March 22, 1966 E. SIEMPELKAMP 3,241,189

TEMPERATURE-CONTROLLED PRESS

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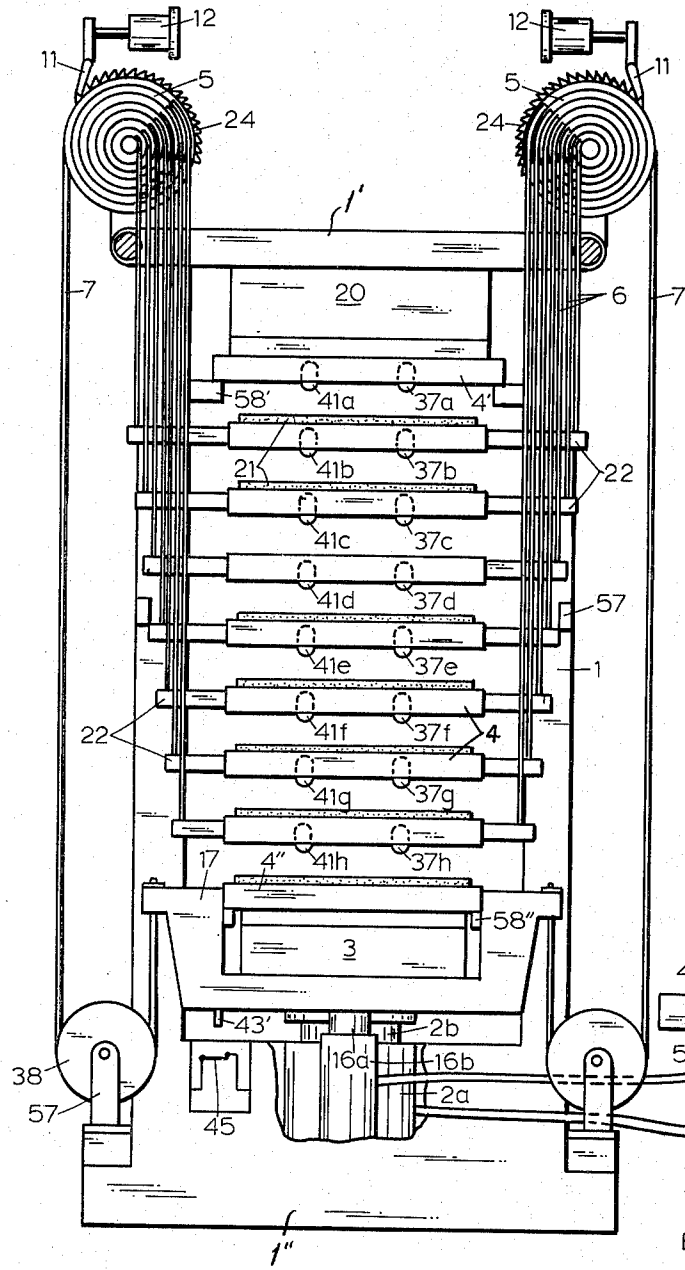


FIG.1

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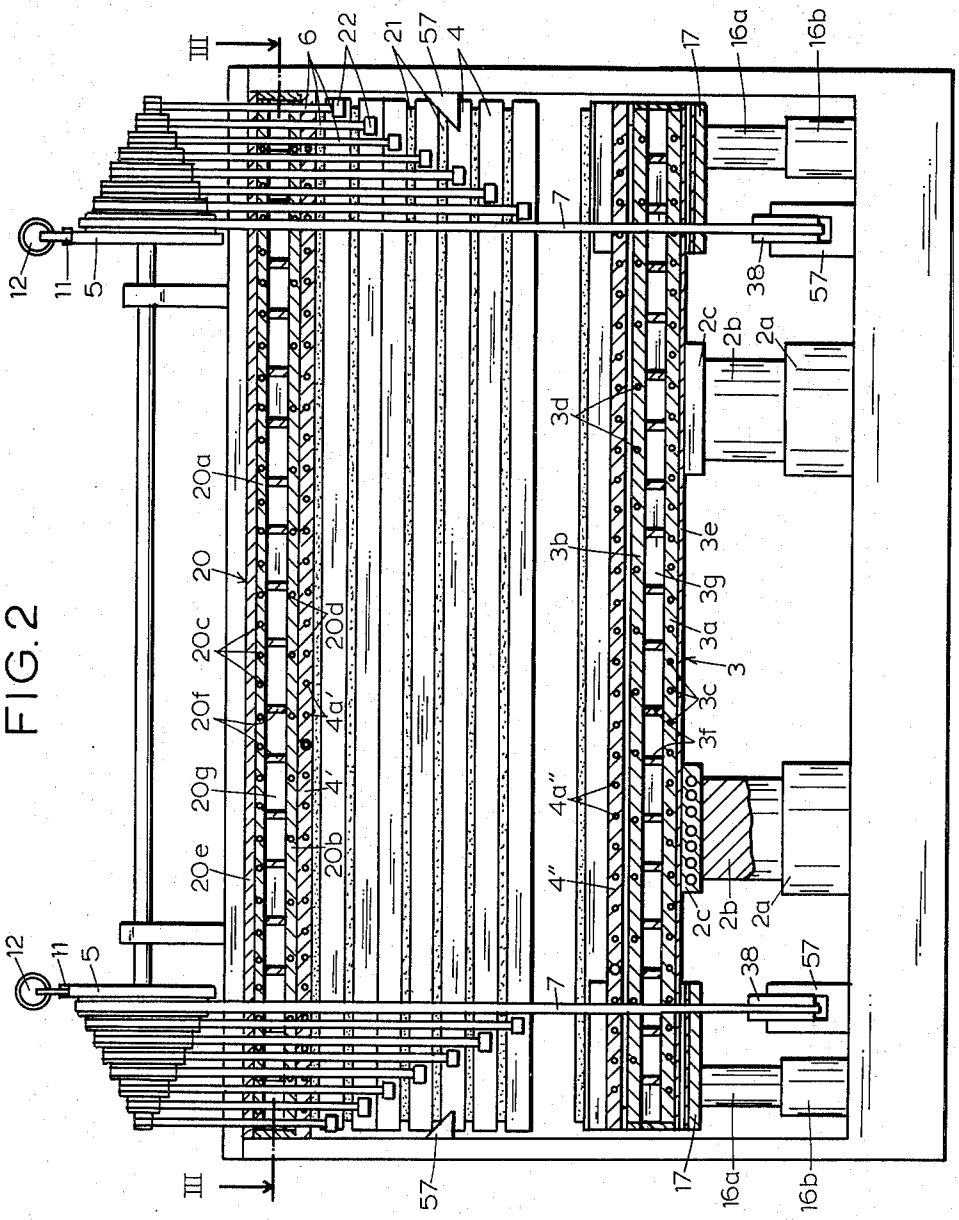


FIG. 2

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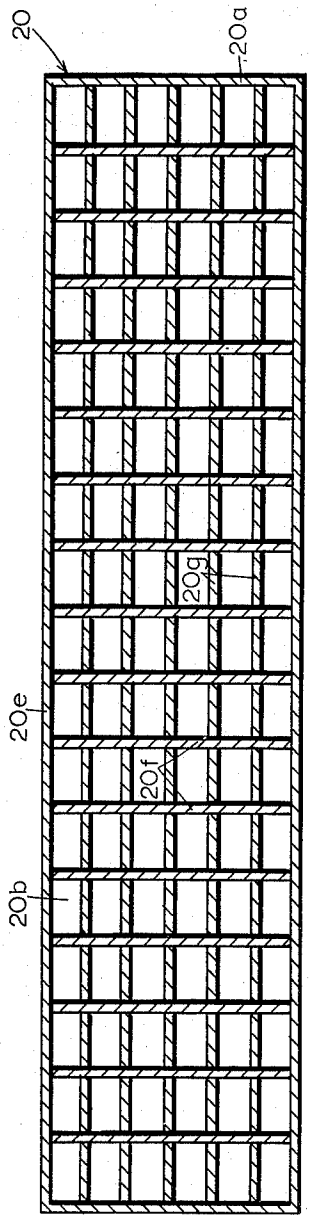


FIG. 3

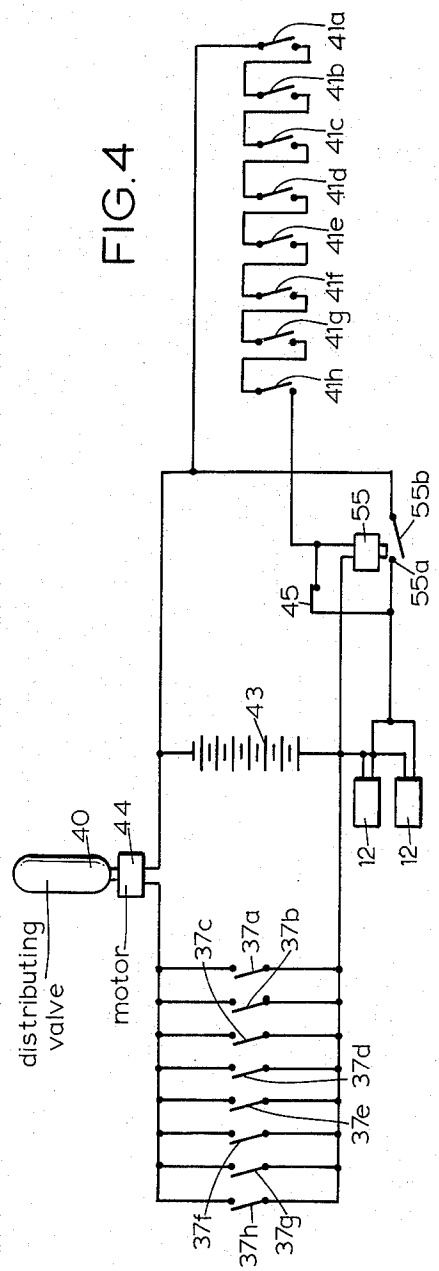


FIG. 4

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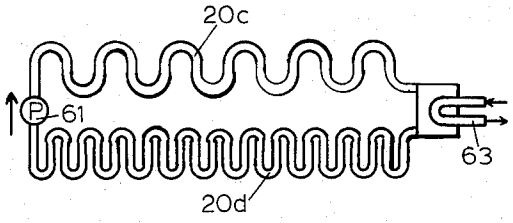


FIG.5

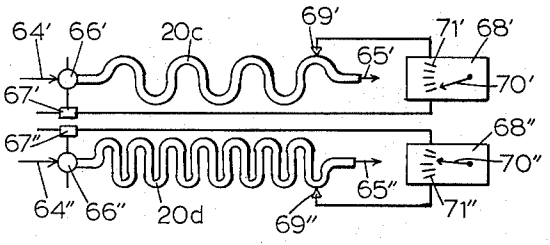


FIG.6

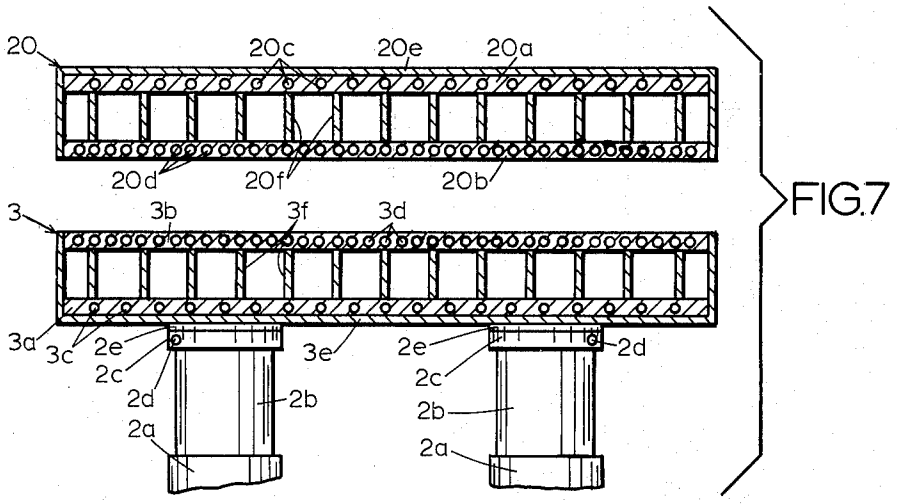


FIG.7

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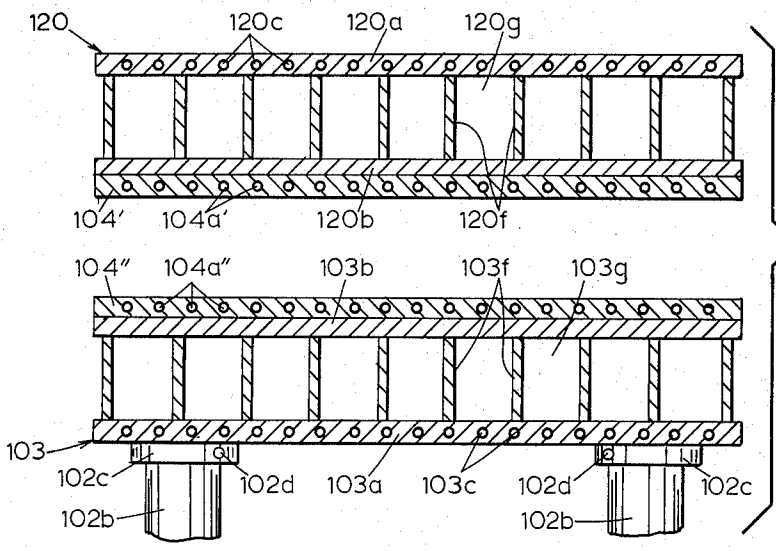


FIG.8

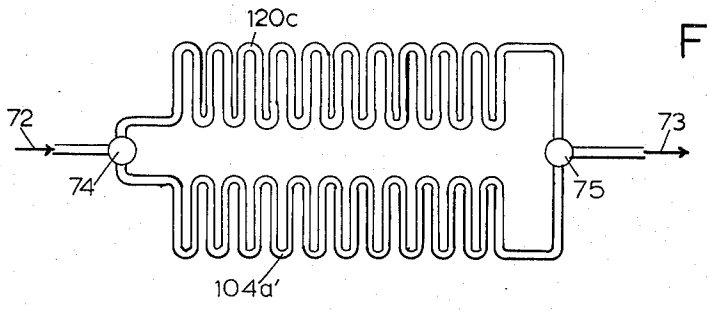


FIG.9

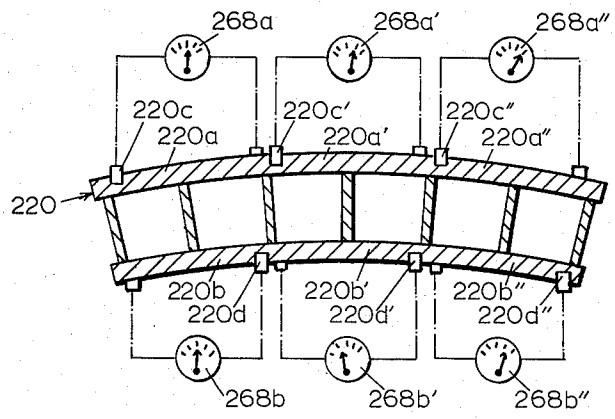


FIG.10

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United States Patent Office

3,241,189

Patented Mar. 22, 1966

3,241,189

TEMPERATURE-CONTROLLED PRESS

Eugen Siempelkamp, Hohenzollernstrasse 69, Krefeld, Germany

Filed May 1, 1962, Ser. No. 192,040
Claims priority, application Germany, June 29, 1961, S 74,571
5 Claims. (Cl. 18—17)

My present invention relates to a press, particularly (though not exclusively) one of the multi-level type, having means for subjecting its load to heating (or, in some instances, cooling) while compressing it between two plate members such as a head plate and a bed plate of which at least one (usually the bed plate) is displaceable toward the other.

The head and bed plates of conventional presses advantageously have a cellular structure with upper and lower flanges and intervening stiffening webs, e.g. in the form of two orthogonally intersecting arrays. Such presses can be used, e.g. as described in my copending application Ser. No. 6,188 filed February 2, 1960 (now Patent No. 3,050,777 issued April 28, 1962), for the heated compression and curing of cellulose-fiber sheets and similar compositions, for the vulcanization of rubber layers, and for a variety of other purposes. As the goods are maintained at elevated or subnormal tempratures during the compression step, e.g. with the aid of intermediate platens heated or chilled by a temperature-controlled fluid, care must be taken to prevent a thermal deformation of the press plates due to the existence of a major temperature difference between their proximal or inner and remote or outer flanges. To this end it has heretofore been the practice to interpose thermally insulating layers between the heated or cooled platens and the head and bed plates; particularly in the case of multi-level presses with heated platens it has also been customary to insert special cooling members between these plates and their insulating layers. Such arrangements are cumbersome, thermally uneconomical and not wholly reliable since the insulating layer tends to be weakened under the operating pressure of the apparatus and to wear unevenly by reason of the often unavoidable non-uniform load distribution; also, the sharp temperature drop between the hot platen and the cooled press plate may lead to moisture condensation at the latter, with corrosive effects.

The general object of this invention is to provide improved means for substantially preventing thermal deformation of the relatively displaceable end plates in a press of the character described.

In accordance with this invention I provide, in a press having a pair of relatively displaceable end plates and at least two temperature-controlled platens respectively adjoining these end plates, means for directly controlling the temperature of at least the outer flange of each plate in such manner as to maintain a temperature difference of substantially invariable magnitude (including zero) between this outer flange and the platen adjacent its inner flange. The connection between the inner flange and the adjacent platen may be tight or loose; in the latter instant it will sometimes be desirable to provide separate temperature-control means for the inner flange as well. In either instance there is no longer a need for interposing a thermal insulation or additional temperature-

stabilizing elements between the press plate and its adjoining platen.

The temperature control may be carried out by any suitable means known per se, including for example electric heating coils, yet I prefer to utilize the circulation of a heating or cooling fluid through appropriate passages in the press flanges. Such a system has a high degree of flexibility since it can be used for both heating and cooling purposes, e.g. with alternation of fluids of different temperatures and/or the provision of separate channels for the selective passage of a heating medium or a coolant.

Whether the two flanges of a press plate are maintained at the same temperature or at temperatures differing in a predetermined manner, the result will always be the elimination of transient thermal stresses which would lead to undesirable deformation. The maintenance of a substantially fixed temperature difference may also be used for the establishment of a particular curvature in the press plate whose flanges are in such case longitudinally subdivided into several zones individually controlled as to temeprature.

The invention will be described in greater detail with reference to the accompanying drawing in which:

FIG. 1 is a somewhat schematic front-elevational view of a multi-platen press similar to that shown in FIG. 2 of my above-identified Patent No. 3,050,777;

FIG. 2 is a side-elevational view (parts broken away) of the press of FIG. 1 in closed position, similar to FIG. 3 of the aforementioned copending application;

FIG. 3 is a sectional plan view taken on the line III—III of FIG. 2;

FIG. 4 is a circuit diagram relating to the press of FIGS. 1–3;

FIG. 5 is a diagrammatic view of the fluid-control system for the press shown in FIGS. 1–3;

FIG. 6 is an alternate fluid-control diagram similar to FIG. 5;

FIG. 7 is a sectional elevational view of a part of a modified press according to the invention;

FIG. 8 is another sectional elevational view, similar to FIG. 7, relating to a further embodiment;

FIG. 9 is a diagrammatic showing of a fluid-control system for the press of FIG. 8; and

FIG. 10 is an elevational view of yet another press plate according to the invention.

The press shown in FIGS. 1–3 is of the type wherein a plurality of platens 4 are raised and lowered by individual mechanical links here represented by cables 6, these cables being secured at one end to bars 22 projecting from the platens 4 and at the other end to suitable transmission members constituted by four stepped pulleys 5 each having a set of cables associated with the several platens 4 connected thereto. The cables attached to the lowest platens engage the largest-diameter steps of each pulley 5 while the successively higher platens are connected with respective smaller-diameter steps. Thus the pulleys, upon rotating, take up the cables in proportion to the required vertical displacement of each platen 4, thereby closing the press gradually and smoothly and without requiring the bed plate 3 of the press or its lower platens to support upper, unloaded platens. Rotation of the pulleys is controlled by a set of traction cables 7 (one for each pulley) which in turn are coupled with

a hydraulic mechanism for elevating the bed plate as more fully described hereafter; upon the establishment of contact between two or more platens 4, through the intermediary of the sheets 21 supported thereon or directly in the absence of such sheet, the traction mechanism is inactivated so that the working pressure is applied to the stack of platens 4 and sheets 21 directly by the bed plate 3 acting against a fixed head plate 20 disposed next to the upper cross-member 1' of the press frame 1. This avoids the development of mechanical strains which would otherwise occur in the differential cables 6 as the result of unequal spacings caused, for example, by the absence of one or more sheets 21 or by substantial differences in the thickness of the inserted sheets.

Each of the traction cables 7 passes under a respective idler pulley 38 fixedly journaled in a bracket 57. The ends of cables 7 remote from pulleys 5 are joined to a pair of yokes 17 extending at least partially within and transverse to the bed plate 13, these yokes being elevatable by a pair of hydraulic cylinders 16*b* whose pistons 16*a* bear thereon from below. Bed plate 3 is also carried on pistons 2*b* of master cylinders 2*a* which bear upon the lower cross-member 1' of frame 1. An uppermost platen 4' and a lowermost platen 4'' rest in the open position of the press (FIG. 1) on fixed supports 58', 58'', respectively, which are rigid with the frame 1; in the normal position (bed plate 3 at its bottom point) they are separated by a small clearance from the plates 3 and 20, respectively.

Each intermediate platen 4 and the top platen 4' are provided with one of a plurality of series-connected switches 41*a*–41*h* and one of a plurality of parallel-connected switches 37*a*–37*h* which are closed by the engagement of their armatures with the next-lower platen 4 or 4''. A normally closed limit switch 45 is mounted on the base of the press so as to be open-circuited upon the downstroke of yoke 17 by a stud 43 carried thereon. The parallel combination of switches 37*a*–37*h* is connected in series with the drive motor 44 of a hydraulic distributing valve 40 and with a source 43 of electric current (see FIG. 4) while the series-connected switches 41*a*–41*h* are connected in a circuit including an electromagnetic holding relay 55 and the battery 43. The relay contacts 55*a*, 55*b* lie in series with battery 43 and with a set of parallel-connected cylinders 12, whose function it is to release a set of pawls 11 from engagement with ratchet teeth 24 on the pulleys 5; switch 45 is inserted in the holding circuit of relay 55.

In operation, hydraulic fluid from a reservoir 27 is forced by a pump 28 through a transmission tube 50 to the master cylinders 2*a* while a part of the fluid enters the cylinders 16*b* via a tube 52, thereby raising the yokes 17 and the bed 3. Advantageously, the flow of fluid is so regulated as to permit the yokes to raise the bed plate 3 at a rate equal to or faster than the speed of ascent of the pistons 2*b* so that these pistons remain spaced from the plate 3 until the pressure begins to close, i.e. until one or more of the parallel switches 37*a*–37*h* operate. Upon such operation an electrical circuit is closed to drive motor 44 which adjusts the distributing valve 40 to shut off the flow of fluid to cylinder 16*b* while continuing the flow under increased pressure to master cylinders 2*a*. The upward motion of the yokes 17 thus ceases whereas the bed plate 3 commences its compression stroke under the urging of the pistons 2*b* now in contact with it, thereby slackening the cables 6 and 7 to disengage the spacer apparatus. At the conclusion of the compression stage, i.e. when all the sheets have been compressed to their predetermined thicknesses, the series-connected switches 41*a* to 41h close to complete a circuit to the winding of relay 55, thereby closing the contacts 55*a*, 55*b* and operating the solenoids 12 to withdraw the pawls 11 from engagement with their ratchet rings 24. After a predetermined curing time has elapsed, the motor 44 in its continuing operation blocks the fluid flow to cylinders 2*a* and opens a return path from the latter to the reservoir 27 via return tube 56. The bed plate thus commences to lower, entraining in the latter part of its descent the yokes 17 to reactivate the spacer mechanism. The distributing valve 40 may be designed to introduce fluid at this time to the tops of cylinders 16*b* and 2*a* via tubes 53 and 51, respectively, to increase the rate at which the press opens, at the same time withdrawing the pistons 2*b* from contact with bed plate 3. As the yoke 17 and the bed plate 3 attain the fully opened position of the press, plunger 43' trips the normally closed switch 45 to deactivate the relay 55, thereby releasing pawls 11 and restoring the spacer assembly to operative condition preparatorily to a new charge.

Abutments 57 (only one shown) on the frame 1 of the press serve as safety stops for the yokes 17 to insure a slackening of the cables upon failure of the switching circuit 37*a* to 37*h*.

As seen in FIGS. 2 and 3, each of the plates 3 and 20 consists of a cellular structure which in the case of head plate 20 includes an outer flange 20*a*, an inner flange 20*b*, a multiplicity of transverse webs 20*f* and intersecting array of longitudinal webs 20*g*; the corresponding elements of bed plate 3 have been designated 3*a*, 3*b*, 3*f* and 3*g*. Outer and inner flanges 20*a* and 20*b* form the upper and lower surfaces, respectively, of head plate 20 whereas in the case of bed plate 3 the flanges are reversed. Each of the four flanges enumerated above is provided with temperature-control means here shown by way of example as set of fluid passages 20*c* in flange 20*a*, a similar set of passages 20*d* in flange 20*b*, and analogous conduits 3*c*, 3*d* in flanges 3*a* and 3*b*, respectively. Similar passages 4*a*' and 4*a*'' are provided in the uppermost and lowermost platens 4' and 4'' and may also be present in the intermediate platens 4. A thermally insulating hood 20*e* covers the top surface and the sides of head plate 20, a similar hood 3*e* being provided for the sides and the bottom surface of bed plate 3. No insulation of any kind exists between plates 3 and 20 on the one hand and platens 4' and 4'' on the other.

It will be noted that the passages 20*d* and 3*d*, provided on the inner flanges of the respective plates, are more numerous (i.e. are of larger total cross-sectional area) than the corresponding passages 20*c* and 3*c* on the associated outer flanges. If these passages are traversed by the same heating or cooling fluid as illustrated for passages 20*c* and 20*d* in FIG. 5, the inner flange will be heated or cooled more intensely than the outer flange whose fluid passages will have only a compensating function to minimize or prevent thermal deformation of the plate. In the system of FIG. 5, for example, a pump 61 circulates a temperature-controlling fluid (preferably a coolant) through the coinduits 20*c* and 20*d* in series, the fluid being maintained at the desired temperature by a primary heating or cooling fluid in a conduit 63. The passages 4*a*' and 4*a*'', shown to be as numerous as the passages 20*d* and 3*d* in the adjacent plate flanges 20*b* and 3*b*, may be included in the circulation system of the flange passages by a connection in series or in parallel, e.g. as described hereinafter with reference to FIG. 9.

Each hydraulic piston 2*b* is provided at its top with a flange 2*c* which contains fluid passages 2*d* similar to those present in the bed and head plates 3 and 20. The conduits 2*d* may be traversed by a suitable cooling medium, yet any heat transfer between flanges 2*c* and 3*a* will be negligible even in the event of a large temperature difference therebetween since, apart from the relatively small area of the piston flange 2*c*, their surfaces are in contact with each other only during the brief interval when the press is closed under hydraulic pressure from the cylinder 2*a*.

In FIG. 6 I have shown a modified circulation system for the passages 20*c* and 20*d* adapted to maintain a predetermined temperature difference between the outer

flange **20***a* and the inner flange **20***b* of head plate **20**; again, a like system can be used for the corresponding flanges of bed plate **3**. The conduits **20***c* and **20***d* are connected in FIG. 6 in two separate circuits each including a source (symbolized by respective arrows **64′**, **64″**) and a sink (similarly symbolized by respective arrows **65′**, **65″**) for a thermally controlled fluid, a valve **66′**, **66″** regulating the rate of flow, an actuator **67′**, **67″** for this valve and a controller **68′**, **68″** coupled with the respective actuator for maintaining a desired flow rate as measured by a temperature feeler **69′**, **69″**, respectively. The feeler **69′** or **69″** works into the controller **68′** or **68″** which compares its output with the setting of a manual regulator **70′**, **70″**; the latter may be a simple rheostat controlled by an indicator arm, this arm co-operating with a scale **71′**, **71″** preferably graduated in units of temperature.

FIG. 7 illustrates the bed plate **3** and the head plate **20** of FIGS. 1–3 in the absence of any intervening platens and without yokes **17**. The pistons **2***b*, which are here in permanent contact with the bed plate **3**, are covered atop their flanges **2***c* by a thermally insulating and resilient layer **2***e* that flattens under the operating pressure of the hydraulic cylinders **2***a* so as to afford the mechanical equivalent of direct surface contact between the pistons and the bed plate. Normally, i.e. when only the dead weight of the plate **3** bears upon the resilient layers **2***e*, their thickness is sufficient to minimize heat transfer between the lower flange **3***a* of the bed plate and flanges **2***c* of the pistons provided with their respective fluid conduits **3***c* and **2***d*.

FIG. 8 illustrates a modified press according to the invention whose head plate **120** is in permanent contact with the uppermost platen **104′** while the lowermost platen **104″** similarly bears upon the bed plate **103**. The plates **103** and **120** are of generally the same structure as their counterparts in preceding figures, these plates being provided with outer flanges **103***a* and **120***a*, inner flanges **103***b* and **120***b*, transverse webs **103***f*, **120***f* and longitudinal webs **103***g* and **120***g*. A thermally insulating shell similar to hood **3***e*, **20***e* may be present but has not been illustrated. In contradistinction to plates **3** and **20**, however, the plates **103** and **120** contain fluid channels **103***c* and **120***c* only in their outer flanges **103***a* and **120***a*; their inner flanges **103***b* and **120***b* are free from such channels and are of solid structure. These inner flanges are maintained at their proper temperatures (either at the same level as the respective outer flanges or with a predetermined temperature difference) by their contact with the platens **104′** or **104″** having fluid passages **104***a′* and **104***a″*. Bed plate **103** rests on pistons **102***b* whose top flanges **102***c* are equipped with fluid passages **102***d* as in the preceding embodiments.

As illustrated in FIG. 9, the conduits **120***c* of head plate **120** and **104***a′* may be connected in parallel between a fluid source (arrow **72**) and a fluid sink (arrow **73**) via junctions **74** and **75**, this arrangement insuring substantial uniformity of temperature throughout the platen structure without any special control device; a like arrangement is contemplated for the bed plate **103**. It should be understood, however, that circulation systems of the type shown in FIGS. 5 and 6 could also be used. A separate fluid circuit, not shown, feeds the conduits **102***d* of piston flanges **102***c*.

In some cases it will be desirable to make the temperature control non-uniform over the length of the head and/or bed plate. In such event one may subdivide the flanges of these plates into a plurality of adjoining heating or cooling zones with individual temperature controls. This has been illustrated in FIG. 10 for a head plate **220** whose upper and lower flanges are divided into zones **220***a*, **220***a′*, **220***a″* and **220***b*, **220***b′*, **220***b″*, the associated fluid passages **220***c*, **220***c′*, **220***c″* and **220***d*, **220***d′*, **220***d″* being provided with individual regulators **268***a*, **268***a′*, **268***a″* and **268***b*, **268***b′*, **268***b″* which may be similar to the devices **68′** and **68″** of FIG. 6. It will be apparent that through proper temperature selection for the several flange zones a certain camber, e.g. upward as in FIG. 10, may be imparted to the press plate.

The invention herein disclosed is believed to admit of many modifications, including substitution or combination of equivalent or compatible features from different embodiments, without departing from the spirit and scope of the appended claims. Certain features not claimed in the present application are the subject matter of claims in my copending application Ser. No. 192,038 filed on even date herewith.

I claim:

1. In a press having an upright frame with an upper and a lower cross-member and a plurality of relatively displaceable platens between said cross-members for the compression of flat goods therebetween at a temperature different from ambient, the combination therewith of:

a fixed end member interposed between said platens and one of said cross-members in direct contact with the latter, and a movable end member interposed between said platens and the other of said cross-members, each of said end members consisting of an outer flange remote from said platens, an inner flange adjacent the respective one of said platens and stiffening web means between said flanges, said outer and inner flanges being respectively provided with a first and a second set of internal fluid passages uniformly distributed therein;

fluid-operated drive means bearing directly upon said movable end member and said other of said cross-members;

circulation means for passing a temperature-controlling fluid through both said first and second sets of passages of each of said end members; and

temperature-control means in said circulation means for individually regulating the temperatures of each of said flanges for preventing thermal deformation of said end members.

2. The combination defined in claim **1** wherein the total cross-sectional area of said second set of passages exceeds that of said first set of passages, said circulation means including a common fluid source for said first and second sets of passages.

3. The combination defined in claim **2** wherein each of said platens is provided with a third set of fluid passages connected to said source, the total cross-sectional area of said second set of passages being substantially equal to that of said third set of passages.

4. The combination defined in claim **1** wherein each of said flanges is longitudinally divided into zones, the respective temperature-control means being correspondingly subdivided into individually adjustable sections for establishing predetermined temperature conditions therein so as to impart a camber to said flanges.

5. In a press having an upright frame with an upper and a lower cross-member and a plurality of relatively displaceable platens between said cross-members for the compression of flat goods therebetween at an elevated temperature, the combination therewith of:

a fixed end member interposed between said platens and one of said cross-members in direct contact with the latter, and a movable end member interposed between said platens and the other of said cross-members, each of said end members consisting of an outer flange remote from said platens, an inner flange adjacent the respective one of said platens and stiffening web means between said flanges, said outer and inner flanges being respectively

provided with a first and a second set of internal fluid passages uniformly distributed therein;

fluid-operated drive means bearing directly upon said movable end member and said other of said cross-members, said drive means including a cooled piston in limited-area contact with said outer flange of said movable end member;

circulation means for passing a cooling fluid through both said first and second sets of passages of each of said end members; and

temperature-control means in said circulation means for individually regulating the temperature of each of said flanges for preventing thermal deformation of said end members.

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