

Dec. 23, 1941.

W. F. HUCK

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SHEET REGISTERING MECHANISM

Filed June 8, 1940

4 Sheets-Sheet 1

Fig. 1.

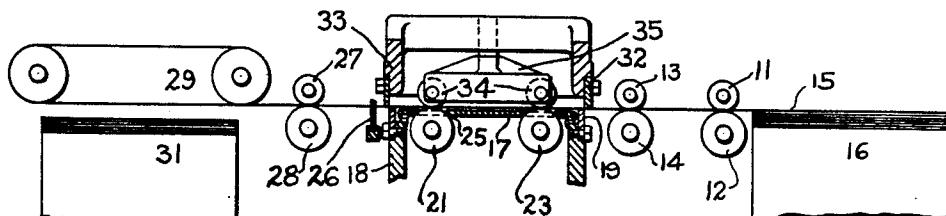


Fig. 3.

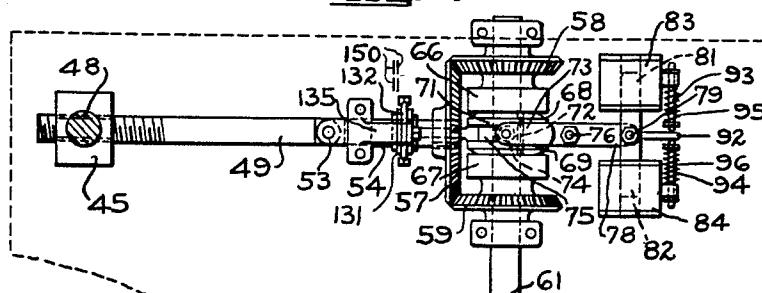


Fig. 2.

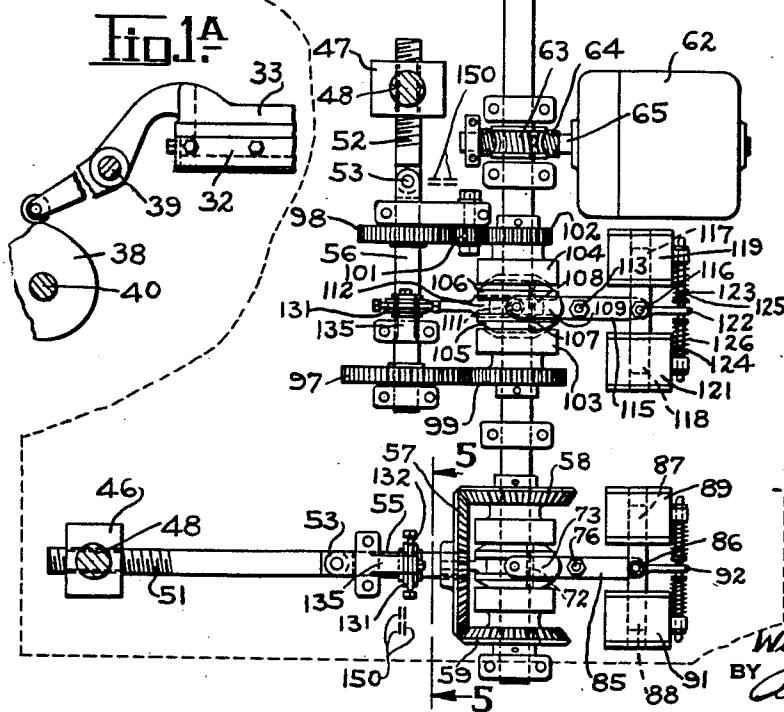
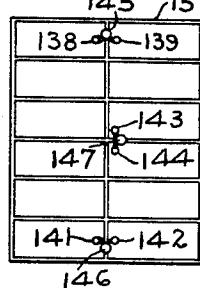
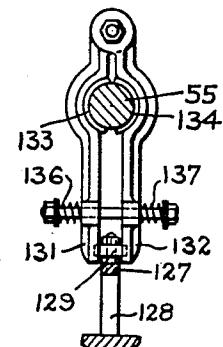


Fig. 5.



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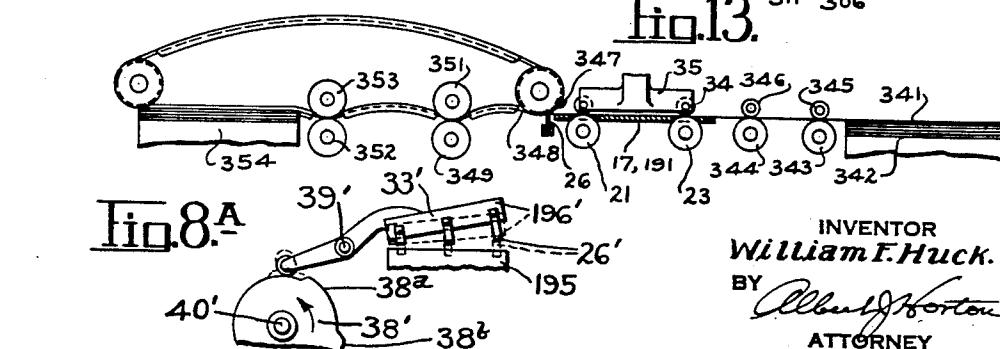
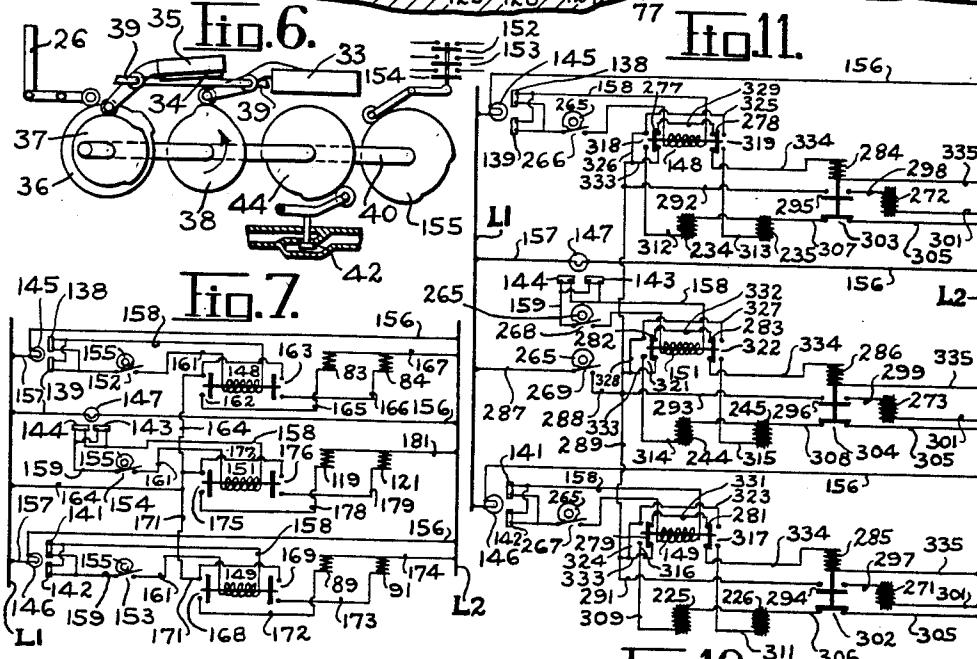
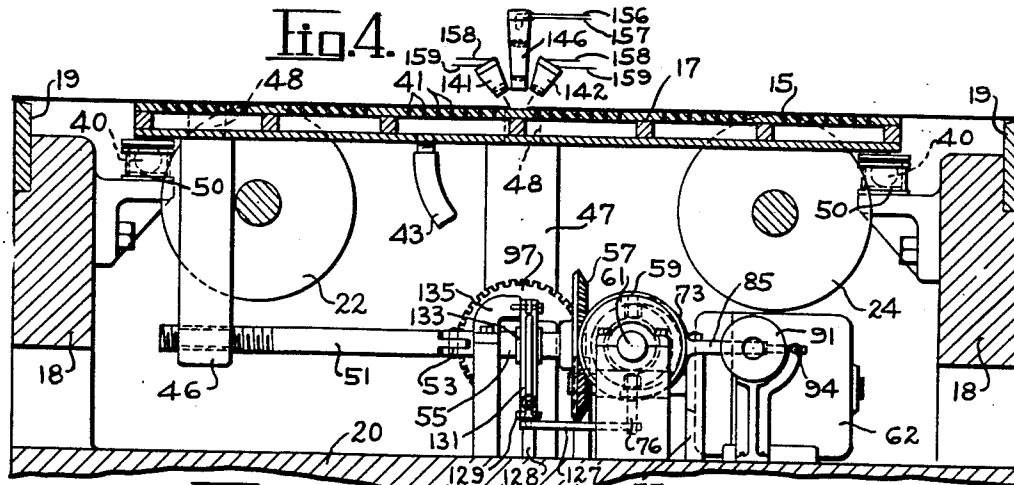
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SHEET REGISTERING MECHANISM

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4 Sheets-Sheet 2



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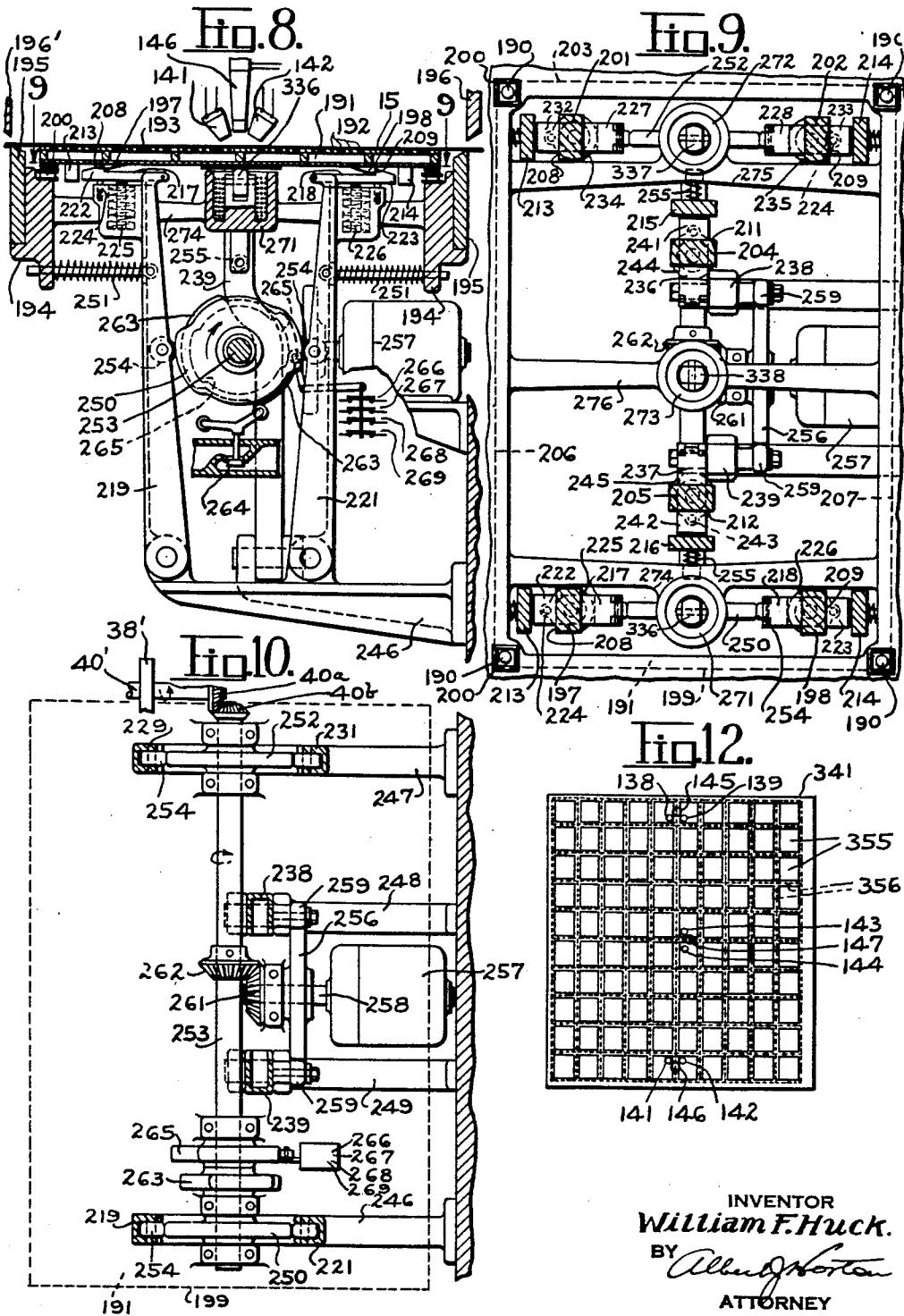
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SHEET REGISTERING MECHANISM

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4 Sheets-Sheet 3



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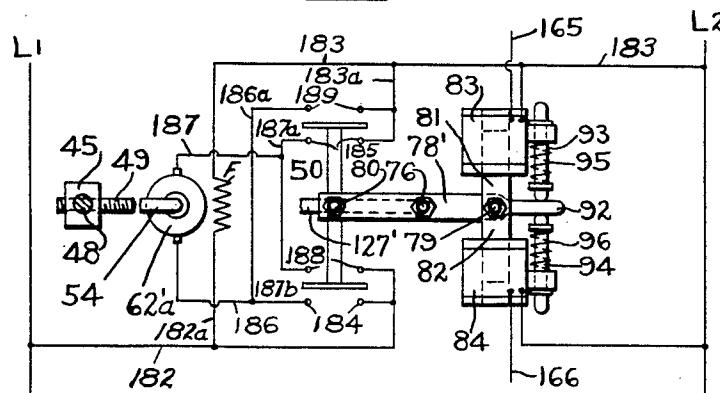
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SHEET REGISTERING MECHANISM

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4 Sheets-Sheet 4

FIG 14



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UNITED STATES PATENT OFFICE

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SHEET REGISTERING MECHANISM

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Application June 8, 1940, Serial No. 339,440

24 Claims. (CL 164—42)

This invention relates to sheet registering mechanism and more particularly to a mechanism for registering an impression printed on a sheet, with respect to components of a machine adapted to trim the sheet, perforate it, or perform any operation that must register with the impression.

In sheet trimming machines of the type used for trimming printed sheets of bank notes, and in sheet perforating machines of the type used for perforating printed sheets of postage stamps, it is particularly desirable that the trimmed edges, and rows of perforations be in register with the impressions printed on the sheets. To obtain this desideratum, it is contemplated as one object of this invention, to provide an improved sheet registering mechanism.

Another object of this invention is to provide in a machine having means to operate upon a printed sheet, means to move the sheet to register the printed impressions with respect to the operating means, and then to hold the sheet in such position during the subsequent operation.

A further object of this invention is to provide in a machine having means for operating upon a printed sheet, means to move the printed sheet in any direction in the same plane to register the printed impressions thereon with the means for operating on the sheet, such as the trimming or perforating means, and means to hold the sheet during the registering and machine operations.

A still further object of this invention is to provide in a printed sheet registering mechanism photo-electric means adapted to be actuated by the printed impressions on the sheet to control the operations of the said registering mechanism.

It is also an object of this invention to provide a sheet registering mechanism of generally improved construction, whereby the device will be simple, durable and inexpensive in construction, as well as convenient, practical, serviceable and efficient in its use.

With the foregoing and other objects in view, which will appear as the description proceeds, the invention resides in the combination and arrangement of parts, and in the details of construction hereinafter described and claimed.

The preferred embodiment of the invention is illustrated in the accompanying drawings, wherein:

Figure 1 is a schematic layout of a sheet trimming machine to which the registering mechanism of this invention is shown applied;

Figure 1A is a schematic side view of the sheet trimming means shown in Figure 1;

Figure 2 illustrates a printed sheet, such as a sheet of bank notes, the edges of which the machine shown in Figure 1 is adapted to trim in accurate register with the printed impressions;

Figure 3 shows a top plan view of one form of mechanism for registering a printed sheet which includes a sheet holding plate, herein shown in dotted lines for the sake of clearness and means for moving it as required to effect registration;

Figure 4 is a cross sectional view of the sheet holding plate, and an end view of the sheet registering mechanism, shown in Figure 3, in operative association with the sheet holding plate;

Figure 5 is an enlarged cross sectional view taken on the line 5—5 of Figure 3 and showing an end view of a brake device adapted for use with this mechanism;

Figure 6 is a schematic layout of the cams used in the sheet trimming machine illustrated in Figure 1 for timing the various operations thereof;

Figure 7 is a schematic electrical diagram showing the photo-electric control mechanism of the invention as disclosed in Figures 3 and 4;

Figure 8 is a vertical cross sectional view of another form of sheet registering mechanism;

Figure 8A is a schematic side view of a somewhat modified form of sheet trimming means;

Figure 9 is a top plan view of the mechanism shown in Figure 8 looking in the direction of the arrows 9—9 in that figure and indicating the sheet holding plate in dotted lines;

Figure 10 is a sectional view of the mechanism shown in Figure 8 taken below the sheet holding plate supporting frame and showing the motor driven shafts and cams for effecting movements of the sheet holding plate;

Figure 11 is a schematic electrical diagram showing the photo-electrical control mechanism of the invention as disclosed in Figures 8, 9 and 10;

Figure 12 illustrates a printed sheet, such as a sheet of postage stamps which requires registering of the printed impressions thereon with respect to the perforating mechanism before being perforated;

Figure 13 is a schematic layout of a sheet perforating machine adapted to perforate the printed sheet shown in Figure 12 and to which either of the sheet registering mechanisms of this invention may be applied; and

Figure 14 is a schematic layout of a somewhat modified arrangement for moving a sheet hold-

ing plate, wherein individual electric motors are used instead of the clutches shown in Figure 3.

Referring now to the drawings and particularly to Figures 1-7 inclusive wherein one form of the invention is illustrated, the trimming machine illustrated schematically in Figure 1 includes means such as cooperating pairs of rollers 11, 12 and 13, 14, rollers 12 and 14 being driven ones to feed printed sheets 15 from a pile 16 thereof toward a plate 17 disposed within a rectangular sheet trimming frame 18 supported on a base 20 and having upwardly facing knife edges 19 around its upper peripheral edge. Four driven rollers 21 and 23 (shown on Figure 1), and 22 and 24 (shown on Figure 4), extend through slots 25 in the plate 17 to engage a sheet 15 thereon to feed it along over the plate against a movable stop member 26, whereby the sheet 15 is initially located with respect to the knife edges 19. Beyond the stop member 26 a free running roller 27 and a driven roller 28 are adapted to engage the sheet 15, after it is trimmed and fed along by the rollers 21-24 inclusive, to feed it to a carrier device 29 wherefrom the sheet is delivered to a pile 31.

The knife edges 19 cooperate with corresponding knife edges 32 carried by a cam operated swinging frame 33 to trim the edges of the sheet 15 as it is held upon the plate 17. Four rollers 34 carried by a cam operated swinging open frame 35 cooperate with the driven rollers 21-24 inclusive to feed the trimmed sheets 15 upon and from the plate 17. Cams 36, 37 and 38 (shown schematically in Figure 6) are secured to a shaft 40 rotatably supported in the frame 20, and driven in timed relation with the sheet feeding rollers 12, 14, 21-24 inclusive and 28 from the machine drive. The shaft 40 is rotated once for each complete cycle of operation of the machine, the several cams operating in sequence. The cam 36 raises the stop member 26 into position to locate a sheet 15 being fed over the plate 17, the cam 37 then lowers the frame 35 to engage the rollers 34 with the rollers 21-24 inclusive, the cam 38 then lowers and raises the knife carrying frame 33 to trim the edges of a sheet by the cooperating action of the knives 19 and 32, the cam 36 then lowers the stop member 26, and the cam 37 raises the frame 35, while the frame 33 is raised. The frames 33 and 35, as herein shown, are pivotally supported by a shaft 39, but may obviously be arranged in any other suitable manner.

The plate 17 (see Figure 4) is hollow and has a plurality of perforations 41 in its upper wall by means of which a suction pump (not shown), but which is connected to the plate 17 through a cam actuated valve 42 (Figure 6) and a tube 43, will act to hold a sheet 15 upon the upper surface of the plate 17. The valve 42 is arranged to be opened by a cam 44 as soon as a sheet 15 has been disposed on the plate 17 by the rollers 21-24 inclusive and 34. The plate 17 is movably supported for movement in any direction in a horizontal plane, on balls 40 carried in boxes 59 mounted upon the frame 18 and positioned under each corner of the plate 17. Posts 45, 46, 47 (Figure 3) having cylindrical ends 48 which extend upwardly into the plate 17, to permit pivotal movement between the respective posts and the plate 17, also extend downwardly from the plate 17 (as shown in Figure 4) to be engaged by screw threaded rods 49, 51 and 52 respectively.

The threaded rods 49, 51 and 52 are screw

threaded into and through the posts 45, 46 and 47 respectively, and upon being rotated, will effect a swinging movement of the plate 17. The axes of the rods 49 and 51 are substantially parallel while the axis of the rod 52 is perpendicular to the axes of the rods 49 and 51. By selection of the rod or rods 49, 51 or 52 to be rotated, and of the direction of rotation thereof, the plate 17 may be moved in any direction in a horizontal plane to effect registration of a sheet 15 held by suction to the plate 17 with the trimming knives 19 and 32.

Instead of using the clutch operating solenoids 83, 84, 89, 91 and 119, 121, as shown in Figure 7 and described hereinafter, the rods 49, 51 and 52 may be rotated in either direction by separate reversible motors, under control of a means to detect faulty register of the printed impressions, the detecting means being arranged to actuate suitable electrical devices for reversing the motors. Such an arrangement is diagrammatically shown in Figure 14 and will be herein-after described.

The rods 49, 51 and 52 are each herein shown connected by universal joints 53 to one end of shafts 54, 55 and 56 respectively. The shafts 54 and 55 are arranged to be rotated in supports fixed to the base 20 by means which includes a bevel gear 57 secured on the other ends of the shafts 54 and 55. The bevel gear 57 is in mesh with opposing bevel gears 58 and 59 mounted for free rotation on a shaft 61 driven by a motor 62 through a worm-wheel 63 secured on the shaft 61 and a worm 64 secured on the motor shaft 65.

Clutch members 66 and 67 are formed integral with, or secured to, the bevel gears 58 and 59 respectively and are disposed in opposed spaced apart relation on the shaft 61 to be selectively engaged by oppositely directed clutch portions 68 and 69 of a sleeve 71 axially slidable on the shaft 61 while being secured thereto by a key 72 on which they slide. A clutch sleeve shifting fork 73, carrying rollers 74 adapted to ride in an annular groove 75 formed in the sleeve 71, is pivoted at 76 to a stationary post 77. The sleeve shifting fork 73 controlling the rotation of the shaft 54, has a portion 78 extending beyond its pivot 76 into connection at 79, with slideable plungers 81 and 82 of a pair of opposed electrical solenoids 83 and 84 respectively. The fork 73 controlling the rotation of the shaft 55 has a portion 85 extending beyond its pivot 76 into connection at 86 with slideable plungers 87 and 88 of solenoids 89 and 91. A tongue 92, extended beyond the extending portions 78 and 85, is engaged by the ends of opposed rods 93 and 94 pressed thereagainst by springs 95 and 96 respectively, to normally hold the clutch shifting forks 73 in a central position, whereby the clutch portions 68 and 69 of the sleeve 71 will be normally held in a neutral position and out of engagement with the clutch members 66 and 67 respectively.

The shaft 56 is adapted to be rotated in supports fixed to the base 20 and in either direction, by having spur gears 97 and 98 secured thereon which are in mesh respectively with a spur gear 99 and an idler gear 101, the idler gear 101 being in mesh with a spur gear 102. The spur gears 99 and 102 are mounted for free rotation upon the shaft 61 and have clutch members 103 and 104 respectively formed integral therewith, which are disposed in opposed spaced apart relation on the shaft 61 to be selectively engaged by oppositely directed clutch portions 105 and

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106 of a sleeve 107 axially slidable on the shaft 61 and secured thereto for rotation therewith by a key 108. A clutch sleeve shifting fork 109, carrying rollers 111 adapted to ride in an annular groove 112 formed in the sleeve 107, is pivoted at 113 to a stationary post 11. The fork 109 has a portion 115 extending beyond its pivot 113 into connection at 116 with slidable plungers 117 and 118 of a pair of opposed electrical solenoids 119 and 121 respectively. A tongue 122 extends beyond the extending portion 115 and is engaged by the ends of opposing rods 123 and 124 pressed thereagainst by springs 125 and 126 respectively, to normally hold the clutch shifting forks 109 in neutral position and the clutch portions and members normally disengaged.

From the above, it will be understood that energization of either of the solenoids 83 or 84 will connect the threaded rod 49 to the driven shaft 61 through the clutch portions 68 or 69 and members 66 or 67. Rotation of the rod 49 will tend to shift one side of the plate 17 generally forward or backward with respect to the direction of the feed of the sheet 15 and about the pivot 48 at the post 46. Likewise, the energization of either of the solenoids 89 or 91 will cause rotation of the rod 51 and tend to shift the opposite side of the plate 17 generally about the pivot 48 at the post 45. Rotation of the rod 52 by energization of the solenoid 119 or 121 will tend to shift the plate 17 generally transversely to the direction of the feed of the sheet 15. It will also be seen that simultaneous rotation of the rods 49 and 51 in the same direction will move the plate 17 either forward or backward in the line of its travel, and if they are simultaneously moved in opposite directions the plate will be swung about the pivot 48 at the post 47. Thus, selective energization of the solenoids 83, 84, 89, 91, 119, 121, under the control of means affected by the position of a printed impression on a printed sheet, will cause the rotation of the rods 49, 51 or 52 to shift the plate 17 in any direction in a horizontal plane to effect the proper register of the printed impressions on the sheet 15 with the knife edges 19 and 32 to insure the proper operation thereof to trim the sheet in register with the printing.

In order to insure that the registering movements of the rods 49, 51 and 52 will not overrun beyond the desired amount, brake mechanisms are provided to act upon each of the shafts 54, 55 and 56 when the clutch sleeve shifting forks are in neutral position. This brake mechanism includes an arm 127 (Figures 4 and 5), one end of which is pivotally connected to and extends from each of the forks to a stationary post 128 to which its other end is pivoted. A cam member 129 is carried by the end of the arm 127 at the post 128 and is adapted to act upon the lower ends of a pair of opposed swingable arms 131 and 132 to spread them apart and thus release brake shoes 133 and 134 from engagement with the respective shaft 54, 55 and 56 with which they are associated. The arms 131 and 132 are pivoted together at their upper ends and to a stationary bracket 135. Oppositely acting springs 136 and 137 acting on the arms 131 and 132, tend to normally maintain the brake shoes in braking engagement with the respective shaft with which they are associated.

The means disclosed herein for automatically and selectively energizing the solenoids 83, 84, 89, 91, 119 and 121 includes three pairs of photo-electric cells 138-139, 141-142 and 143-144

(Figure 2) and a source of light for each pair of cells such as lamps 145, 146 and 147 respectively. Each pair of cells with its associated light source is disposed to be effected in this instance by the printed impressions on the printed sheet 15. The three pairs of photo-electric cells 138-139, 141-142, and 143-144 and the lamps 145, 146, and 147 may be mounted in any convenient manner, such as on a stationary support extending from the rear frame of the machine, to a location within the open frame 35 which supports the rollers 34, clearance being provided to permit the small vertical motion of the frame that occurs during operation. As an illustration, the photo-cells are directed at the adjacent edges of printed impressions, such as those on a sheet of bank notes, one pair 138, 139 being disposed adjacent the top of the sheet and affected by vertical edges, one pair 141, 142 being disposed adjacent the bottom of the sheet and affected by vertical edges, and the other pair, 143, 144, being disposed adjacent the center of the sheet and affected by horizontal edges. Each of the photo-cells controls one of the solenoids through polarized relays 148, 149, and 151 (Figure 7), one relay for each pair of cells.

The arrangement is such that each pair of cells is connected into the circuit of the respective polarized relay by switches 152, 153 and 154. These switches are simultaneously closed by a cam 155 rotated in timed relation with the cams 36, 37 and 38 (Figure 6), so that the cells will be placed in operative condition after a sheet 15 has been initially disposed on the plate 17 and held thereagainst by suction, and before the knife carrying frame 33 is lowered to trim the sheet. Referring particularly to Figure 7, the electrical circuit arrangement schematically shown therein includes line wires L1 and L2. The light sources 145, 146, and 147 are respectively connected between the line wire L1 and L2 by conductors 156 and 157. One terminal of each cell of each pair is connected by a conductor 158 to its associated relay 148, 149 or 151, and the other terminal of each cell of each pair is connected by a conductor 159 to the associated switch 152, 153 or 154. Each of the switches 152, 153 or 154 is connected by a conductor 161 to the respective relay 148, 149 or 151. The relay 148 is arranged to close normally open switches 162 and 163, one terminal of each of which is connected to the other and to the line wire L1 by a conductor 164. The other terminal of the switch 162 is connected by a conductor 165 to the solenoid 83, and the other terminal of the switch 163 is connected by a conductor 166 to the solenoid 84. The solenoids 83 and 84 are commonly connected to the line wire L2 by a conductor 167.

The relay 149 is arranged to close normally open switches 168 and 169, one terminal of each of which is connected to the other and to the line wire L1 by a conductor 171. The other terminal of the switch 168 is connected by a conductor 172 to the solenoid 89 and the other terminal of the switch 169 is connected by a conductor 173 to the solenoid 91. The solenoids 83 and 91 are commonly connected to the line wire L2 by a conductor 174. The relay 151 is arranged to close normally open switches 175 and 176, one terminal of each of which is connected to the other and to the line wire L1 by a conductor 177. The other terminal of the switch 175 is connected by a conductor 178 to the solenoid 119 and the other terminal of the switch 176 is connected by a con-

ductor 179 to the solenoid 121. The solenoids 119 and 121 are commonly connected to the line wire L2 by a conductor 181.

Briefly the operation of the above described sheet trimming machine and the sheet registering mechanism is as follows: A sheet 15 fed from the pile 16 by rollers 12 and 14, and 23, 24 and 21, 22 to a position upon the plate 17, is initially located thereon by the stop member 26. The cam 44 now actuates the valve 42 to apply a suction to the sheet 15 to firmly hold it against the plate 17, and the cam 37 actuates the frame 35 to raise the pressure rollers 34 from the sheet 15. The cam 155 now closes the switches 152, 153 and 154, placing the cells 138-144 inclusive in operative condition in respect to the relays 148, 149 and 151. Should the sheet 15 be out of register, the change in the ratio of the light reflected by the edge of the printed impression, to the light reflected from the unprinted margin space, will affect at least one of the photo-cells, which in turn will actuate its relay switch and energize one of the solenoids 83, 84, 89, 91, 119 or 121 to cause the rotation in the proper direction of the proper threaded rod 49, 51 or 52 and shift the sheet 15 through shifting of the plate 17 and thus register the printed impression with the trimming means 19, 32. When the sheet is in register the light received by each photo-cell and its mate is in balance and the relays 148, 149 and 151 remain in normal position and the rods 49, 51 and 52 are at rest. If the sheet is out of register both laterally and longitudinally, two of the photo-cells will be affected simultaneously and both of the corresponding correcting mechanisms will operate together.

After a suitable interval of time allowed for sheet registering action has elapsed, the cam 155 opens the switches 152, 153 and 154, and the cam 38 allows the frame 33 to be lowered to trim the sheet. After the sheet 15 is trimmed, the cam 38 raises the frame 33, the cam 44 closes the valve 42 to shut off the suction and free the sheet 15 from the plate 17, the cam 37 lowers the frame 35 to dispose the pressure rollers 34 into cooperating relation with the feed rollers 21, 22, 23 and 24, and the cam 36 lowers the stop member 26 to permit the trimmed sheet 15 to be fed from the plate 17 to be picked up by the rollers 27 and 28 and fed to the delivery 29. Before the next cycle of the above operations starts, the plate 17 is preferably brought back into substantially a central position before another sheet 15 is fed thereto, by closing the switches 152, 153 and 154 by proper timing of the cam 155 to connect the cells 138-144 with the respective relays 148-151. Marks, indicated by dotted lines 160 (Figure 3) on the plate 17 affect the cells to cause such adjustment of the plate 17.

As hereinbefore stated, separate reversible motors may be used in place of the clutch arrangement shown in Figure 3 to rotate the rods 49, 51 and 52 through the shafts 54, 55 and 56. Figure 14, in which similarity to the upper portion of Figure 3 will be noticed, illustrates the use of a separate reversible motor 62a for rotating the rod 49 through the shaft 54, and it will be understood that the rods 51 and 52 of Figure 3 may be rotated in like manner through shafts 55 and 56, each connected to another motor like 62a. In this arrangement, the solenoids 83 and 84, instead of actuating the clutch mechanism of Figure 3, actuate a motor reversing switch 50, and thus the rods 49, 51 or 52 may be rotated in either direction under the control of the respective photo-

to-electric cells 138-139, 141-142 and 143-144 through the instrumentality of the respective solenoids 83-84, 89-91 and 119-121.

In Figure 14, the solenoids 83 and 84 are arranged to be operated by the respective photo-electric cells 138-139 through conductors 165-166 in the same manner as shown in Figure 7. In this instance, slideable plungers 81 and 82 are operably connected to a bar 78' instead of the portion 78 of the sleeve shifting fork 73. The bar 78' is pivoted at 76' and connected at 80' to the motor reversing switch 50, so swinging movement of the bar 78' will operate the reversing switch in the well known manner and cause the motor 62' to rotate the rod 49 through the shaft 54 in the direction required to properly move the plate 17 to register a sheet 15. An extension 127' may be provided on the bar 78' to actuate a brake, as in the previously described form.

The circuit to the field of the motor as shown in Figure 14, may be traced from L1 through conductors 182 and 182a, through the motor field F and thence through conductor 183 to L2. Rotation of the shaft 49 in one direction will result when the solenoid 83 is energized, for the reversing switch 50 will be moved to bridge the contacts 184 and 185, thereby establishing a circuit from L1 through conductor 182, contacts 184, conductor 186, armature of motor 62a, and thence through conductors 187 and 187a, contacts 185, conductors 183a and 183 to line L2. Rotation of the shaft 49 in the opposite direction results, when the solenoid 84 is energized, for the reversing switch will then be moved in the opposite direction to bridge contacts 188 and 189, thus establishing a circuit from L1 through conductor 182, contacts 188, conductors 187b and 187 to the armature of motor 62a, then passing through the armature in the reverse direction from that previously described, and through conductors 186 and 186a, contacts 189, and conductors 183a and 183 to line L2.

Referring now to the form of sheet registering mechanism shown in Figures 8-11 inclusive, the sheet 15 is fed as above described into position over a hollow plate 191 having perforations 192 through its upper wall 193, whereby suction may be used to hold the sheet 15 thereagainst. The plate 191 is supported by balls 190 in boxes 200 mounted upon the upper edge surfaces of a stationary frame 194 carrying in this instance, the lower sheet trimming knives 195. The upper knives 196' may be secured to a swinging cam operated frame 33' as in the previous form. The photo-cells 138-144 inclusive (Figure 12), and the light sources 145, 146 and 147 are used with this form of mechanism, and the cells are connected to the polarized relays 148, 149 and 151 in the same manner (see Figure 11).

In the form of the invention previously described, a separate cam operated sheet stop 26 was provided, but in this form, sheet stops 26' are secured to the left hand knife 196' (Figures 8 and 8A), to swing therewith. The arrangement is such that the cam 38' provided to lower and raise the knife frame 33' has a camming surface 38a which permits the frame 33' to be held at an intermediate elevation to present the stops 26' in front of the forward edge of the moving sheet while holding the knives separated sufficiently to allow a sheet to pass between them (see dotted lines in Figure 8A). The camming surface 38a is disposed ahead of the camming surface 38b which latter surface acts to permit the knives to lower to trim the sheet. In this form, the shaft 40' is

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driven in timed relation with the cams 250, 263 and 265 by being drivingly connected to the shaft 253 by bevel gears 40a and 40b (Figure 10).

While in the form shown in Figures 1 to 7, the plate 17 was adapted to be shifted in any direction in the same plane to register a sheet 15 by mechanical means actuated by solenoids controlled by the photo-cells, in this form, the plate 191 is adapted to be shifted by a combination of magnetic and mechanical means. This combination includes a pair of catch lugs 197 and 198 formed integral with, or secured to, the underside of the plate 191 adjacent a side edge 199 and being spaced apart in the direction of the feed of the sheets 15. Another pair of catch lugs 201 and 202 identically formed and spaced apart, are disposed adjacent the other side edge 203 of the plate 191. Still another pair of catch lugs 204 and 205 are formed integral with or secured to the underside of the plate 191, and are spaced apart transversely to the direction of the feed of the sheets 15, and are disposed substantially on the medial line of the plate 191, between its opposite edges 206 and 207. The catch lugs 197, 201 and 198, 202 have their catch shoulders 208 and 209 facing the opposite edges 206 and 207 respectively of the plate, while the catch lugs 204 and 205 have their catch shoulders 211 and 212 facing the side edges 203 and 199 respectively of the plate 191.

Stop lugs 213 and 214 also formed integral with or secured to the plate 191, depend from its underside and are spaced from the catch shoulders 208 and 209 of the catch lugs 197, 201 and 198, 202 respectively toward the opposite plate edges 206 and 207. Other stop lugs 215 and 216, likewise formed integral with or secured to the plate 191, depend therefrom and are spaced from the catch shoulders 211 and 212 toward the opposite plate edges 203 and 199 respectively of the plate 191. Catch arms 217 and 218, pivotally fastened to opposed swingable elongated arms 219 and 221 respectively, extend outwardly therefrom toward the opposite plate edges 206 and 207 respectively and are adjacent the plate edge 199. Catch members 222 and 223 on the free ends of the arms 217 and 218, are adapted to normally lie in engagement with the catch shoulders 208 and 209 of the catch lugs 197 and 198 respectively by the upward urge of spring pressed pins 224. The catch arms 217 and 218 extend over electromagnets 225 and 226 respectively, which are respectively carried by and at the upper ends of the arms 219 and 221, and when energized, act upon the catch arms 217 and 218 to pull them downwardly and disengage the catch members 222 and 223 from the respective catch shoulders 208 and 209. The catch members 222 and 223 are disposed between the catch shoulders 208 and 209 and the stop lugs 213 and 214 and their outer ends are adapted to engage these stop lugs when the elongated arms 219 and 221 are swung outwardly by the cam 250, thereby moving the adjacent end of the plate 191 to a central position between the knives 195 acting on the forward and rear edges of the sheet.

Catch arms 227 and 228, pivotally fastened to opposed swingable elongated arms 229 and 231 respectively (Figure 10), extend outwardly therefrom toward the plate side edges 206 and 207 respectively and are adjacent the plate edge 203. Catch members 232 and 233 (Figure 9) on the free ends of the arms 227 and 228, are adapted to normally lie in engagement with the catch shoulders 208 and 209 of the catch lugs 201 and

202 respectively by the upward urge of spring pressed pins 224. The catch arms 227 and 228 extend over electromagnets 234 and 235 respectively, which are respectively carried by and at the upper ends of the arms 229 and 231, and when energized, act upon the catch arms 227 and 228 to pull them downwardly and disengage the catch members 232 and 233 from the respective catch shoulders 208 and 209. The catch members 232 and 233 are disposed between the catch shoulders 208 and 209, and the stop lugs 213 and 214 and their outer ends are adapted to engage these stop lugs when the elongated arms 229 and 231 are swung outwardly by the cam 252, and similarly center the adjacent end of the plate 191.

Similar catch arms 236 and 237 pivotally fastened to opposed swingable elongated arms 238 and 239 respectively extend outwardly therefrom toward the plate side edges 203 and 199 respectively. Catch members 241 and 242 on the free ends of the arms 236 and 237 are adapted to normally lie in engagement with the catch shoulders 211 and 212 of the catch lugs 204 and 205 respectively, by the upward urge of spring pressed pins 243. The catch arms 236 and 237 extend over electromagnets 244 and 245 respectively, which are carried by and at the upper ends of the arms 238 and 239, and when the magnets are energized, they act upon the catch arms 236 and 237 to pull them downwardly and disengage the catch members 241 and 242 from the respective catch shoulders 211 and 212, in a manner similar to the action of the magnets carried by the arms 219—221, and 229—231. The catch members 241 and 242 are disposed between the catch shoulders 211 and 212 and the stop lugs 215 and 216, and their outer ends are adapted to engage these stop lugs when the elongated arms 238 and 239 are swung outward by the cam 256 thereby moving the plate 191 to a central position between the knives 195 that cut the side edges of the sheet.

The elongated arms 219 and 221 extend downwardly and are pivoted to a stationary bracket 246, and the elongated arms 229 and 231 are similarly arranged and extend downwardly and are pivoted to a stationary bracket 247. The elongated arms 238 and 239 extend downwardly and are pivoted to stationary brackets 248 and 249 respectively. A compression spring 251 (Figure 8) is provided adjacent the upper end of each of the elongated arms 219, 221, 229 and 231, and are arranged to react between the respective arm and the stationary frame 194 to constantly urge the opposed arms 219, 221, and 229, 231 toward each other. Cams 250 and 252 are secured to a cross shaft 253, and are disposed respectively between each pair of opposed arms 219, 221, and 229, 231 to be engaged by a roller 254 mounted on each of the arms. A compression spring 255 (Figure 9) is provided adjacent the upper end of each of the elongated arms 238 and 239 to constantly urge them toward each other. A cam 256 (Figure 10) secured preferably on the output shaft 258 of a combined electric motor and reducing gear 257 is disposed between the opposed elongated arms 238 and 239 to be engaged by a roller 259 mounted on each of the arms. The output shaft 258 has a bevel gear 261 secured thereto which is in mesh with a bevel gear 262 secured on the cross shaft 253.

A cam 263 secured on the shaft 253 is formed to engage and actuate a valve 264 which controls the suction for the plate 191, whereby the sheet 15 is held thereon during predetermined

intervals in the operation of the registering mechanism. Another cam 265 is secured on the shaft 253 to actuate a plurality of electrical switches 266, 267, 268 and 269. The cams 250, 252, 256, 263 and 265 are arranged and timed in respect to the operation of the sheet trimming machine, to open the valve 264 to apply suction to the sheet when it is initially fed onto the plate 191, close the switches 266-269 inclusive, and then permit the respective elongated arms with their rollers 254 and 259 to follow the cams 250, 252 and 256 under urge of the springs 251 and 255.

Rotation of the cams 250, 252 and 256 will cause movement of the elongated arms 219-221, 229-231 and 238-239 as the cams are rotated from a position where a roller 254 or 259 is engaged by a high portion of the cam, to a position where a low portion of the cam is opposite the roller. After the energization (by action of the photo-cells), of either or both magnets of each of the three pairs of electromagnets carried by the elongated arms, and the consequent withdrawal of their catch members from engagement with the cooperating catch lug, movement of any elongated arm carrying a released catch member, as such arm is moved toward the center of the cam, will have no effect on the plate 191, but if any catch member is in engagement with a catch lug on the plate, when the elongated arm carrying it is moved inward, the plate will be moved in the same direction, the motion being continued until it is stopped by energization of the electromagnet carried by that arm, which action occurs when proper registration of the sheet affects a pair of photo-cells, and through their relay, energizes the electromagnet.

The cells 138, 139, 141, 143 and 144 (Figure 12) with their associated light sources 145, 146 and 147, and the polarized relays 148, 149 and 151 (Figure 11) are adapted for use, as in the previously described form of registering mechanism, for selecting the desired electromagnet of this mechanism to be energized, to obtain the proper movement of the plate 191 to register the sheet 15 with the printed impression thereon. The electric circuit for this form of registering mechanism wherein electromagnets are used, is also schematically shown and it will be observed that the circuit for the light sources 145, 146 and 147, and the circuits and connections between the cells 138-144 inclusive, and the respective relays 148, 149 and 151 are very similar to those of the previously described form, but with the following differences. The cam operated switches 152, 153 and 154 of the first form have been replaced by the cam operated switches 266, 267 and 268, and that the cam 155 for actuating these switches has been replaced by the cam 265.

The electric circuits from the relays 148, 149 and 151 of the electromagnets are different from those used in the previous form to the clutch actuating solenoids, due to the addition in this latter form, of magnetic means to hold the plate 191 in its adjusted sheet registered position. This magnetic plate holding means includes electromagnets 271, 272 and 273 respectively disposed along the transverse axis of the plate 191, one adjacent the side edge 199, another adjacent the side edge 203, and the other at the center. The electromagnets 271, 272 and 273 are supported directly beneath the plate 191 by cross-bars 274, 275 and 276 respectively. The arrangement is such that when the registering control electromagnets are not energized, the plate hold-

ing magnets are energized; this being effected by the closing of a switch 269 by the cam 265, and the switches 294, 295 and 296 which are closed by the coils 284, 285 and 286 respectively, which are in turn energized by circuits through the normally closed switches of relays 148, 149 and 151.

The switch 269 controlled by the cam 265 is connected by a conductor 287 to the line wire L1 and by a conductor 288 to a common conductor 289 to which normally open switches 294, 295 and 296 are connected by conductors 291, 292 and 293 respectively, these switches being connected by conductors 297, 298 and 299 to the plate holding magnets 271, 272 and 273; each of which are connected to the line wire L2 by a conductor 301. Normally closed switches 302, 303 and 304 are each connected to the line wire L2 by a conductor 305 and are respectively connected to one terminal of the plate shifting magnets 225, 226, 234, 235 and 244, 245 by conductors 306, 307 and 308. The opposite terminals of the plate shifting magnets are respectively connected by conductors 309, 311, 312, 313, 314 and 315 to one terminal of each of the normally open switches 316, 317, 318, 319, 321 and 322 which in pairs are under the control of the relays 149, 148 and 151 respectively. The other terminal of the switches 316 and 317 at the relay 149, are connected together by a conductor 323, and to the common conductor 289 by a conductor 324. The other terminal of the switches 318 and 319 at the relay 148, are connected together by a conductor 325, and to the common conductor 289 by a conductor 326. The opposite terminals of the switches 321 and 322 at the relay 151, are connected together by a conductor 327 and to the common conductor 289 by a conductor 328.

One terminal of each of the normally closed switches 277 and 278 at the relay 148 is connected by a conductor 329 to the other. One terminal of each of the normally closed switches 279 and 281 at the relay 149 is similarly connected by a conductor 331. One terminal of each of the normally closed switches 282 and 283 at the relay 151, is similarly connected by a conductor 332. The other terminals of the switches 277, 279 and 282 are connected by a conductor 333 to the common conductor 289, and the other terminals of the switches 278, 281 and 283 are connected by a conductor 334 to the respective coil 284, 285 and 286, each of said coils being connected by a conductor 335 to the line wire L2. As in the previously described form, the plate 191 is centralized during the interval a trimmed sheet 15 is being removed and another fed to the plate 191. This is accomplished by the action of the outer ends of the respective catch arms upon the stop lugs adjacent thereto. Thus, as soon as the switches 266-269 are opened by the cam 265, the catch arms snap away from the respective electromagnets, and due to the movement given them by the respective cams 250, 252 and 256 through the respective elongated arms, engage the stop lugs to centralize the plate 191.

By means of the above described electrical control circuit, the form of sheet registering mechanism shown in Figs. 8-11 inclusive, will operate to efficiently register the printed impressions upon a sheet with the means to operate thereon, such as the trimming knives. As in the previously described form, the photo-cells when affected by improper register of impressions, will effect energization of one or more of the registering control magnets, but in the form presently

under consideration, one or more of the catch arms 217 or 218, 227 or 228, and 236 or 237 will be energized, thereby allowing the other catch arm of the pair to move the plate to the extent necessary to effect registration, when the catch arms are moved by the movement of the elongated arms under influence of the springs 251 or 255. When the plate has been moved to the extent necessary to bring the sheet into the proper registration, the catch arm that has been engaged to move the plate will be attracted by its magnet, stopping movement of the plate at the proper position.

Due to the interlocking switches actuated by the coils 284, 285 and 286 under the control of the switches 277—278, 279—281, 282—283, only the plate holding magnet 271, 272 or 273 associated with the particular registering control magnet energized will be deenergized to permit shifting of the plate 191. Rollers 336, 337 and 338 (Figure 9) journaled in each of the plate holding magnets 271, 272 and 273 respectively, lightly engage the plate 191 when these magnets are de-energized, whereby no drag upon the plate 191 will be experienced when shifting action is taking place at the released point, but when the holding magnets are energized these rollers grip the plate and in conjunction with other portions of the magnets, hold it securely.

Briefly the operation of the latter form of sheet registering mechanism is as follows, assuming that a sheet 15 has been initially disposed upon the plate 191 and the cam 263 has opened the valve 264 to secure the sheet 15 to the plate 191 by suction. At this point in the operation of the mechanism, the cam 265 closes the switches 266—269 inclusive so that the coils 284, 285 and 286 are energized to open the switches 302, 303 and 304, and to close the switches 294, 295 and 296, whereby the plate holding magnets 271, 272 and 273 are energized and are acting on the plate 191 to hold it in position and down upon the respective rollers 336, 337 and 338.

The switches 266, 267 and 268 being closed, the circuits of the cells 138—144 inclusive are completed to the respective relays 148, 149 and 151. Now should one or more of the cells be affected due to the sheet 15 being out of register with a printed impression thereon, for instance the cell 138, the relay 148 will be actuated to open the switch 277 and close the switch 318. Opening of the switch 277 will deenergize the coil 284 whereupon the switch 295 will open and the switch 303 will close. Opening of the switch 295 will de-energize the plate holding magnet 272 to release the plate at this point. Closing of the switches 318 and the switch 303 will energize the registering magnet 234 and pull the catch arm 227 downwardly to release it from the catch lug 201. The high portions of the cams 250, 252 and 256 now rotate beyond the rollers 254 and 259 that are carried by the respective elongated arms 219—221, 229—231 and 238—239, and the arms are moved inward by the respective springs 251 and 255. The catch arm 228 being in engagement with the catch lug 202, the inward movement of the arm 228 will move the plate 191 toward the left as seen in Figures 8 and 9, the motion being continued until the point of proper registration is reached, at which time the action of the cells 138 and 139 will balance, deenergizing the relay 148 and thereby closing the switch 277 and opening the switch 318, which in turn will energize the coil 284 closing the switch 295 to energize the plate holding magnet 272. A similar action will

take place whenever any one of the cells 138—144 inclusive are affected by the edge of the printing impression being out of register with the cutting knives or other means operating upon the sheet 15. Thus the mechanism is adapted to move the sheet 15 through the instrumentality of the plate 191 in any direction in the plane of its surface.

In instances where a sheet 341 (Figure 12), having printed impressions 355 thereon is to be provided with perforations, marks, or indentations 356 which outline the impressions by being formed in the sheet 341 in vertically and horizontally disposed rows between the impressions thereon, as in the case of sheets of perforated postage stamps, it is desirable to include a sheet registering mechanism in the structure of a machine adapted to so perforate it. Such a combination is shown in Figure 13 wherein the sheets 341 are suitably fed from a pile 342 by driven rollers 343 and 344 and cooperating pressure rollers 345 and 346 respectively, into an initial position over a plate 17 or 191 of the desired registering mechanism described above. The registering mechanism selected then operates to register the printed impressions on the sheet 341 with timed sheet feeding or transfer means, in a manner as described, and the sheet 341 is then released and picked from the plate 17 or 191 by grippers 347 carried on an accurately timed transfer chain 348 and by it transferred to cooperating sheet perforating cylinders 349 and 351 whereby the sheet 341 is perforated, or impressed transversely of the direction of its travel. From the cylinders 349 and 351, the sheet 341 is transferred by further movement of the timed transfer chain 348 to which it is secured by grippers 347 to cooperating sheet perforating cylinders 352 and 353 whereby the sheet is perforated, or the like, in the same direction as it is moving and perpendicular to the first perforations. From the cylinders 352 and 353, the sheet is delivered to a pile 354.

It will be understood that the invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof, and it is therefore desired that the present embodiments be considered in all respects as illustrative and not restrictive, and it will be further understood that each and every novel feature and combination present in or possessed by the mechanism herein disclosed forms a part of the invention included in this application.

What I claim is:

1. In a machine having means for operating on printed sheets in register with the printed impressions thereon, a sheet support, a plurality of photo-electric cells positioned to detect improper register of the printed impressions on a sheet deposited on the support, with respect to the said means, and electrically actuated means controlled by the photo-electric cells for moving the sheet in the plane of its surface in any direction as required to bring the printed impressions into register with the operating means.
2. In a machine having means to operate on printed sheets, a sheet holder, means to move the sheet holder to shift the sheet in any direction in the plane of its surface when on the holder, and means to detect improper register of the printed impressions on the sheet in respect to the operating means and to control the actuation of the sheet holder moving means, to register the printed impressions on the sheet on the holder with the operating means.
3. In a machine having means to operate on

printed sheets to provide a uniform border about printed impressions thereon, a sheet holder movable in any direction in the plane of the surface of the sheet held thereby, means to move the sheet holder, and means to detect improper register of the printed impressions on the sheet in respect to the operating means and to control the actuation of the sheet holder moving means to register the printed impressions with the operating means.

4. In a machine for trimming printed sheets, cutting mechanism adapted to trim a plurality of the edges of a sheet in register with printed impressions thereon, a sheet support, a plurality of photo-electric cells positioned to detect improper register of the said impressions on a sheet deposited on the support with respect to the cutting mechanism, and means controlled by the photo-electric cells for moving the holder to shift the sheet in the plane of its surface in any direction as required to bring the printed impressions into register with the cutting mechanism.

5. In a machine having means for operating on a printed sheet to provide a uniform border about printed impressions thereon, a sheet support movable in any direction in the plane of the sheet supported thereby, a plurality of detecting devices positioned to detect improper register of the printed impressions on the sheet with the operating means, and means controlled by said detecting devices for moving the sheet support to shift the sheet to register the printed impressions thereon, with the operating means.

6. In mechanism for registering impressions printed on a sheet with an operable device for operating upon the sheet to provide a uniform border about the printed impressions thereon, a sheet support movable in any direction to shift the sheet supported thereby in the plane of its surface, means to so move the sheet support, and a plurality of photo-electric devices positioned to detect improper register of the printed impressions, with the device for operating on the sheet, and to control the actuation of the sheet support moving means.

7. In mechanism for registering impressions printed on a sheet with an operable device for operating upon the sheet to provide a uniform border about the printed impressions thereon, a sheet support movable in any direction to shift the sheet supported thereby, in the plane of its surface, means to so move the sheet support, releasable means to hold the sheet support at the position into which it is moved, and a plurality of photo-electric cells positioned to detect improper register of the printed impressions, with the device for operating on the sheet, and to control the actuation of the sheet support moving means.

8. In mechanism for registering impressions printed on a sheet, with an operable device for operating upon the sheet to provide a uniform border about the printed impressions, a sheet support movable in any direction to shift the sheet supported thereby in the plane of its surface, means to so move the sheet support, releasable means to hold the sheet support at the position into which it is moved, a plurality of photo-electric cells positioned to detect improper register of the printed impressions, with the device for operating on the sheets and to control the actuation of the sheet support moving means, and electrically operable means controlled by the photo-electric cells to release the sheet support holding means.

9. In combination with means to operate upon a sheet, mechanism for registering printed impressions on a sheet with the means to operate upon the sheet, a sheet supporting member movable in any direction in a single plane, means to so move the said member, and means affected by the position of the printed impressions on the sheet, in respect to the means to operate upon the sheets, in control of the member moving means.

10. In combination with means to operate upon a sheet, mechanism for registering impressions printed on a sheet, with the means to operate upon the sheet, a sheet supporting member movable in any direction in one plane, the said member moving means and the control means therefor being operable when a sheet is removed from the member, to effect movement of the member back into its initial position to receive another sheet, and means affected by the position of the printed impressions on the sheet, in respect to the means to operate upon the sheets, in control of the member moving means.

11. In combination with means to operate successively upon a plurality of sheets, mechanism for registering impressions printed on a sheet with the means to operate upon the sheets, a sheet supporting member movable in any direction in one plane, means to so move the said member, means operable when a sheet is moved away from the member to effect movement of the member back into its initial position to receive another sheet, and means affected by the position of the printed impressions on each sheet, in respect to the means to operate upon the sheet, in control of the member moving means.

12. In combination with means to operate successively upon a plurality of sheets, mechanism for registering impressions printed on a sheet with the means to operate upon the sheets, a freely supported sheet holding plate, means to move the plate in any direction in one plane only, means adjacent opposite edges of the plate adapted to be engaged by the plate moving means to move the plate generally in one direction, means adjacent the center of the plate adapted to be engaged by the plate moving means to move the plate generally in a direction perpendicular to the first mentioned movement, and means affected by the impressions printed on the sheet, to selectively actuate the plate moving means.

13. In combination with means to operate successively upon a plurality of sheets, mechanism for registering impressions printed on a sheet, with the means to operate upon the sheets, a freely supported sheet holding plate, means to move the plate in any direction in a single plane, means adjacent opposite edges of the plate adapted to be engaged by plate moving means to move the plate generally in one direction, means adjacent the center of the plate adapted to be engaged by plate moving means to move the plate generally in a direction perpendicular to the first mentioned movement, means operable when a sheet is removed from said plate to effect movement thereof back into its initial position to receive another sheet, and means affected by the impressions printed on the sheet to selectively actuate the plate moving means.

14. In combination with means to operate upon a sheet, mechanism for registering impressions printed on a sheet, with the means to operate upon the sheet, a freely supported sheet holding plate, means to move the plate in any direction in a substantially horizontal plane, means adja-

cent opposite edges of the plate adapted to be engaged by plate moving means to move the plate generally in one direction, means adjacent the center of the plate adapted to be engaged by plate moving means to move the plate generally in a direction perpendicular to the first mentioned movement, means affected by the printed impressions on the sheet, to selectively actuate the plate moving means, and marks on the plate adapted to be affected by the actuating means to cause it to actuate the plate moving means to substantially centralize the plate when a sheet is removed therefrom.

15. In combination with means to operate upon a sheet, mechanism for registering impressions printed on a sheet, with the means to operate upon the sheet, a sheet supporting member movable in any direction in a substantially horizontal plane, means to so move the said member, and means affected by the position of the printed impressions on the sheet, in respect to the means to operate upon the sheet, in control of the member moving means, and releasable means to hold the sheet supporting member in the position to which it is moved, while the operating means is being actuated.

16. In combination with means to operate upon a sheet, mechanism for registering impressions printed on a sheet, with the means to operate upon the sheet, a freely supported sheet holding plate, means to move the plate in any direction in a substantially horizontal plane, means adjacent opposite edges of the plate, adapted to be engaged by the plate moving means to move the plate generally forward and backward, means adjacent the center of the plate adapted to be engaged by plate moving means to move the plate generally in a direction perpendicular to the first mentioned movement, means affected by the printed impressions on the sheet to selectively actuate said plate moving means, and releasable means to hold the plate in the position into which it is moved while said operating means is being actuated.

17. In a mechanism for positioning a sheet having impressions thereon that is to be cut in a precise relation with the impressions, a support for the sheet freely movable in a substantially horizontal plane, means for moving opposite sides of the support forward and backward, means to move the support bodily in a line substantially perpendicular to the edges of the said sides of the support, and photo-electric means disposed to be affected by a plurality of spaced apart impressions printed on the sheet, and adapted to control the operation of the said plate moving means to so position the plate, that the sheet thereon will be cut in the desired precise relation with the impressions.

18. In a mechanism for positioning a sheet having impressions thereon that is to be cut in a precise relation with the impressions, a sheet support freely movable in a substantially horizontal plane, means for moving opposite sides of the support forward and backward, means to move the plate bodily in a line substantially perpendicular to the edges of the said sides of the support, and photo-electric means disposed to be affected by a plurality of spaced apart impressions printed on the sheet, and adapted to control the operation of the said plate moving means to move the plate bodily in any horizontal direction and to swing it as may be necessary to so position the plate that the sheet thereon will be cut in the desired precise relation with the impressions.

19. In a trimming machine for sheets having impressions printed thereon, a plurality of cutting knives, a sheet feeding mechanism having means to advance a sheet to a sheet support freely movable in all directions, a stop to limit the motion of the sheet, a plurality of means to move the sheet support and to hold it in position, means for holding the sheet on the support, a plurality of photo-electric cells affected by a plurality of impressions on the sheet and acting on the support moving means to position the support with each impression in a desired position, means to actuate the cutting knives, means to remove the stop from the path of the sheet, and means to forward the sheet to a delivery, all of said means being directly connected to and operated by the machine.

20. In a machine having means for operating on sheets, a sheet support, a plurality of photo-electric cells positioned to detect improper register of printed impressions on a sheet held on the support with respect to the said means, and motor operated means controlled by the photo-electric cells for moving the support longitudinally and transversely in a horizontal plane as required to bring the printed impressions into register with the operating means.

21. In a machine having means for operating on sheets, a sheet support, a plurality of photo-electric cells positioned to detect improper register of printed impressions on a sheet held on the support with respect to the said means, electrically operated means controlled by the photo-electric cells and actuated when necessary to move the support longitudinally and transversely in a horizontal plane as required to bring the printed impressions into register with the operating means.

22. In a machine having means for operating on sheets, a sheet support, a plurality of photo-electric cells positioned to detect improper register of printed impressions on a sheet held on the support with respect to the said means, and cam operated means controlled by the photo-electric cells and actuated when necessary to move the support longitudinally and transversely in a horizontal plane as required to bring the printed impressions into register with the operating means.

23. In a machine having means for trimming printed sheets, a sheet support on which a printed sheet is held, a plurality of photo-electric cells positioned to detect improper register of impressions on the printed sheet, with respect to the trimming means, and a plurality of means operably controlled by the photo-electric cells for moving the support longitudinally and transversely in a horizontal plane as required to bring the printed impressions into register with the trimming means.

24. In a machine having means to successively cut a plurality of sheets each having a similar device whereby it may be registered, a sheet holder, means to move the sheet holder and a sheet thereon, to shift the sheet in any direction in the plane of its surface, and means to detect improper register of the device of each sheet, in respect to the cutting means, and when improper register exists, to control the actuation of the sheet holder moving means to move the device of the sheet into proper register, whereby a plurality of sheets may be successively cut in the same relation to their registering devices.