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(54) APPARATUS AND METHOD FOR BINDING BOOKS

(71) We, VELO-BIND INC., formerly known as Abildgaard Laboratories, Inc., a Corporation organised and existing under the Laws of the State of California, United States of America, of 650 Almanor Avenue, Sunnyvale, State of California, 94086, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an apparatus and method for binding apertured sheets to produce a book and is an improvement in or a modification to the invention described in Patent Application No. 6831/70, Serial No. 1305788.

The invention provides an 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 platen table adjacent said locating means to support said apertured sheets with their apertures aligned with said holes, a pressure bar 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, co-operating means comprising a pressure bar motor mounted on said frame, means articulately connecting said motor and said pressure bar, and co-operating guide means on said frame and said pressure bar for guiding the pressure bar, said motor forcing said pressure bar in a direction perpendicular to said platen table to compress one of said strips toward the other, with said studs projecting through said holes, and cutting means to cut off the ends of said studs projecting through said second strip and to form heads on the cut off ends of said studs, said cutting means comprising a plurality of blades, means reciprocating said blades in a direction parallel to said platen table to cut said studs, means to move said blades in a direction to form said heads and heating means to heat said blades.

The invention further provides a method for binding sheets having spaced apertures along a marginal edge to form a book comprising, providing a first strip having 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, inserting said studs through said apertures and said holes, pressing said strips toward each other with said sheets between said strips, cutting off the excess lengths of said studs extending beyond said second strip with heated knife blades and forming heads on the cut off ends of said studs by moving said heated knife blades into contact with the severed studs of said studs to make said stubs plastic, moving said knife blades toward said second strip to deform said stubs into heads, to secure said strips and sheets in bound condition and withdrawing said knife blades.

Some embodiments of the invention will now be described by way of example with reference to the accompanying drawings, in which:—

Fig. 1 is a front elevation of the apparatus.

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. 3A is a side elevation of a portion of the apparatus not shown in Fig. 3.

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

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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. 10A is a view similar to Fig. 3A showing the remainder of the apparatus not shown in Fig. 10.

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

Fig. 12 is a circuit diagram of the apparatus.

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

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

The apparatus hereinafter described is used to bind together either temporarily or permanently and to de-bind 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 gound is likewise subject to variation between a very few sheets and a stack having a thickness which is less than the length of the studs 23 of the strip 24.

First strip 24 is preferably of rectangular cross-section being about 1/4" wide and 1/16" 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" and 1/8" in diameter and may be in length up to about 3".

The second strip 26 also is approximately 1/4" in width and 1/16" 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 butadiene styrene (ABS).

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. 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. 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.

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 cheek 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 in which reciprocate punch cylinders 61 having tongues 60 which fit into slots 58. Thus, when shaft 57 oscillates, the punch cylinders 61 reciprocate 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 cheek 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.

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 first 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, 3A 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 (see Fig. 10A) to pulley 79 no 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 bifurications 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 connecetd 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.

After the strips 26, 24 the 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 studs 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 (Registered Trade Mark) 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 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 ensures that the links 116R oscilalte 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 movement is shown in Fig. 6. Under the influence of the 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.

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 sleeve 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 sleeve 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 Fig. 9 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 forms 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.

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" light 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 PS5 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 "debind" 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 a ten to fifteen seconds, the output terminals transfer from contacts 1 and 4 to contacts 1 and 3, re-starting 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.

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 counter-bores 28 facing downward in the space be-

tween 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 indicate to the operator that it is possible to proceed with the binding operation.

The operator then moves PS3 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 then 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 blades 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 extnd 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 frm 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. Whe 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 switch 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.

It will be appreciated that the present invention 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.

It will further be appreciated that the

apparatus 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, loose-leaf, 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.

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 alternative 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 de-binding the book.

WHAT WE CLAIM IS:—

1. An 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 platen table adjacent said locating means to support said apertured sheets with their apertures aligned with said holes, a pressure bar 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, co-operating means comprising a pressure bar motor mounted on said frame, means articulately connecting said motor and said pressure bar, and co-operating guide means on said frame and said pressure bar for guiding the pressure bar, said motor forcing said pressure bar in a direction perpendicular to said platen table to compress one of said strips toward the other, with said studs projecting through said holes, and cutting means to cut off the ends of said studs projecting through said second strip and to form heads on the cut off ends of said studs, said cutting means comprising a plurality of blades, means reciprocating said blades in a direction parallel to said platen table cut said studs, means to move said blades in a direction to form said heads and heating means to heat said blades.

2. An apparatus as claimed in claim 1 in which said guide means comprises at least one slot in said frame having an angularly disposed upper end and a guide roller mounted on said pressure bar and 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 table.

3. An apparatus as claimed in claim 1 or claim 2 in which said motor advances said pressure bar through a resiliently-biased lost motion connection which flexes as the pressure of said pressure bar on said strips increases, and which further comprises a switch actuated by flexure of said connection through 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.

4. An apparatus as claimed in any of the preceding claims 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, and 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.

5. An apparatus as claimed in any of the preceding claims which further comprises a punching platen on said frame, a plurality of punches, a punch motor, and means connecting said punch motor and said punches for reciprocation of said punches.

6. An apparatus as claimed in any of the preceding claims in which said cutting means comprises 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 and articulately connected to said casing for first moving said casing toward said studs so that the 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 its initial position.

7. An apparatus as claimed in claim 6 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.

8. A method for binding sheets having spaced apertures along a marginal edge to form a book comprising, providing a first strip having projecting thermoplastic studs

apparatus 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, loose-leaf, 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.

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WHAT WE CLAIM IS:—

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2. An apparatus as claimed in claim 1 in which said guide means comprises at least one slot in said frame having an angularly disposed upper end and a guide roller mounted on said pressure bar and 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 table.

3. An apparatus as claimed in claim 1 or claim 2 in which said motor advances said pressure bar through a resiliently-biased lost motion connection which flexes as the pressure of said pressure bar on said strips increases, and which further comprises a switch actuated by flexure of said connection through 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.

4. An apparatus as claimed in any of the preceding claims 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, and 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.

5. An apparatus as claimed in any of the preceding claims which further comprises a punching platen on said frame, a plurality of punches, a punch motor, and means connecting said punch motor and said punches for reciprocation of said punches.

6. An apparatus as claimed in any of the preceding claims in which said cutting means comprises 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 and articulately connected to said casing for first moving said casing toward said studs so that the 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 its initial position.

7. An apparatus as claimed in claim 6 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.

8. A method for binding sheets having spaced apertures along a marginal edge to form a book comprising, providing a first strip having projecting thermoplastic studs

* C L M S *

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, inserting said studs through said apertures and said holes, pressing said strips towards each other with said sheets between said strips, cutting off the excess lengths of said studs extending beyond said second strip with heated knife blades and forming on the cut off ends of said studs by moving said heated knife blades into contact with the severed stubs of said studs to make said stubs plastic, moving said knife blades toward said second strip to deform said stubs into heads, to secure said strips and sheet in bound condition and withdrawing said knife blades.

9. A method as claimed in claim 8, wherein means are moved towards said heads to shape and cool the heads.

10. An apparatus substantially as hereinbefore described with reference to and as illustrated by the accompanying drawings.

11. A method for binding sheets substantially as hereinbefore dscribed.

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