March 5, 1963 H. W. LAMB 3,079,661

AUTOMATIC THICKNESS CONTROL MEANS FOR FLAT PRODUCTS

Filed March 6, 1961 4 Sheets-Sheet 1

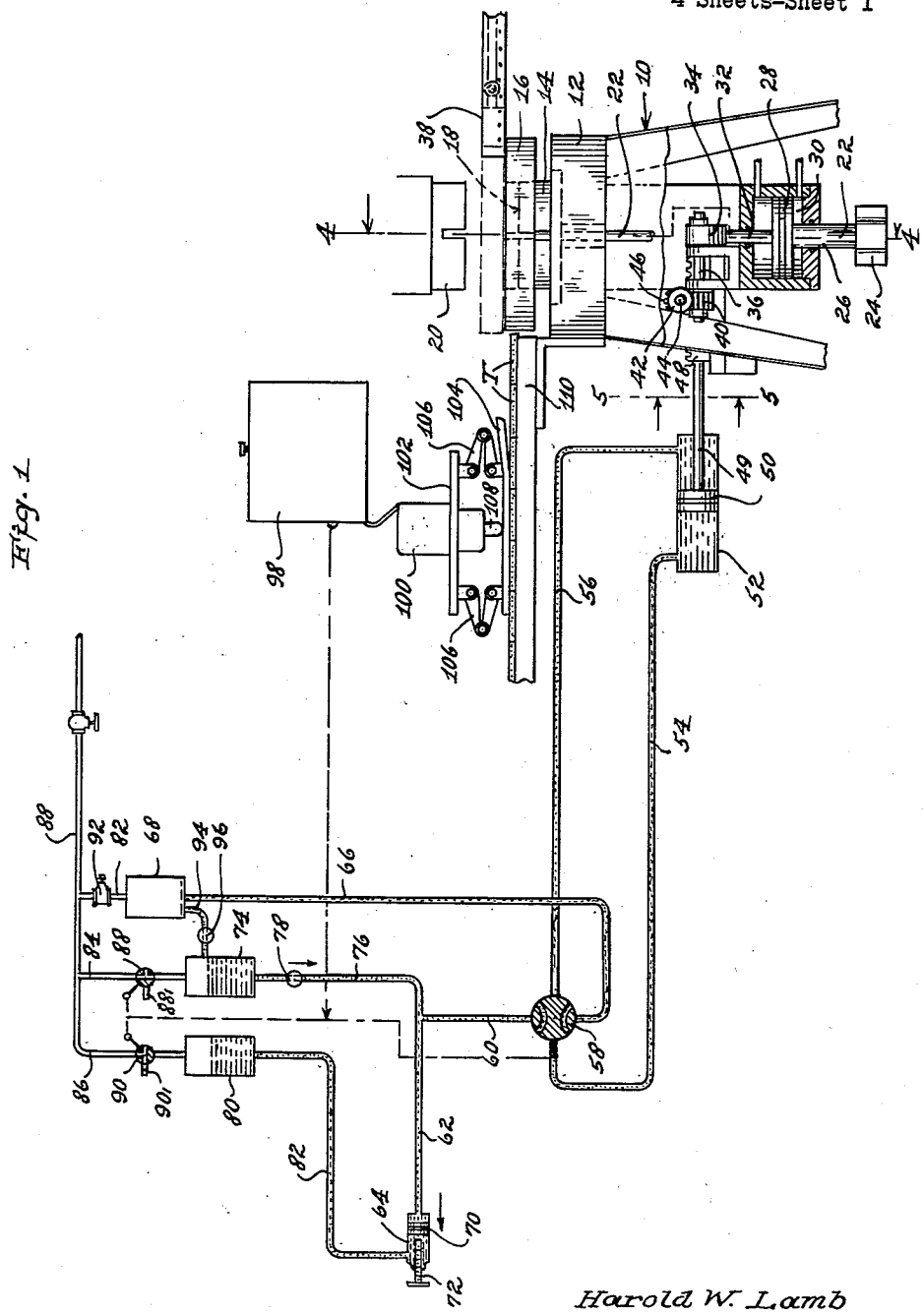


Fig. 1

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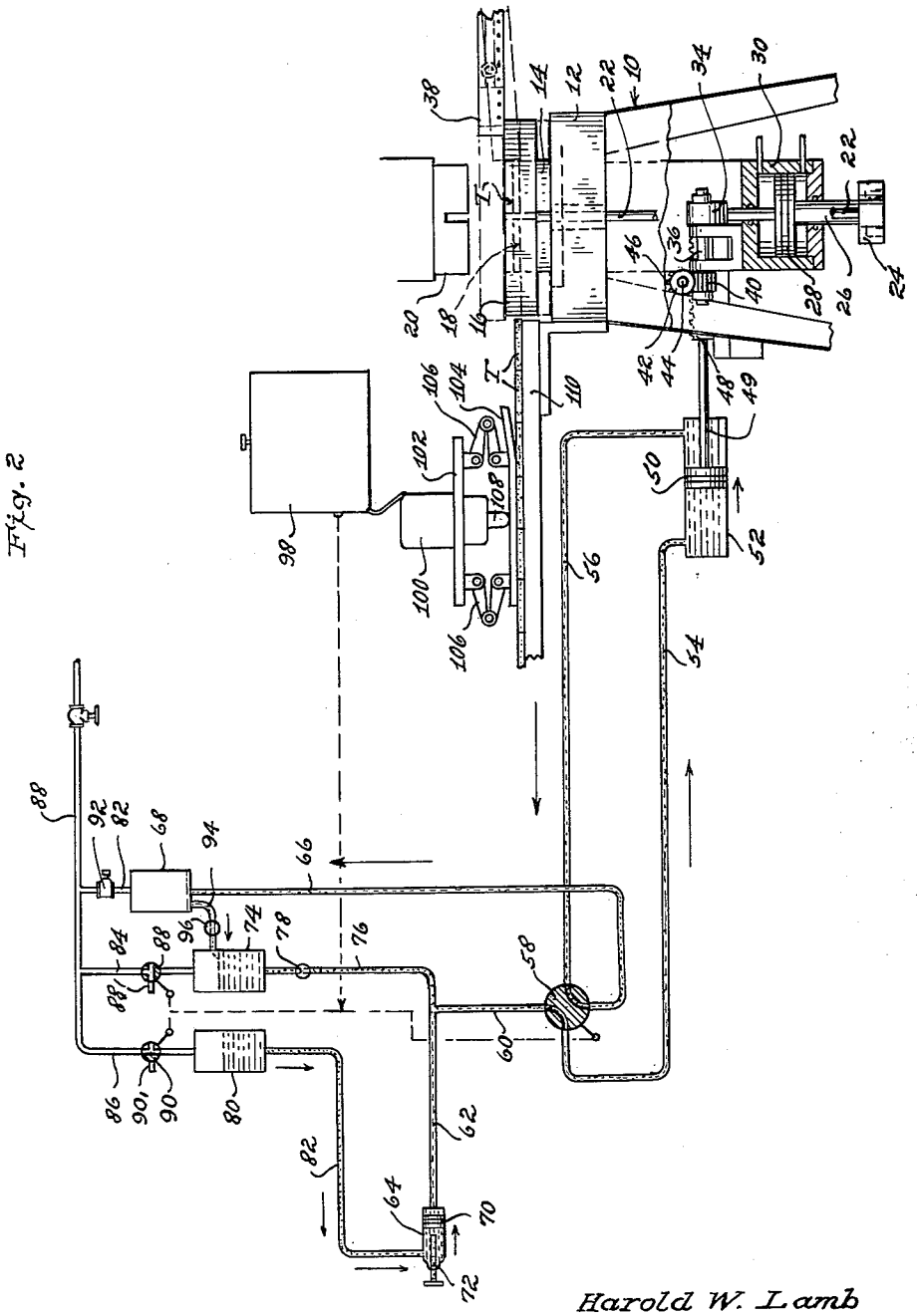


Fig. 2

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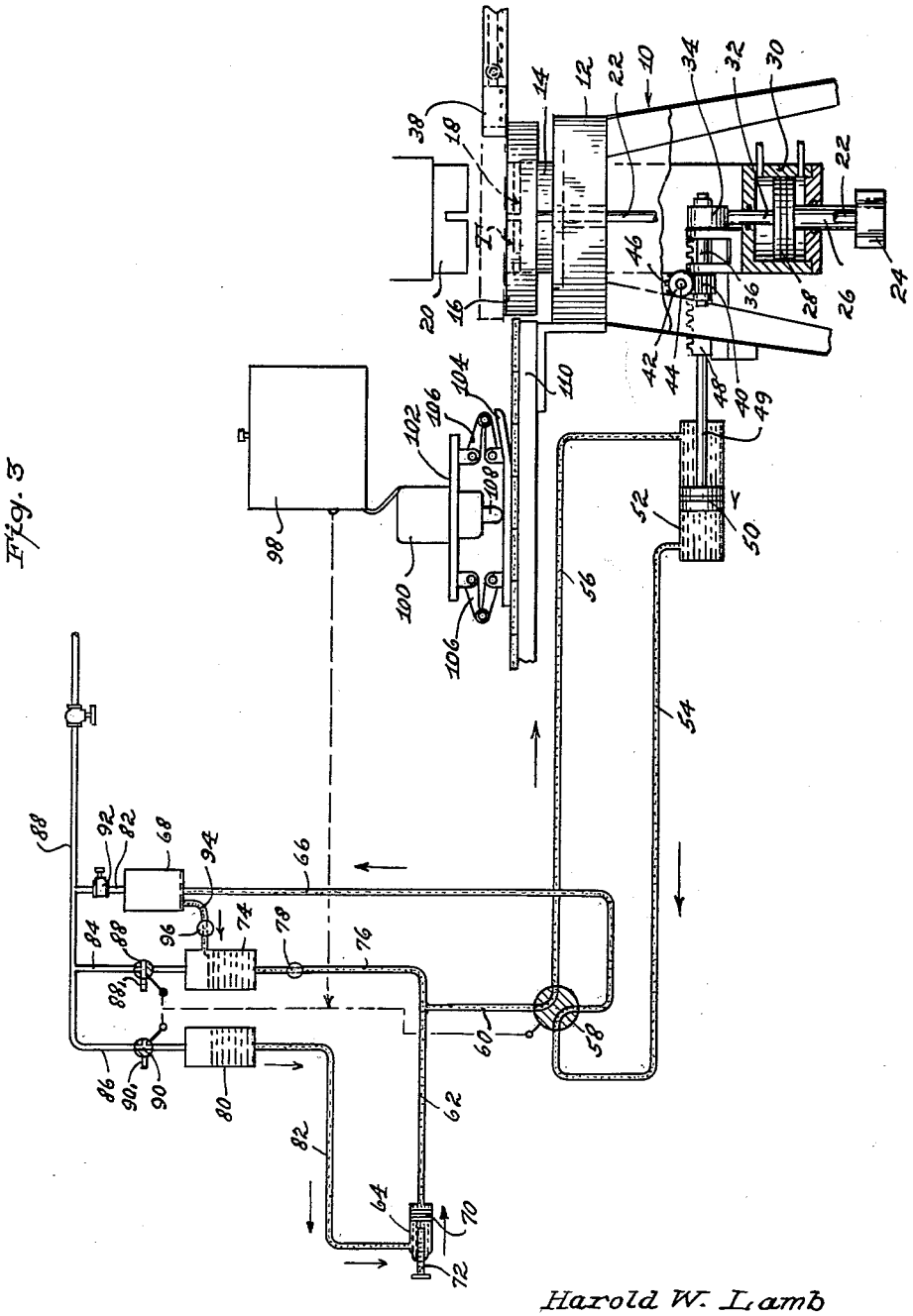
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AUTOMATIC THICKNESS CONTROL MEANS FOR FLAT PRODUCTS

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Fig. 3



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AUTOMATIC THICKNESS CONTROL MEANS FOR FLAT PRODUCTS

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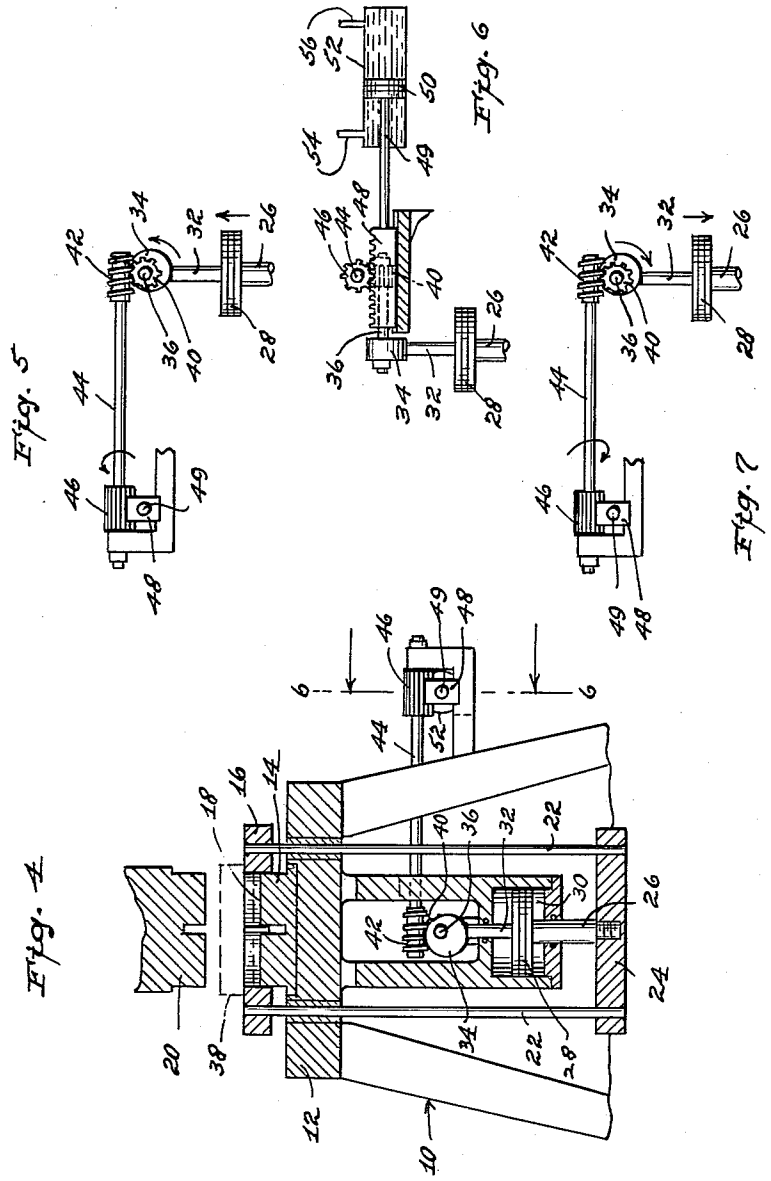


Fig. 4

Fig. 5

Fig. 6

Fig. 7

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AUTOMATIC THICKNESS CONTROL MEANS FOR FLAT PRODUCTS

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5 Claims. (Cl. 25—56)

This invention relates to devices or apparatus for regulating or controlling the thickness of flat products formed or finished in continuous or intermittent succession and dependent for their thickness upon the limit of spacing or opposed die or other operating members between which the products are formed or finished, as in pressing, milling, planing, sanding and other operations in which, at least, one of the operating members is adjustable toward and from the other, to reduce or increase the space between the members when conditions of the material or operations results in rendering the product too thick or too thin.

In a clay tile press, for example, the tile is formed by depositing a measured quantity of clay dust in the die cavities formed by a die case slidably mounted on a flat bottom member resting on the base of the press and compressing the clay by means of an impact member carried by the press ram. The die case is connected to the piston rod of an air cylinder by means of which the die case is raised to form the die cavities to receive the clay dust to be pressed and lowered to permit the completed tile to be pushed from the top of the die by the clay dust box as it crosses the die to deposit a charge of clay dust into the die cavities.

In the operation of such presses the limit of the stroke of the ram and impact member does not need adjustment. However, due to atmospheric or other conditions the degrees of compressibility in different lots of clay dust may vary to such an extent as to cause the tile to be too thick or too thin. Therefore it has been customary to provide means for adjusting the limit of the upward movement of the die case to decrease or increase the depth of the cavities, thus correspondingly reducing or increasing the quantity of clay dust deposited in the cavities, the surplus dust being swept from the die surface by the dust box as it leaves the die. The adjustment of the upward movements of the die case is effected by means of a rotary cam for abutting engagement with the free end of a stem projecting axially from the top side of the piston which operates the die case. With this arrangement it is necessary for the operator to manually gauge the tile at intervals and adjust the cam in one direction or the other when he finds the tile to be too thick or too thin.

It is highly essential that tile be of substantially uniform thickness. However, it is inevitable that in modern automatic and rapid operating tile presses large numbers of tile of greater or lesser thickness than permitted under the predetermined tolerances allowed in the trade may be produced during the intervals between gaugings of the tile. The same conditions apply generally to other products, such as tablets and the like compressed into form from dust or powder in dies designed for the purpose.

Therefore, one of the principal objects of the present invention is to provide in a press of the character mentioned automatic means for continuously gauging the product produced by the press and simultaneously adjusting the limit of upward movement of the die case to reduce or increase the depth of the die cavities, so that when the gauging device encounters a tile or like product which is too thick or too thin the limit of movement of the die case will be automatically corrected while the press is in continuous or intermittent operation.

The direct function of the present embodiment of the invention is to effect automatic adjustment of a rotary cam which limits the upward movement of the piston attached to the die case by abutment with the free end of the stem projecting from the piston, or with other suitable abutment means carried by the piston. This is accomplished by means of a worm gear on the cam shaft rotatable in either direction by means of a worm on a shaft having a gear connection with a rack movable in either direction by means of a hydropneumatic cylinder under impulses from an injection cylinder supplied with oil or other liquid from wells or other reservoirs partially filled with liquid under air or other gas pressure. The flow of liquid into and from the injection cylinder is controlled by electrically actuated control valves in cooperative sequence by a relay connected in an electrical circuit with a linear activator having a depending actuating element in contact with the top surfaces of tile pushed from the press die by the clay dust box in the manner previously mentioned. Under a very slight variation in the thickness of the tile the depending valve element will move axially a sufficient distance in one direction or the other to correctly activate the relay for operating the valves as required to move the piston of the hydro-pneumatic cylinder and, through it, rotate the die case limit cam in the proper direction to correct the depth of the die cavities to the extent afforded by one increment of liquid from the injection cylinder and, consequently, the thickness of the tile produced in subsequent cycles of operation, thus reducing to the minimum the number of defective tile produced.

Since, as previously mentioned, certain tolerances in the thickness of tile for various purposes are permitted. For example, the predetermined tolerance may permit a variation in the thickness of the tile in either direction of .005 inch, and the piston of the injection cylinder may be set for liquid increment movements of the piston of the hydro-pneumatic cylinder to change the depth of the die only .001 inch. Therefore, if an abnormally thick or thin tile produced by a defective cycle of operation of the press passes under the linear activator the die case will be adjusted only one step of .001. If that leaves the thickness of the succeeding tile within the predetermined tolerance, there will be not further action of the injection cylinder piston until another tile of a thickness outside the tolerance limit, one way or the other, passes under the linear activator.

As already mentioned the automatic thickness control referred to can be adapted to any product formed or finished by and between two opposed members in which the thickness of the product is dependent upon the limit of spacing of the two members.

Further objects and advantages of the improved thickness control apparatus will be apparent or pointed out in the following specification, in which reference is had to the accompanying drawings forming a part thereof, and in which—

FIG. 1 is a schematic view showing the apparatus for thickness control as applied to a clay tile press, upon the beginning of a cycle of operation;

FIG. 2 is a view similar to FIG. 1 but showing the hydro-pneumatic cylinder moving in the direction to reduce the thickness of tile being produced;

FIG. 3 is a view similar to FIGS. 1 and 2 but showing the hydro-pneumatic cylinder moving in the direction to increase the thickness of tile being produced;

FIG. 4 is a section taken on the line 4—4 of FIG. 1;

FIG. 5 is a partial sectional view, as on the line 5—5 of FIG. 1, and showing the piston of the die case cylin-

der moving in the direction to reduce the thickness of the tile;

FIG. 6 is a partial section as on the line 6—6 of FIG. 1; and

FIG. 7 is a view similar to FIG. 5, but showing the piston of the die case cylinder moving in the direction to increase the thickness of the tile.

Referring to the drawings in which like numerals designate like parts or elements in the several views, the numeral 10 designates a conventional clay tile press of the general type illustrated and described in Miller Patent No. 2,770,862, including a base 12, a bottom die member 14 and a die case 16 mounted for vertical telescopic movement on the bottom die member to form cavities 18 within the die case for the reception of clay dust to be pressed by an impact member 20 into clay tile T, the impact member being operated by press elements, not shown. The die case 16 is connected by rods 22 to the ends of a cross-bar 24 which is connected by an axially projecting stem 26, to the bottom of the piston 28 of an air or other fluid pressure cylinder 30, the operation of which is controlled by electrical valve elements in the press forming no part of the present invention, and, therefore, not shown. Another stem or stud 32 projects axially from the top of the piston 28, the free end of this stud being for abutment against a cylindrical cam 34 fixedly mounted eccentrically on a shaft 36 to limit the upward movement of the die case, and thereby limit the depth of the cavities formed above the bottom die member 14 by the die case member 16.

As previously mentioned, it has heretofore been the practice to correct the thickness of clay tile being produced by manually adjusting the cam 34 after the tile has been found by manual gauging to be too thick or too thin, so that the limit of upward movement will be reduced if the tile is found to be too thick, and increased if the tile is found to be too thin, thereby correspondingly reducing or increasing the depth of the die cavities. The clay dust is conveyed over and deposited in the die cavities by means of a reciprocating dust box 38 having a sieve-like bottom and being hingedly connected at its outer end to the piston rod of an air cylinder not shown in the accompanying drawing, but corresponding to the piston rod "108" and piston "104" connected to the dust box or material conveyor member "110" as illustrated in FIG. 2 of the above mentioned patent. Assuming that a tile has been pressed, the die case 16, through reversal of movement of piston 28 of cylinder 30, will drop to the base, as shown in dotted lines on FIG. 2, leaving the top of the die case flush with the top surface of the bottom die member 14. The front end of the hinged dust box 38, containing a charge of clay dust for the next tile follows the die case downwardly and then moves forward, thereby pushing the completed tile from the die to any suitable receptacle. By other conventional means (not shown) in the press the dust box is subjected to a series of rapid reciprocatory movements to shake the dust into the die cavities. As the dust box is withdrawn from the die for another charge of dust it wipes the surplus dust from the top of the die and the impact member 20 immediately moves to press the dust in the cavities into tile.

The automatic gauging and thickness control means may be applied to the clay press referred to above without any change in the construction or operation, except to connect the cam shaft 36 to automatic means for rotatably adjusting it together with the cam 34. The automatic tile gauging and thickness control means will now be described.

Mounted on the cam shaft 36 is a worm gear 40 connected with a worm 42 on a shaft 44 extending at right angles to the shaft 36 and a hydro-pneumatic cylinder 52. On the opposite end of shaft 44 is a spur gear 46 connected with a rack 48 extending at right angles to the shaft 44. The rack is connected by a piston rod 49 to a piston 50 mounted intermediate of the ends of the cylinder 52 communicating at its ends through pipes 54 and 56 with a four-way valve 58. This valve also communicates selectively through pipes 60 and 62 with the end of a small injection cylinder 64 and through pipe 66 with a well 68. In the cylinder 64 is a floating piston 70 limited in its rearward movement by an axial screwthreaded stud 72. A well 74 partially filled with oil or other suitable liquid communicates through pipes 76 and 62 with the front end of cylinder 64 and the pipe 76 is provided with a check valve 78 to prevent back flow toward the well 74. Another well 80, also partially filled with liquid, communicates through pipe 82 with the rear end of the injection cylinder 64. Wells 68, 74 and 80 are connected above the level of the liquid in said wells through pipes 82, 84 and 86 with a pipe 88 communicating with a source of air pressure. Pipes 84 and 86 are provided with control valves 88 and 90. Pipe 82 is provided with a pressure reducing valve 92 for the reason that the air pressure in well 68 is lower than the pressure in wells 74 and 80, or at least that of well 80. Well 68 communicates with well 74 through pipe 94 in which is a check valve 96 to prevent back flow toward well 68.

Although control valves 58, 88 and 90 are shown for purposes of illustration as of rotary construction it should be understood that they are all of conventional electrical types connected in an electrical circuit (not shown) with a conventional relay 98, which is connected in the same circuit with a conventional electrical linear actuator 100 mounted on a horizontal support 102 which is movably connected to a thin contact plate 104 through adjustable links 106. The linear activator 100 has a loose plunger type switch operating member 108 resting on the contact plate 104 and provided with means for adjusting the activator to various elements in said activator (not shown). The tiles T are pushed from the press die by the dust box 38 onto a table 110 and thence under the contact plate 104.

The relay 98 and the linear activator 100 are of such sensitive construction that a very slight variation in the thickness of tile passing under and in contact with the plate 104 will actuate the relay and operate valves 58, 88 and 90 and cause the automatic adjustments of the cam 34 as illustrated in the drawings and hereinafter described.

As shown in FIGS. 1, 2 and 3 the rack 48, operating cylinder 52, the injection cylinder 64 and all the communicating pipes up to certain planes in wells 68, 74 and 80 are filled with oil or other liquid, the space above the liquid in well 68 being under constant air or other gas pressure, and the other two wells being under selective valve controlled air or gas pressure. The air pressure in well 68 is lower than that in the other two wells, or, at least, the pressure in well 80 which supplies liquid to the rear end of the injection cylinder 64. The two cylinders, the pipes and the wells form a closed circulation system of the liquid for adjusting the cam 34.

The air pressure control valves 88 and 90 are provided with air exhaust outlets 88 and 90, which are open to the atmosphere when the valves are closed.

As shown schematically in FIG. 1 the system is being primed for the first adjustment of the cam 34 which may be in either direction of rotation of the cam. In this cycle of operation the four-way valve 58 and the air pressure control valve 90 are closed, with the air pressure in well 80 being exhausted to the atmosphere. The valve 88 is open, allowing the air pressure in well 74 to force liquid into the front end of injection cylinder 64 and thereby drive the floating piston back against the stud 72, leaving the front end of the cylinder filled with a small increment of liquid to be forced through the four-way valve 58 into one end of rack operating cylinder 52 when that valve is actuated by relay 98 in response

to a variation in the thickness of tile T passing under contact plate 104.

As shown in FIG. 2 the relay 98 has responded to a tile which is too thick. The four-way valve 58 is now open to permit the increment of liquid in the front end of injection cylinder 64 to be forced by piston 70 into the front end of rack operating cylinder 52, causing the rack 48 to rotate worm shaft 44 in the direction of the arrow (FIG. 5) thereby rotating the cam shaft 36 and cam 34 in the direction shown by the other arrow. This increases the limit of upward movement of the piston 28 and die case 16, thereby reducing the depth of the die cavities 18. After this cycle is completed the valves 58, 88 and 90 will immediately return to the positions shown in FIG. 1 and the system will be primed for another thickness correcting cycle.

As shown in FIG. 3 the relay 98 has responded to a tile which is too thin. The four-way valve 58 is now open to permit the liquid increment in the front end of injection cylinder 64 to be forced by piston 70 into the rear end of rack operating cylinder 52, causing the rack 48 to rotate worm shaft 44 in the direction of the arrow (FIG. 7), thereby rotating the cam shaft 36 and cam 34 in the direction shown by the other arrow in FIG. 7. This reduces the limit of upward movement of the piston 28 and die case 16, thereby increasing the depth of the die cavities 18. After this cycle is completed the valves 58, 88 and 90 will immediately return to the positions shown in FIG. 1 and the system will be primed for another thickness correcting cycle.

As previously mentioned, the air pressure in the well 68 is less than that above the liquid in well 80, the purpose being to permit a quantity of liquid from either end of the rack operating cylinder 52 equal to that displaced by the movement of the piston 50 under impulse from an increment of liquid from the injection cylinder 64 to be forced through four-way valve 58 and pipe 66 into the bottom end of well 68, from which the liquid drains into well 74 through pipe 94 and check valve 96, the air pressure control valve 88 being then closed, as shown in FIGS. 2 and 3, so that there is no loss of liquid from the system.

Since the movement of the rack 48 effected by the liquid increment from the injection cylinder 64 is extremely slight the first cycle of operation may be insufficient to fully correct the thickness of the tile. In such event the tile passing under the plate 104 will again activate the linear activator 100 and relay 98 to further increase or reduce the limit of upward movement of the piston 28 and die case, according to whether the automatic gauging shows the tile to be too thick or too thin.

As previously mentioned the valves 58, 88 and 90, the relay 98 and the linear activator 100 are all of conventional types available on the market and connected together in an electrical circuit to affect the operation through the relay 98 of the valves 58, 88 and 90 in correct automatic sequence, as indicated by the broken linking lines in FIGS. 1, 2 and 3. The specific construction of the instrumentalities referred to form no part of the present invention and are therefore not illustrated.

The movement of the tile on the table 110 under the contact plate 104 is effected by contact with the front end of the dust box 38 which pushes the completed tile T from the top of the bottom die member 14, when the die case 16 is in its lowermost position, as indicated in broken lines in FIG. 2.

From the foregoing description it will be seen that when the automatic thickness control device is applied to a conventional tile press any thickness of a continuously or intermittently moving row of tile for which the device is set will be automatically gauged and corrected in the event of any variation in the thickness of the tile passing under the contact plate 104, beyond the limit of the predetermined tolerance in either direction.

It will be seen further that the device can be adapted to the automatic gauging and correction of thickness of any continuously or intermittently moving flat product produced or finished between two opposed members when a correction of the thickness is effected by an adjustment of one of the members toward or from the other, as in the production of linoleum, sanding of a surface, and also in milling and rolling operations, the details of which are ont illustrated or described.

Obviously various changes or modifications of my improved means for controlling the thickness of flat products may be made without departing from the spirit and scope of my invention shown and described. Therefore, it should be understood that the embodiment of my invention shown and described is intended to be illustrative only, and restricted only by the appended claims.

I claim:

1. In a press having respective stationary and movable die members in telescopic relation for forming a die cavity, a dust box reciprocally movable across said die cavity to deposit dust therein, an impact member above said cavity for pressing dust therein into flat products, a horizontal table adjacent to said press and onto which said products are pushed in succession by the front end of said dust box, said press also having an operating cylinder with its piston connected to said movable die member for effecting movement thereof on said stationary member in either direction, a cam shaft having thereon a fixed cam journaled in said press, and an abutment on said piston in engagement with said cam for limiting the forward movement of said piston together with said movable die member: means in said press for rotatably adjusting said cam to correct variations in the thickness of flat products pressed in said die cavity, said means comprising, in combination, a hydro-pneumatic cylinder having a piston, a series of cooperative members connecting said piston to said cam shaft for effecting rotary adjustment of said cam toward and from the abutment on said piston, an injection cylinder having communication at its ends with sources of liquid pressure and with each end of said hydro-pneumatic cylinder for forcing small increments of liquid pressure into either end of said cylinder, electrical valve means for controlling the flow of liquid pressure into and from said injection cylinder, an electrical linear actuator mounted above the aforesaid horizontal table and actuated by complated flat products passing thereunder in slidable contact therewith, an electrical relay connected in an electrical circuit with said linear actuator and with all of said electrical valve means for actuating said valve means cooperatively in response to variations in the thickness of flat products passing under said linear actuator for controlling the movement of the piston of the hydro-pneumatic cylinder in either direction and thereby, through the aforesaid series of cooperative members, effecting rotary adjustment of said cam together with the depth of said die cavity.

2. Means for the correction of variations in the thickness of flat products as in claim 1 in which the abutment on the piston of the operating cylinder consists of a stud projecting from the front end of said piston.

3. Means for the correction of variations in the thickness of flat products as in claim 1 in which the series of cooperative members connected with the piston of the hydro-pneumatic cylinder comprise a worm gear on the cam shaft, a worm shaft at right angles to said cam shaft and said hydro-pneumatic cylinder, a worm on said worm shaft in engagement with said worm gear, a spur gear on said worm shaft and a rack in engagement with said spur gear and connected to the piston of said hydro-pneumatic cylinder for rotating said worm shaft with the cam shaft and cam in either direction.

4. Means for the correction of variations in the thickness of flat products as in claim 1 in which the sources of liquid pressure communicating with the ends of the injection cylinder and electrical valve means include a pair of wells partially filled with liquid and having communica-

tion above the liquid level with a source of air pressure through three-way electrical control valves having air relief ports, the bottom of one of said wells communicating with the rear end of the injection cylinder and the other with the front end of said cylinder, the front end of said injection cylinder being also in communication through a 4-way control electrical valve with each end of said hydro-pneumatic cylinder, said control means also including a third well communicating at its upper end with a source of air pressure, at least, lower than that in the first mentioned well, and being normally substantially empty of liquid, said third well being in communication at its bottom through said electrical 4-way control valve with the ends of said hydro-pneumatic cylinder and, through a one-way conduit, with the well supplying liquid under pressure to the front end of said injection cylinder for draining into that well the liquid displaced by increments of liquid forced into either end of said hydro-pneumatic cylinder by the piston of said injection cylinder, all of said electrical valves being actuated by said linear actuator through said relay.

5. Means for the correction of variations in the thickness of flat products as in claim 1 in which the movable die member has a central opening fitting telescopically over the stationary member.

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