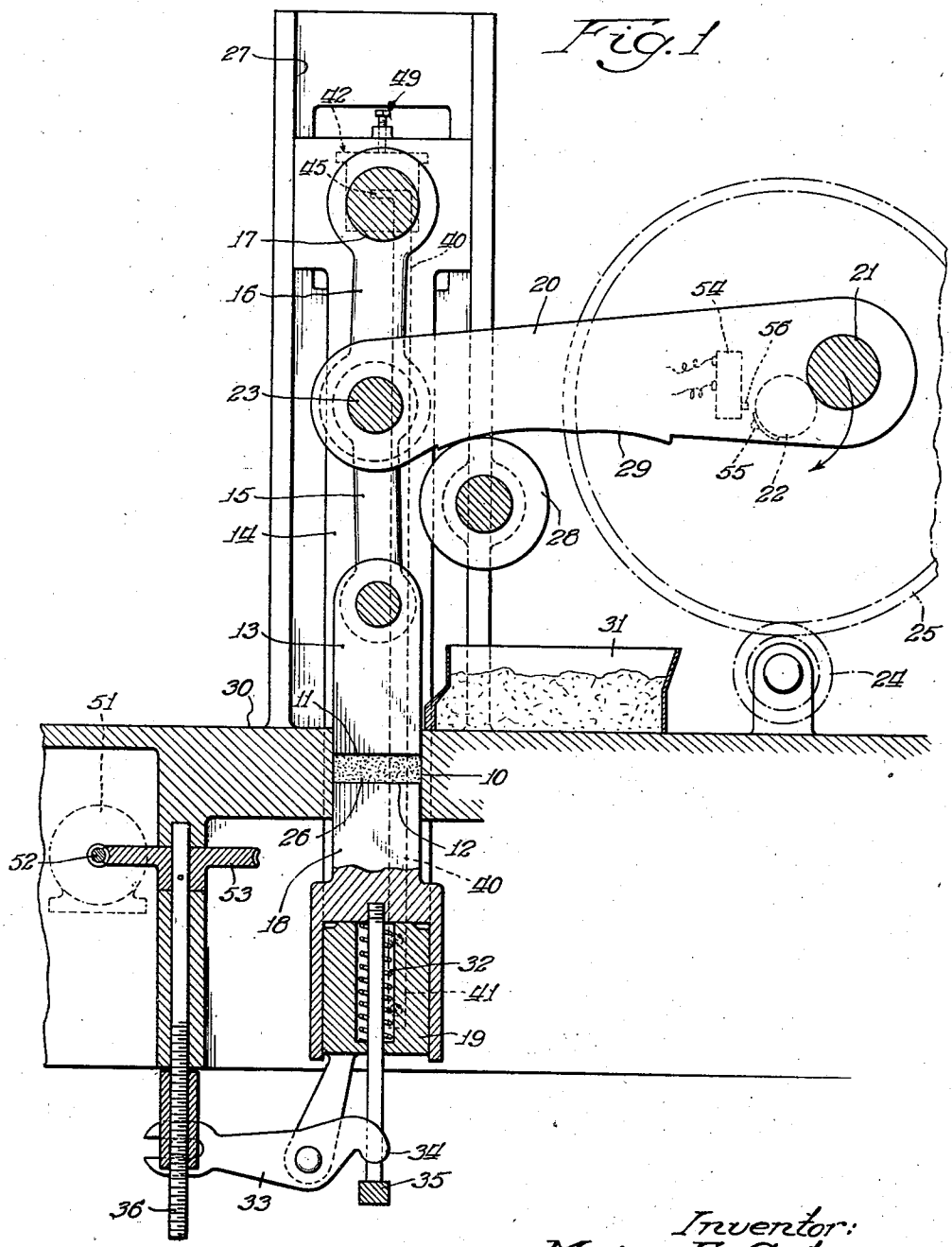
Aug. 25, 1942. M. E. GATES 2,293,815

CONTROLLING APPARATUS FOR PRESSES AND THE LIKE

Filed Dec. 4, 1939 2 Sheets-Sheet 1

Fig. 1



Inventor:
Major E. Gates
By:
Roland C. Rehm
Atty.

Aug. 25, 1942. M. E. GATES 2,293,815

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Filed Dec. 4, 1939 2 Sheets-Sheet 2

Fig. 3

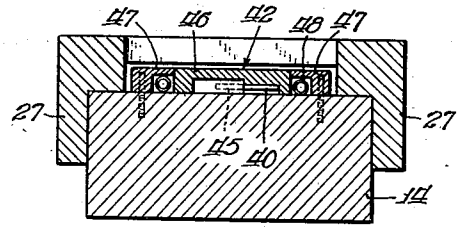


Fig. 2

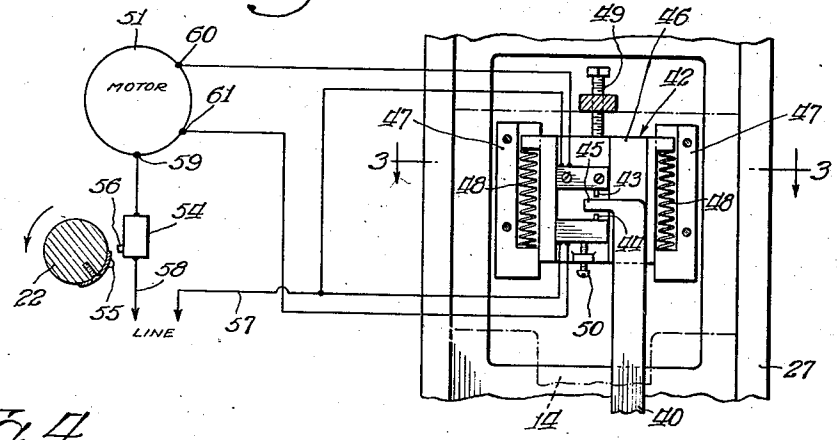
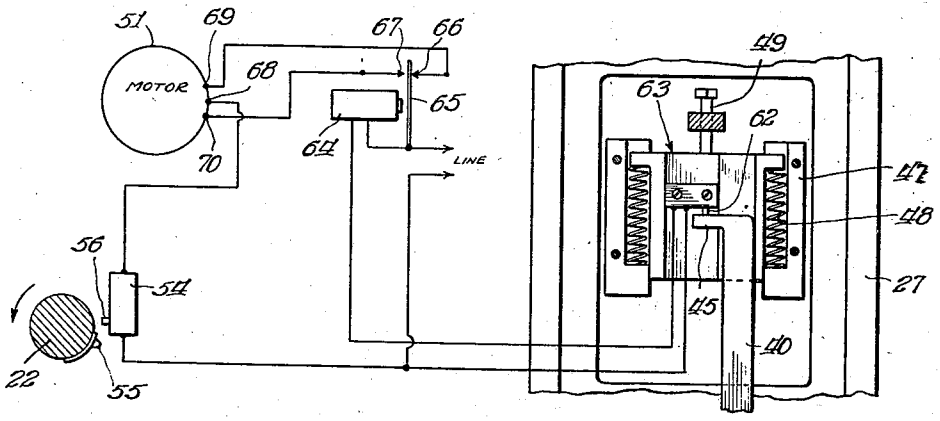


Fig. 4



Inventor:
Major E. Gates
By:
Roland C. Rehm
Atty.

Patented Aug. 25, 1942

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CONTROLLING APPARATUS FOR PRESSES AND THE LIKE

Major E. Gates, Crystal Lake, Ill.

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7 Claims. (Cl. 18—16)

This invention relates to presses and other apparatus for applying substantial forces to materials in the treatment or fabrication thereof, and, among other objects, aims to improve the control of the forces applied.

The nature of the invention may be readily understood by reference to one illustrative apparatus, embodying the invention and shown in the accompanying drawings.

In said drawings:

Fig. 1 is a sectional elevation of a mechanical press equipped with apparatus for automatically regulating pressures;

Fig. 2 is an elevation partly diagrammatic in character of the regulating apparatus;

Fig. 3 is a section thereof taken on the plane 3—3 of Fig. 2; and

Fig. 4 is an elevation similar to Fig. 2, illustrating a different form of regulating apparatus.

In presses and many other types of apparatus, no means have been provided for reliably determining the magnitude of the force applied, i. e., whether it is less or greater than the proper force, nor for effectively controlling the force applied to secure uniform treatment of successive articles. For example, in a mechanical press it has heretofore been impossible to apply a predetermined compression to an article or to ascertain whether the compression actually applied was too great or too little. In a brick press, to refer to a specific case, variation in moisture content, grain size, wear in machine parts, etc., results in variation of the force applied by the press. The brick may be underpressed or overpressed and no means are provided for ascertaining the extent of departure, if any, from the correct pressure, despite the fact that overpressing or underpressing produces an inferior brick. This is of particular importance in fire-brick where underpressing or overpressing shortens the life of the brick. The same applies to many other pressed articles.

In a mill for rolling sheet metal, to refer to another example, it is important that the sheet delivered be uniform in thickness throughout. For many uses, such as deep drawing, even slight variations in sheet thickness are objectionable. Yet such variations do occur because of variations in temperature and malleability of the sheet and its thicknes as it enters the rolls. These produce varying strains in the roll stands which alter the spacing of the rolls. Control of the roll spacing in response to pressures exerted on the sheet will produce greater uniformity in sheet thickness with fewer passes through the rolls.

The invention is here illustrated as applied to a brick press. The press in this instance is a so-called Boyd press, details of which are disclosed in Patents Nos. 985,153 and 987,124. It will be understood, of course, that the invention is not limited to a brick press and that the details of such press form no part of the invention. Only so much of the press as required to disclose the invention is illustrated in the drawings. For complete details of this specific type of press, reference is made to the aforesaid patents.

In general, the press comprises a stationary brick mold 10, the upper and lower faces 11 and 12 of which are movable relatively to each other and to the mold 10. The upper face 11 is embodied in a plunger 13 slidable vertically on the side bars 14 and operated in this instance by toggle links 15 and 16. The bearings 17 for the upper toggle links are carried by the side bars 14 adjacent their upper ends. The lower face 12 of the mold also comprises a plunger 18 vertically slidable on the side bars 14 and supported in its lower position on the crosshead 19 extending between and connected to the lower ends of side bars 14. The plunger 13 and the toggle links are, in this instance, operated by a connecting rod 20 reciprocated by the crank 21 of crank shaft 22 and connected to the toggle links at the intermediate bearing 23. The drive for the crank shaft 22 is here shown as a drive pinion 24 and gear wheel 25 connected with the crank shaft. Reciprocation of the connecting rod thus effects a reciprocation of plunger 11. Maximum compression is delivered to the brick 26 in the mold when the toggle arms 15 and 16 are practically in alignment as in Fig. 1 where they are shown approaching alignment. In that position the lower plunger 18 is supported on crosshead 19 and the side bars 14 assume the stresses developed during the compression of the brick. As shown in Fig. 3, these bars are of substantial section, being in the case of a multiple brick mold about 5"x7" in section.

To effect discharge of the brick and subsequent filling of the mold with clay, the entire assembly of side bars, plungers, etc., is made slidable in guideways 27. Vertical movement of the assembly is effected by the cam action of connecting rods 20 on cam roll 28. The cam surface 29 on the connecting rod is so designed that when the latter is retracted (to open the toggle) the entire assembly is elevated to bring the lower face 12 of the plunger flush with the

face 30 of the stationary mold to permit discharge of the compressed brick. At the same time the opening of the toggle considerably elevates upper plunger 13. Thereafter the lower plunger recedes a predetermined distance and the slidable hopper 31 passes over the mold cavity and fills the same level with a fresh charge. After the hopper is withdrawn the upper plunger again descends to compress the clay in the mold.

Adjustment of the amount of clay placed in the mold is effected by varying the elevation of the face 12 of the mold at the time the charge is deposited therein. As here shown, the plunger 18 is resiliently urged upwardly by spring 32 after the compressed brick has been discharged. This upper position is regulated by an adjustable lever 33 whose end 34 engages the stop element 35 carried by the plunger 18, thereby limiting the level of the face 12 at the time of filling the mold. A regulating screw 36 controls the position of lever 33. Upon compression of the brick, the plunger is again forced down upon the crosshead 19.

I have discovered that the magnitude of the pressure delivered to the brick may be determined by measuring the elongation of the side bars 14 at the instant of the delivery of maximum pressure. Despite the substantial section of these side bars, they elongate appreciably under the stress exerted thereon. In the present type of multiple brick press, the maximum stress is in the neighborhood of 500 tons and the elongation of the side bars is several thousandths of an inch. In the present apparatus, I utilize such elongation to regulate automatically the maximum pressures delivered by the press. This regulation is effected in this instance by adjusting the volume of the mold by means of the regulating screw 36.

The illustrative extensometer employed in this instance comprises a bar 40 connected at its end 41 to the side bar and extending along the side bar to a control switch 42 operated by the relative movement between the side bar and the extensometer bar 40 when the former is elongated under stress. The control switch in the apparatus illustrated in Fig. 2 comprises a pair of contact points 43 and 44 adapted to be engaged by the projection 45 on the extensometer bar. The contact points are mounted on a vertically adjustable plate 46 slidable in guideways 47 carried by the side bar 14. Mounting plate 46 is urged in one direction by springs 48 and is held in adjusted position by an adjusting screw 49. The separation between the contact points 43 and 44 is regulated by an adjusting screw 50 by means of which one of the contacts can be adjusted relatively to the other.

The contacts control the mechanism for adjusting the regulating screw 36. In the present instance, such mechanism is represented by reversible motor 51 operating a worm shaft 52 for rotating the worm gear 53 connected to regulating shaft 36. To limit response of the adjusting mechanism to the condition of elongation of the side bars 14 at the time of maximum stress, the circuit for controlling motor 51 is rendered operative only at approximately the time when maximum compression is being exerted on the brick, i. e. at the time the toggle links 15 and 16 are in alignment or dead center. The device for thus limiting the circuits is here shown in the form of a switch 54 under the control of crank shaft 22 and closed thereby during the time the press is exerting its maximum compression. Various devices for rendering the circuit operative at predetermined times in the cycle may be employed. That here shown comprises a cam member 55 carried by a shaft and engaging the switch lever 56 to close the circuit only during the time the lever is under the control of the cam member. The cam member 55 is advantageously made removable to permit variation in the point of closing as well as the length of the period during which switch 54 is closed. Generally for a press of this kind the switch 54 is closed only for a very short time, the adjustment required being very small.

When properly adjusted the projection 45 on the extensometer bar (at the instant of maximum compression) engages contact 44 if the compression is excessive and engages contact 43 if it be deficient. Neither contact is engaged when the compressive force is neither excessive nor deficient. When energized, motor 51 adjusts the regulating screw in one direction or another, depending upon whether the compression is excessive or deficient. If excessive, the regulating screw is adjusted to reduce the volume of the mold and when deficient to increase the volume of the mold. The adjustment, if any, at each cycle is preferably slight. If there be a sharp departure from proper compressive forces, adjustment may require several cycles. Ordinarily the condition of the clay does not vary so abruptly as to require substantial adjustment at any given instant. Preferably the reversible motor 51 is of the series type, being relatively slow in starting. Since the interval during which the circuit is operative is relatively short, the extent of adjustment effected by the motor at any given cycle is thus relatively small.

The contacts 43 and 44 may advantageously be in the form of micro switches. Such switches may be obtained on the open market under that name. The details thereof are disclosed in Patent No. 1,960,020. These switches require a movement of as little as .0002 (two ten-thousandths) of an inch to shift the contact points from open to closed position and vice versa. However, ordinary contact points properly insulated from each other may be employed instead. In that event the projection 45 serves as a contact point and it should be properly connected in the circuit. Condensers should preferably be employed across contact points if sparking is excessive.

In the circuit illustrated, one side of each of the contact switches is connected to the line wire 57. The other side 58 of the line is connected through the control switch 54 to the common terminal 59 of the reversible motor 51. The other two terminals 60 and 61 are connected respectively to the remaining terminals of contact switches 43 and 44.

A somewhat simplified control system is illustrated in Fig. 4. This system eliminates the neutral position and a circuit is closed on each cycle. Only one contact member 62 is employed. Such contact member may advantageously be a micro switch. The switch is carried on an adjustable plate 63 similar to the plate 46 and vertical adjustment thereof relative to the extensometer projection 45 is preferably effected in the same manner. As here shown, the switch is normally closed (i. e. normally engaged by the extensometer bar).

The switch controls a relay 64 having a double throw switch 65 which is normally closed (when the relay is unexcited) on contact 66. When

energized, switch 65 makes contact with the other switch point 67. The common terminal 68 of reversible motor 51 is connected to the line through the phase control switch 54 operated in the same manner as in the circuit illustrated in Fig. 2. The relay contacts 66 and 67 are respectively connected with the forward and reverse terminals 69 and 70 of motor 51. When switch 62 is open, a circuit is established through relay contact 67 and the motor is rotated in a direction to reduce the volume of the mold. On the other hand, if the pressure delivered by press be deficient, switch 62 will remain closed and effect a rotation of the motor in reverse direction, i. e. to increase the volume of the mold. Preferably contact 62 is adjusted relatively to the projection 45 so that when the compression is neither excessive nor deficient, switch 62 will remain closed for only one-half of the interval during which phase switch 54 is closed. The result is that motor 51 is first rotated in one direction and then in the opposite direction and the net adjustment is, therefore, zero. The more the pressure exceeds the proper compression, the longer switch 62 will be held open and, therefore, the greater the adjustment. If the compression be deficient, the switch remains closed for substantially longer period than it is open, if it be opened at all.

With an appropriate rearrangement of the control circuits, the switch 62 may be placed on the opposite side of the extensometer projection 45, i. e. in the same relative location as switch 44, In that event the switch will normally be open and will be closed when the compression is excessive.

It will be understood that the extensometer may be connected with other portions of the press under strain responsive to the force exerted by the press. The part to which the extensometer is attached may be strained either in tension or compression. In presses the element or elements under tension are generally more conveniently and easily equipped with the extensometer. The regulation or adjustment controlled by the extensometer depends, of course, on the article operated on by the press. In the present type of brick press regulation is advantageously effected by varying the volume of the mold. In other presses, adjustment may be effected, for example, by adjusting the approach of the dies, as by elongating or shortening a die plunger or its connecting rod, or by elevating or depressing a stationary die.

In wide presses, such as a multiple brick press, extensometers may be applied to each of the side bars 14 and each may independently control adjusting for its side of the press. In brick presses, for example, it often happens that the condition of the clay in the molds on one side of the press will be different (as regards porosity, etc.) from that at the other side, and thereby require a different adjustment.

Control by power consumption is not a satisfactory method of producing uniformity of product. Power consumed is not necessarily proportional to pressures exerted. In a press, for example, the maximum power consumption does not generally occur at the instant of greatest pressure, since at that point there is very little movement.

In the control of rolling mills, an extensometer applied to the roll stands may be employed to adjust the roll spacing to secure greater uniformity in sheet thickness. Thicker, cooler, or less malleable sheets would produce relatively higher stretch in the roll stands, resulting in a relatively greater roll spacing and a thicker sheet. The extensometer in response to such higher stretch would compensate therefor by reducing the roll spacing. The opposite would occur for a thinner, hotter or more malleable sheet. A rolling mill thus controlled would produce sheets of greater uniformity in thickness with fewer passes through the rolls.

Obviously the invention is not limited to the details of the illustrative apparatus since these may be variously modified. Moreover, it is not indispensable that all features of the invention be used conjointly since various features may be used to advantage in different combinations and sub-combinations.

Having described my invention, I claim:

1. In apparatus for exerting pressure on material, the combination comprising pressure applying means, supporting apparatus therefor including a structure for assuming the reaction of the pressure applying means, devices for regulating the pressure exerted by said pressure applying means, an extensometer associated with said structure and responsive to the stresses therein set up by the pressure then being applied by said pressure applying means, mechanism controlled by said extensometer for operating said devices to regulate the pressure subsequently to be applied, and means for rendering said extensometer inoperative except during the period when the maximum pressure is exerted.

2. In a press or the like, the combination comprising a press mold having an adjustable bottom, means for cyclically applying pressure to material in the mold, a structural element in the press assuming a portion of the reaction created by the pressure applying means and subject to a strain proportional to the pressure applied, an extensometer associated with said element and responsive to the maximum strain therein, and means controlled by said extensometer for adjusting the bottom of the mold for the next cycle inversely in accordance with the extent to which the maximum pressure on the preceding cycle varied from a predetermined pressure.

3. In a press or the like, the combination comprising a press mold, means for cyclically applying pressure to material in the mold, a structural element in the press assuming a portion of the reaction created by the pressure applying means and subject to a strain proportional to the pressure applied, an extensometer associated with said element and responsive to the maximum strain therein during a given cycle, and means controlled by said extensometer for varying the volume of the mold for the next cycle.

4. In a press or the like, the combination comprising a press mold, means for cyclically applying pressure to material in the mold, a structural element in the press assuming a portion of the reaction created by the pressure applying means and subject to a strain proportional to the pressure applied, an extensometer associated with said element and responsive to the maximum strain therein, and means controlled by said extensometer for varying the volume of the mold inversely in accordance with variations in the maximum pressure applied on the preceding cycle to adjust the maximum pressure to be applied during the next cycle.

5. In an apparatus of the character described, the combination comprising means for mechanically applying force to an article, a structural

element in the apparatus assuming a portion of the reaction created by the force applying means and subject to a strain proportional to the pressure applied, an extensometer associated with said element responsive to strains in said element under the force then being applied, and mechanism controlled by said extensometer for varying the force to be subsequently applied.

6. In apparatus of the character described, the combination comprising means for mechanically applying force to an article, a structural element in the apparatus assuming a portion of the reaction created by the force applying means and subject to a strain proportional to the force applied, an extensometer associated with said element and having electric switches closed in response to strains in said element caused by the forces then being applied, and means including a reversible motor controlled by said switches for adjusting said force applying means to vary responsively to said extensometer the force subsequently applied by said force applying means.

7. In apparatus of the character described, the combination comprising means for mechanically applying force to material, a structural element in the apparatus assuming a portion of the stress in the apparatus created by the application of the said force and subject to strain proportional to the force applied, an extensometer associated with said element responsive to strains in said element caused by forces then being applied, means including a reversible electric motor for effecting a variation of the force applied, and circuits controlled by said extensometer for operating said motor to vary the force subsequently applied inversely with the said strain in said element.

MAJOR E. GATES.