading means upset said plastic ends, said heading means being heat conductive to cool said ends.

10. Apparatus for binding apertured sheets together using a first strip, a plurality of studs projecting from and spaced longitudinally relative to said first strip and a second strip formed with holes spaced longitudinally of said second strip at intervals complementary to said studs, said apparatus comprising a frame having second strip locating means shaped to receive said second strip, a binding platen adjacent said locating means to support said apertured sheets with their apertures aligned with said holes, a pressure bar movably slidable on said frame formed to engage said first strip and to press said strips toward each other with said studs extending through said apertures and said holes and projecting beyond said second strip, cooperating means on said frame and said pressure bar to move said pressure bar toward said first-mentioned means to bring said strips together with said studs projecting through said holes, and cutting means mounted on said frame and movable to cut off the ends of said studs projecting through said second strip, said cutting means comprising a plurality of blades, means reciprocating said blades in a direction transverse to said studs and heating means to heat said blades.

11. Apparatus according to claim 10 which further comprises means for reciprocating said blades in a direction toward said second strip to form heads on the stub ends of cut studs.

12. Apparatus according to claim 11 which further comprises means for holding said blades stationary in close proximity to said second strip to melt said heads to debind said strips.

13. Apparatus for binding apertured sheets together using a first strip, a plurality of studs projecting from and spaced longitudinally relative to said first strip and a second strip formed with holes spaced longitudinally of said second strip at intervals complementary to said studs, said apparatus comprising a frame having second strip locating means shaped to receive said second strip, a binding platen adjacent said locating means to support said apertured sheets with their apertures aligned with said holes, a pressure bar movably slidable on said frame formed to engage said first strip and to press said strips toward each other with said studs extending through said apertures and said holes and projecting beyond said second strip, cooperating means on said frame and said pressure bar to move said pressure bar toward said first-mentioned means to bring said strips together with said studs projecting through said holes, and cutting means mounted on said frame and movable to cut off the ends of said studs projecting through said second strip, said cutting means comprising a casing, a plurality of blades projecting from said casing, a heater in said casing to heat said blades, a cam, means for rotating said cam, follower means actuated by said cam articulately connected to said casing for first moving said casing toward said studs so that said blades cut said studs and then moving said casing so that said blades move toward said second strip to deform the severed stub ends of said studs to form heads on said studs and then retracting said casing to initial position.

14. Apparatus according to claim 13 which further comprises forming fingers, means on said frame mounting said fingers for reciprocation toward and away from said second strip, and second follower means actuated by said cam for moving said fingers toward said severed ends to shape said heads, said fingers being heat conductive to cool and set said heads.

15. A method for binding sheets having spaced apertures along a marginal edge to form a book comprising providing a first strip having a plurality of projecting thermoplastic studs spaced longitudinally of said first strip the same distance as said apertures and longer than the thickness of sheets to be bound and a second strip having holes spaced the same distance as said apertures, supporting said second strip in a manner to resist pressure tending to bend said second strip but to permit said studs to project through said holes, supporting said sheets with their apertures aligned with said holes, inserting said studs substantially simultaneously first through said apertures and then through said holes with the ends of said studs extending beyond said second strip, said first strip resting against the topmost sheet, pressing against said first strip to move said first strip toward said second strip and thereby to clamp said sheets between said strips with a predetermined pressure, maintaining said pressure until completion of said binding method, passing heated blades transversely through said studs in the location where they project beyond said second strip to cut off the excess length of said studs and to heat the stub ends of said stubs when cut off, forming heads on said stubs, cooling said heads to secure said strips and sheets in bound condition, and releasing said pressure.

16. A method according to claim 15 in which said step of forming heads is performed by moving said blades into contact with the severed stubs of said studs to make said stubs thermoplastic and then moving said blades toward said second strip to deform said stubs into heads.

17. A method according to claim 16 which further comprises withdrawing said blades and then moving second members toward said heads to shape and cool said heads.

18. A method according to claim 17 in which the face of said second strip opposite said sheets is formed with counterbores aligned with said holes, said members shaping said heads to substantially fill said counterbores.

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