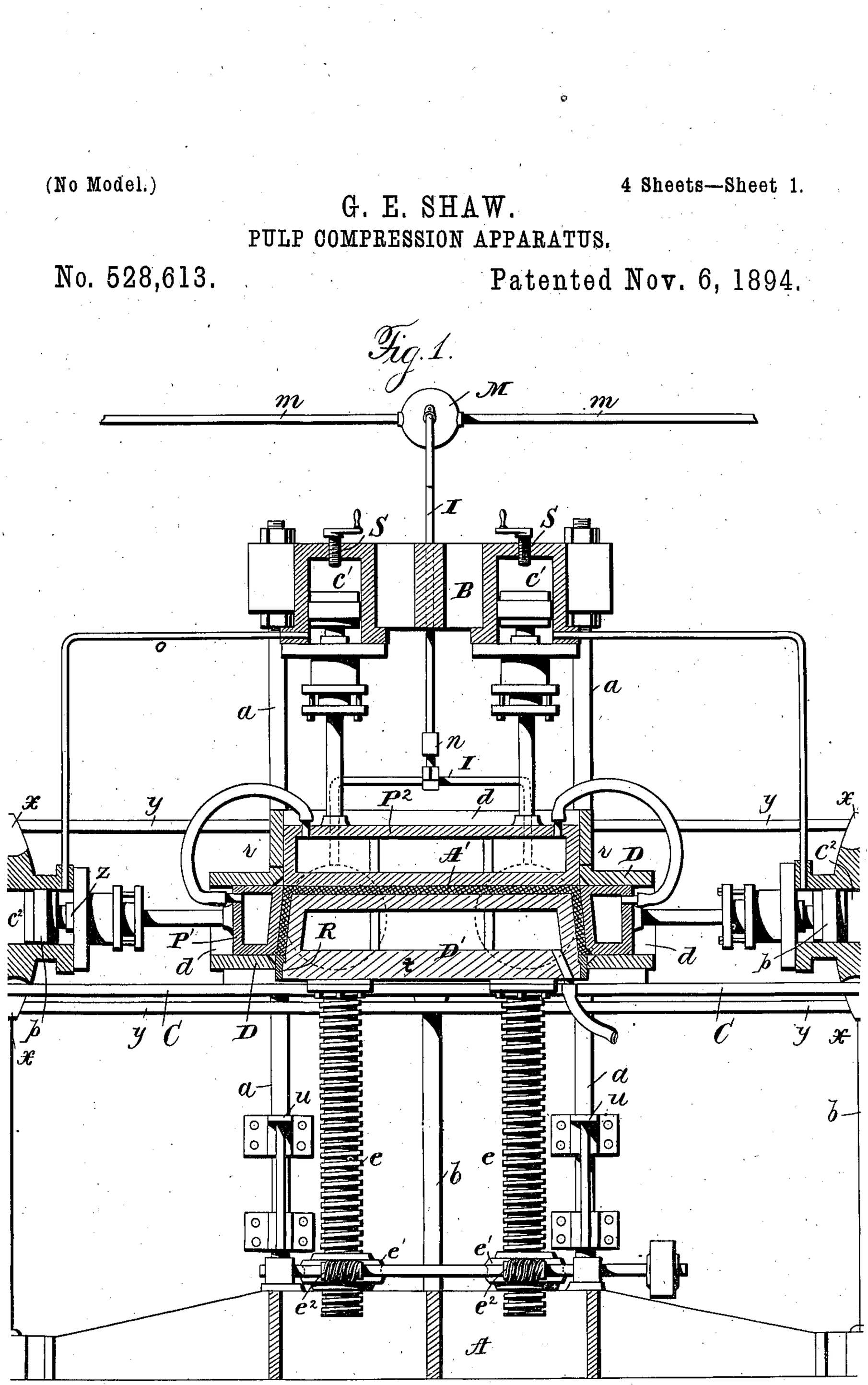
(No Model.) 4 Sheets—Sheet 1.

G. E. SHAW.

PULP COMPRESSION APPARATUS.

No. 528,613. Patented Nov. 6, 1894.

Fig. 1.



Witnesses:
Jas. E. Hutchinson.
Robert Everett.

Inventor.
George E. Shaw,
By L. M. Vosey Attorney.

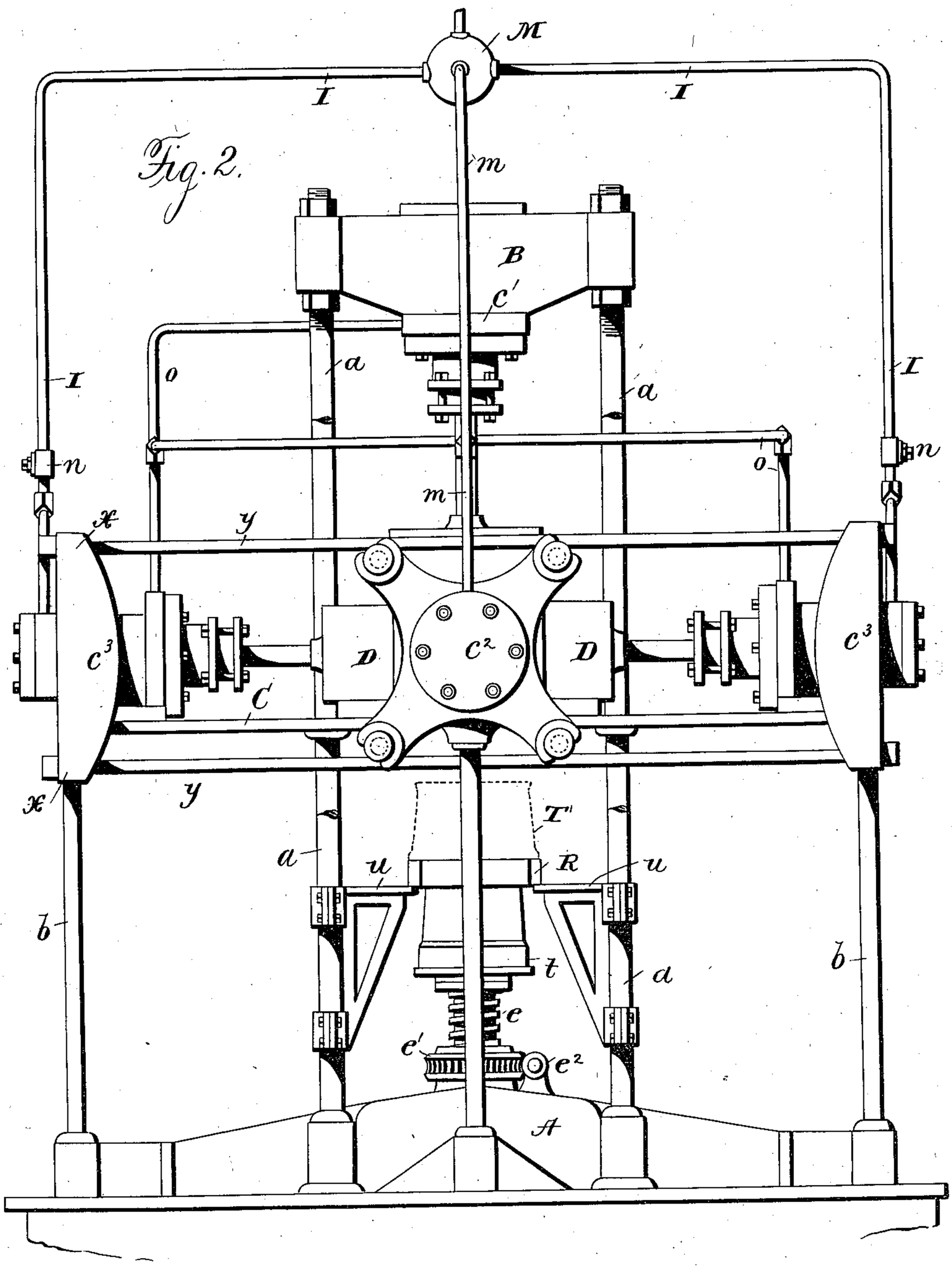
(No Model.) 4 Sheets—Sheet 2.

G. E. SHAW.

PULP COMPRESSION APPARATUS.

No. 528,613. Patented Nov. 6, 1894.

Fig. 2.



Witnesses:
Jas. E. Hutchinson.
Robert Everett.

Inventor.
George E. Shaw.
By L. W. Hosea Attorney

(No Model.) 4 Sheets—Sheet 3.

G. E. SHAW.

PULP COMPRESSION APPARATUS.

No. 528,613. Patented Nov. 6, 1894.

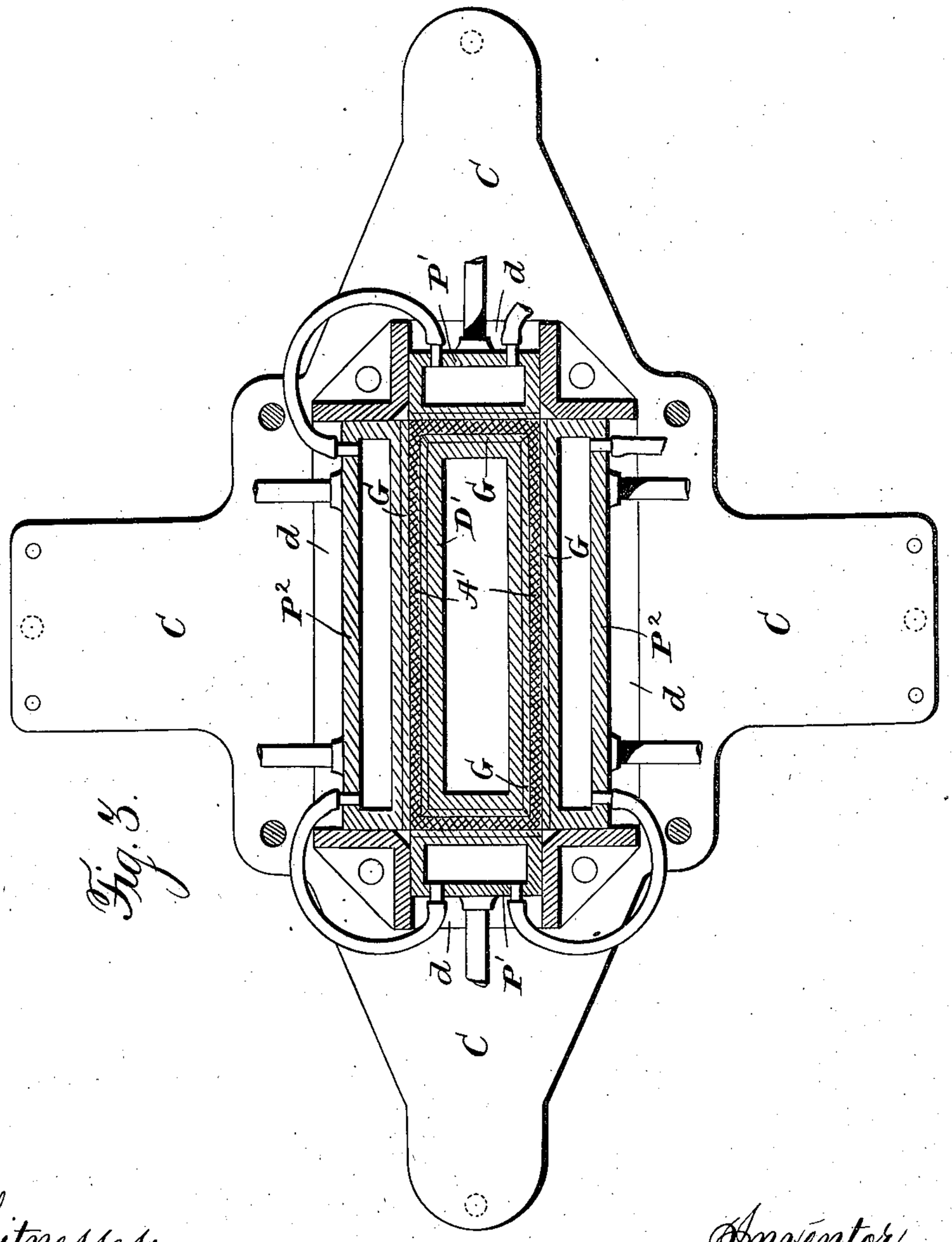


Fig. 3.

Witnesses:
Jas. E. Hutchinson
Robert Everett

Inventor.
George E. Shaw;
By
L. W. Serrell
Attorney.

(No Model.) 4 Sheets—Sheet 4.

G. E. SHAW.

PULP COMPRESSION APPARATUS.

No. 528,613. Patented Nov. 6, 1894.

Fig. 4.

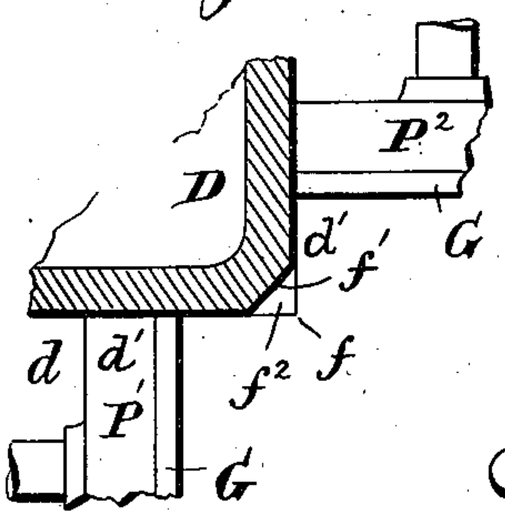


Fig. 5.

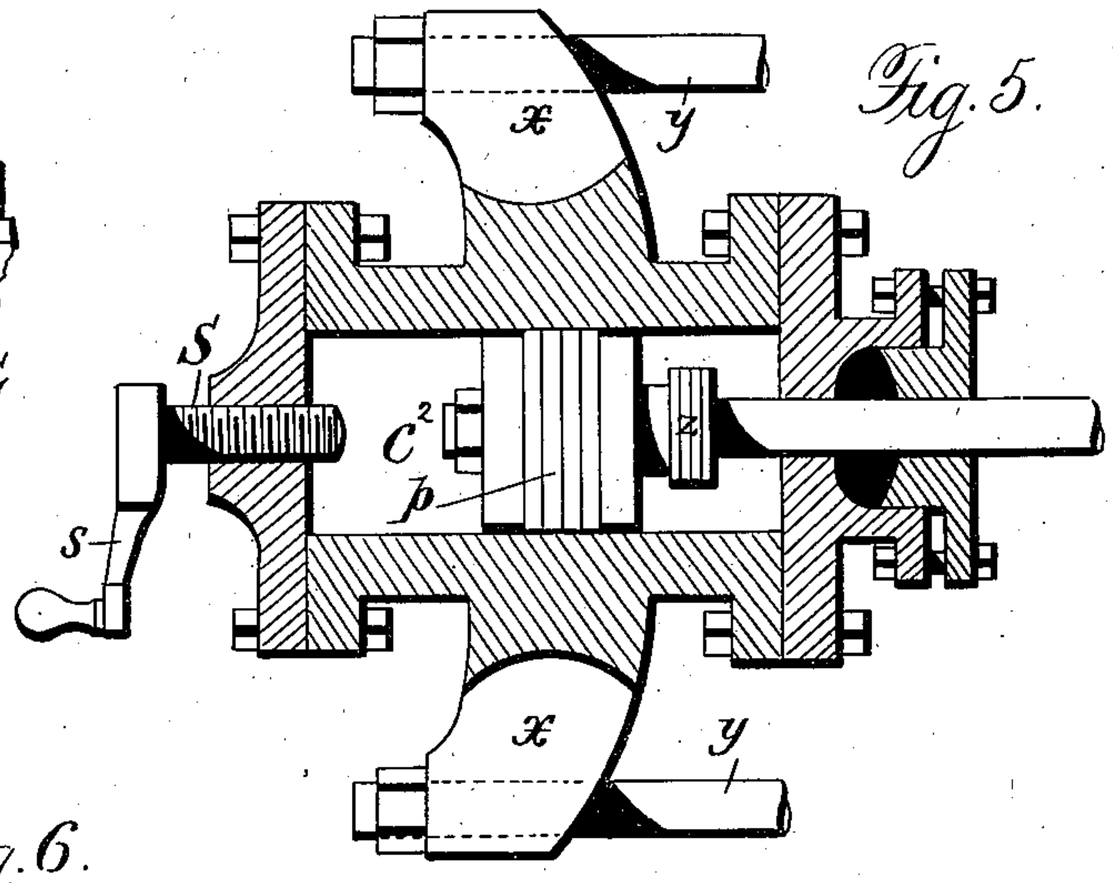


Fig. 6.

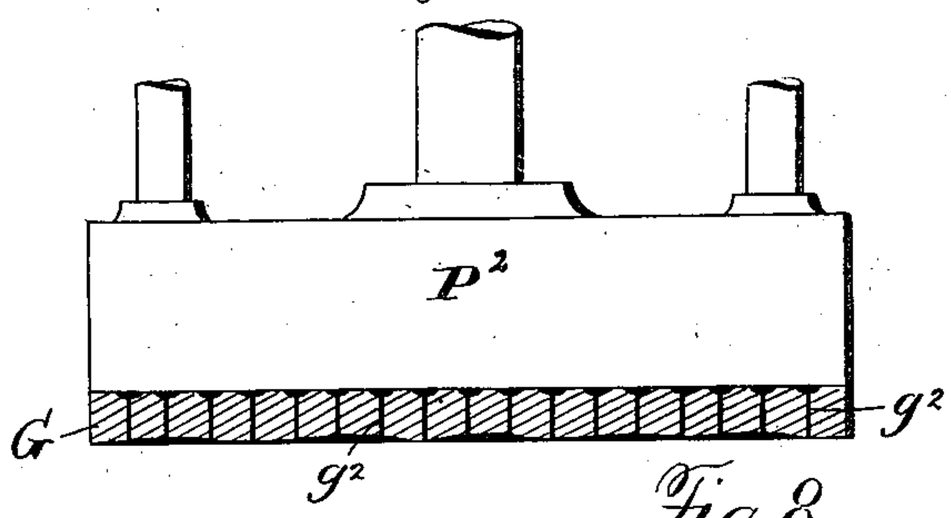


Fig. 7.

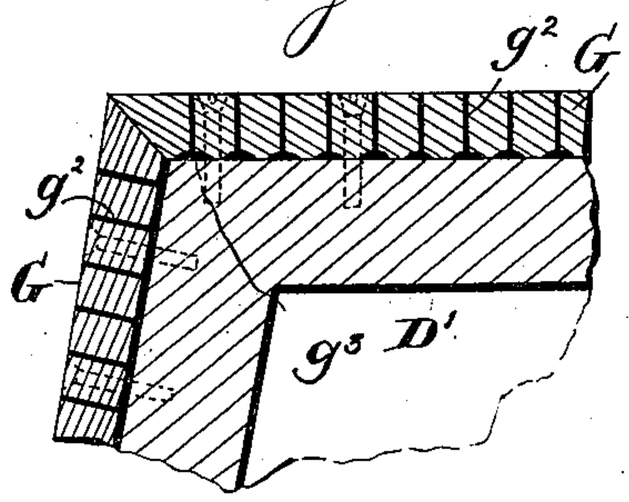


Fig. 8.

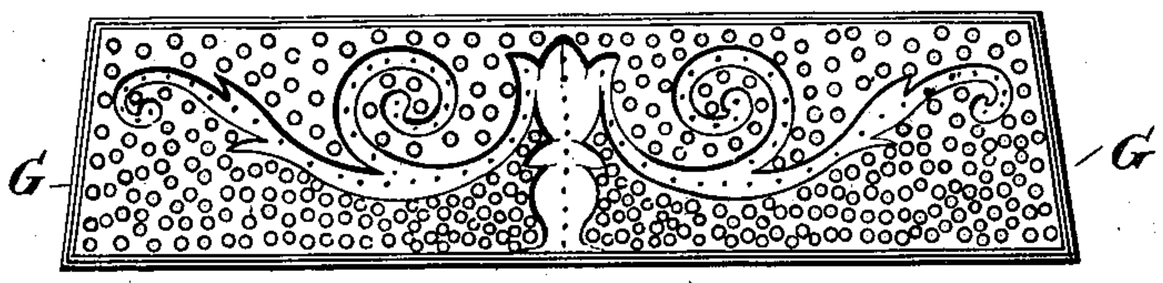
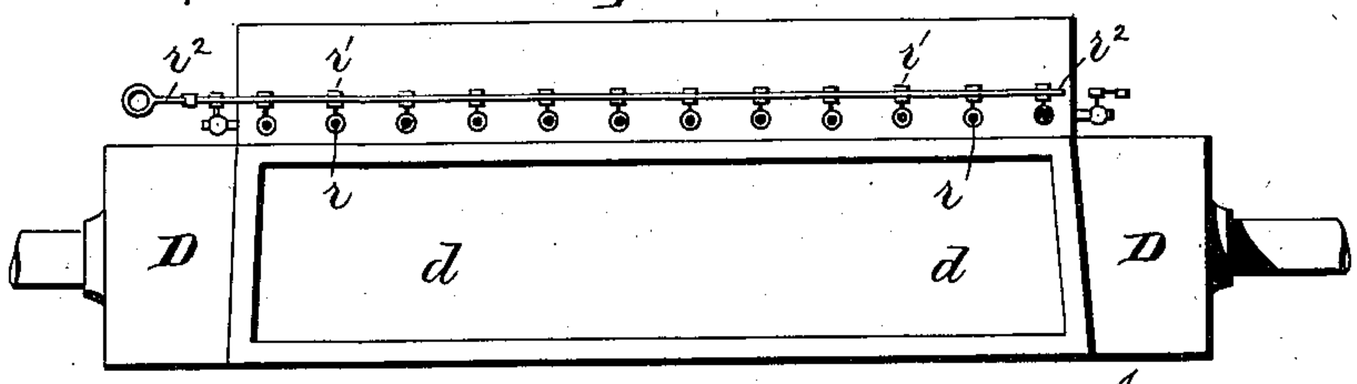


Fig. 9.



Witnesses:
Jas. E. Hutchinson.
Robt. Ewell.

Inventor.
George E. Shaw,
By L. M. Nova Attorney

UNITED STATES PATENT OFFICE.

GEORGE E. SHAW, OF CINCINNATI, OHIO.

PULP-COMPRESSION APPARATUS.

SPECIFICATION forming part of Letters Patent No. 528,613, dated November 6, 1894.

Application filed June 7, 1894. Serial No. 513,810. (No model.)

To all whom it may concern:

Be it known that I, GEORGE E. SHAW, a citizen of the United States, residing at Cincinnati, Ohio, have invented new and useful Improvements in Pulp-Compression Apparatus, of which the following is a specification.

My invention relates to compression apparatus for the manufacture of pulp material into articles of use, its object being to provide a practical and efficient machine adapted to the production, in one continuous operation of solid layers of compressed pulp material of great density, toughness and resisting strength, and particularly to the manufacture of burial caskets and other box shaped articles from pulp material.

To this end my invention consists primarily in pulp compression apparatus, combining a homogeneous imperforate core co-extensive with the entire inner surface of the layer to be produced, a homogeneous imperforate compression plunger co-extensive with the entire outer surface of said layer, and provided with means to operate directly against the layer held upon said core surface, both core and plunger being hollowed to admit a heating agent directly against the entire compression surfaces, and minutely perforated drainage and facing plates for both plungers and core also co-extensive with the compression surfaces; secondly, in pulp compression apparatus for the production of plane sided hollow articles, combining a fixed, homogeneous imperforate hollow core co-extensive with the interior of the article to be produced, a series of minutely perforated drainage and facing plates fitted to the exterior of the core co-extensive with the inner sides and bottom of the article to be produced, each to each, a series of hollow imperforate plungers co-extensive with the outer sides and bottom of the article to be produced respectively, and similar minutely perforated drainage facing plates upon the plunger, whereby equal and uniform drainage is afforded and heat applied at both sides of the layer under compression; thirdly, in a compression apparatus embodying substantially a base, a series of standards seated in and rising therefrom, an intermediate plate supported by and upon said standards, a series of compression chambers seated on said intermediate plate in radial axes, vertically and horizontally about a central opening in the plate, means attached to said plate for operating plungers in the horizontal chambers, and means attached to upward extensions of the standards for operating the plungers of the vertical compression chamber; fourthly, in a compression apparatus of the character indicated, a supporting frame embodying a base, a series of standards rising therefrom, an intermediate supporting plate for carrying the compression chambers and the means for operating the horizontal plungers, and an upper frame carried upon extensions of the central group of standards for supporting the means for operating the vertical plunger, substantially as described; fifthly, in compression apparatus of the character indicated, the combination of the centrally open supporting plate, the compression chambers radially arranged about said opening, the compression plungers and means of operation; a platen normally filling said opening, the core supported on said platen, the screw shafts (one or more) supporting said platen, and the disks threaded upon said screw-shafts and furnishing a bearing for the same upon the base and by their rotation elevating or lowering the platen and core; sixthly, in compression apparatus, the combination of the core-supporting platen, the embracing ring surrounding and supported upon said platen, means for raising or lowering the platen, and bracket stops projecting in the lower path of the ring independently of the platen to engage and retain the ring and allow the platen to descend through and clear of the same; seventhly, in compression apparatus of the character indicated, the combination with a plunger operating in a compression chamber, an actuating cylinder in the rear-projected axis of the compression plunger with its piston rod connected to and operating the plunger, and adjustable regulating stops in the cylinder to limit the stroke of the piston; eighthly, in compression apparatus of the plunger type in combination with two adjacent plunger chambers, a chamfered meeting edge of the junction walls, whereby a vacant space is left outside the path of the plunger; ninthly, in pulp compression apparatus of

the plunger type, the combination with imperforate plungers, of facing plates carried directly upon the plunger faces, said plates having smooth dressed outer surfaces and perforated at approximately uniform distances apart by minute drainage apertures sunk without disturbing the surrounding outer face, and connected at the rear of the plate by shallow channels; tenthly, in pulp compression apparatus, in combination with a series of centripetally acting plungers, a central imperforate core provided with facing plates fitted each to each to exactly define the interior of the body produced, each plate having a smooth dressed outer surface, and perforated at approximately uniform distances apart by minute apertures sunk without disturbing the surrounding outer surface, and conneeted at the rear by shallow channels; eleventhly, in compression apparatus of the character indicated, the combination of a plunger chamber, a plunger moving therein, a perforated drainage plate facing said plunger, and a series of openings through the chamber wall in a plane perpendicular to its axis; twelfthly, in pulp compression apparatus, in combination with a compression plunger or die, a removable facing plate having an intaglio design recessed therein to form a relief design upon the compression pulp layer, and a series of minute perforations carried through the plate in the recessed portions to a drainage space at the rear of the plate.

Mechanism embodying my invention, is illustrated in the accompanying drawings, showing a machine designed for the production of burial caskets, in which—

Figure 1, is a side elevation, partly in section, of my invention complete; Fig. 2, an end elevation; Fig. 3, a horizontal plan view through the core, compression chambers and plungers, showing their relations and construction, and the form of the supporting plate. Fig. 4, is an enlarged detail of the meeting corner of two adjacent plunger-chambers, showing the construction with reference to the production of reinforced corners of box-shaped articles. Fig. 5, is a detail axial section of one of the compression cylinders showing the construction and the means of limiting the travel of the plungers and the means for attachment of tie-rods. Figs. 6 and 7 are detail views showing the construction of the drainage facing-plates of plungers and core. Fig. 8 is a face view of one of the facing-plates, showing the intaglio surface for the production of the relief designs and the relation of the drainage apertures to the design recesses. Fig. 9 is a side elevation of the plunger-chamber-casing showing the series of external drainage apertures and their valves.

Referring now to the drawings, the general supporting frame of the machine consists of a base A, from which rise four central standards, *a*, supporting a cylinder frame B, embodying the two upper compression cylinders *c*, *c'*, (hereinafter more fully described;) and midway between the base A, and the upper cylinder frame B, a horizontal plate C, supported upon the standards, *a*, and likewise upon additional outer standards, *b*, of shorter length acting merely as strut supports.

Upon the intermediate plate, C, is carried a series of plunger-chambers, *d*, embodied in casing, D, which I prefer to form as a single casting. The casing D embodies four lateral chambers opening outwardly in a common horizontal plane arranged oppositely each to each, (corresponding in cross area with the sides and ends of the casket to be produced) and a vertical chamber *d*, corresponding with the bottom of the casket (the casket being produced in the machine in an inverted position). All the plunger chambers have parallel side walls for the reception and play of corresponding plungers P', P², &c., hereinafter described.

A central opening of the plate C, in the projected vertical axis of the upper chamber *d*, (and somewhat larger than the cross area, of the chamber) is occupied by a vertically movable core or "former" D', of the form and dimensions of the interior of the casket body. The core is supported upon two columns or standards, *e*, *e*, arranged in the projected vertical axes of the two upper compression cylinders *c'*, *c'*. These columns are preferably screw-shafts, extended through the base A, and threaded through two rotating supporting disks, *e'*, *e'*, resting upon the base and preferably having cogged peripheries engaged by a driving screw-shaft e^2, which is connected to a suitable source of power. The supporting screw-shafts and rotating disks may be formed with oppositely moving threads and engaged by right and left screws upon the shaft e^2, and thus absorb the end thrust of the driving shaft in itself.

At opposite sides outwardly upon the plate C, opposite the ends of the casket-core (Fig. 1) are bolted two cylinder frames each embodying a compression cylinder c^2, c^2, and in the same general relation, opposite the sides of the casket-core, (Fig. 2) are two cylinder-frames each embodying two compression cylinders c^3, c^3. These cylinder frames, whether single or double, are substantially similar in construction; being ordinary working cylinders adapted to operate pistons *p*, by fluid pressure, and cast with strong radially projecting ears *x*, whereby they are engaged and tied across the machine by parallel tie-rods *y*, so that each cylinder or pair is tied across to its oppositely acting mate; thus, opposing the stress in one direction, to that in the opposite direction, and relieving the general frame work of the machine which may therefore be much lighter than would otherwise be required, besides insuring a free and exact operation of the moving parts, and improved results in the final product, inasmuch as all parts under stress of use are held to exact positions. The upper cylinders *c'*, are tied

in the same manner to the base A, by their supporting standards *a*.

The pistons *p*, operate in the projected axes of the compression chambers, or, in case of doubled cylinders, parallel thereto, (each longer plunger forming a side or bottom of the casket and provided with two actuating cylinders to distribute the pressure more uniformly) and are proportioned so as to give, with a fluid pressure common to all the cylinders of the entire series, an equal compression of the pulp material at all points in each side, end and bottom of the casket, whatever be the area of the surface layer of material acted upon. The piston rods *p'*, are connected directly and rigidly to the plungers, whereby the plungers and pistons are perfectly guided and move in their casings without binding.

The relative positions of the plungers in their ultimate compression limit, are shown in Figs. 1 and 3, adjacent plungers meeting exactly edge to edge. This limit is defined and regulated by a stop-collar *z*, (Fig. 5) placed upon each piston-rod preferably an aggregation of metal washers added to or diminished in number as required to accommodate wear, &c., and acting as a stop against the head of the cylinder *c*. The withdrawing-limit of the plungers is defined by a set screw S, threaded through the rear head of the cylinder and projecting inwardly into the path of the piston *p*, and outwardly provided with a crank or hand-wheel *s*, rendering the stop adjustable. This adjustment, by defining the withdrawing-limit of the plungers, regulates the amount of pulp employed in each individual case, which differs according to the nature of the material, or according to the quantity of material required in the ultimate product. The limiting stop is arranged therefore to be freely accessible and under control of the attendant at all times; whereas, the forward stop, when once adjusted, is fixed and permanent, excepting as influenced by wear or other accidental causes, and will be rarely changed.

Suitable mechanism and indicators, (not herein shown) are also provided, so that the exact position of each plunger of the series, at any given period in the progress of its action, and its relative rate of speed, are indicated to the attendant as a guide to the manipulation of the valves, &c., now to be described.

The motive power for the operation of the compression pistons, is furnished, preferably, by oil or water under pressure, from a suitable pressure-reservoir or pump. (Not shown.) The motor-fluid is first delivered to a hollow distributing chamber M, (preferably spherical) to which connect, radially, the distributing pipes *m*, (with branches to doubled cylinders) through which the motor-fluid under pressure, is delivered to the several compression cylinders behind the pistons *p*. The series of distributing pipes is arranged to present, as nearly as possible, the same length and uniform conditions as to friction, &c., and each pipe is furnished with a regulating valve *n*, near the cylinder or pair into which the fluid is distributed. By suitable attention and regulation during a few preliminary trials and observant attention thereafter, from time to time, exact correspondence of movement of the plungers, is secured. Such correspondence is essential, for the reason that the material under compression is not plastic in a proper sense, but its constituent fibers tend to "set" and lose their freedom of inter-movement under a pressure that excludes the water of suspension; and any action of one part of the series of compressing elements, out of correspondence with others, tends to displace and disrupt the fibers of the mass and impair the product. The pistons are receded by the motor-fluid delivered through a similar distributing system of pipes *o*, entering the cylinders at the opposite ends, the motor-fluid first used being forced thereby back into the supply tank through the first named pipe system.

As the object of compression is to exclude the water of suspension and compact the solid constituents of the pulp, the provision for drainage next demands attention; and, as the constructive features in this regard, depend somewhat upon those for the application of heat which supplements the drainage by vaporization of the residual moisture, in the operation of the apparatus, the construction of the plungers and core, now to be described, is determined by all these considerations jointly.

Both core D, and plungers P', &c., are imperforate hollow castings, suitably strengthened by ribs and braces, and faced exteriorly upon the compression faces, by metal plates G, to be presently described. The plungers are connected by flexible hose sections, extending from one to the next, so that the hollow interiors of the plungers form a practically continuous passage way for steam, hot air, or other heating fluid, raised to a given temperature, and passed through in sufficient excess to make good any loss of heat by radiation, condensation, &c., whereby the metal contact faces at both sides of the layer of pulp under compression are maintained at a given temperature for any length of time desired, and the heat transmitted by direct contact of the pulp layer with the heated metal.

The drainage of the pulp-material is effected by metal facing-plates G, upon the compression faces of the plungers and the outer surfaces of the core perforated at uniform distances apart, by minute apertures g^2, extending through to shallow cross grooves g^3 at the under sides of the plates, as shown in Figs. 6 and 7. The plates rest against and are secured to the pressure surfaces of the plungers and core, and the recesses or grooves g^3, form channels with the surfaces against which the plates rest, permitting the water to flow freely

outward. The drainage facing plates of the core are fitted together diagonally at the corners, as shown in Fig. 7, and the upper plates of the core (corresponding with the bottom of the casket) may be formed with a double set of intersecting channels crossing and connecting with those of the side-plates of the core, which are arranged vertically (as are also those of the side end and plungers) and lead out below at the inner side of the ring presently to be described; whereby a free escape is afforded the expressed water, aided by gravity as compression proceeds, the fit of the ring R, around the core being sufficiently loose to allow the water to pass downward.

The drainage of the water passing through the perforated plunger facing-plates is provided for as follows:—That from the side and end plungers, finds its way out below past the ring R (presently to be described) whose joints with the lower opening of the casing D, or supporting plate C, are sufficiently open to allow the escape of water under pressure. The water passing upward through the facing plate of the upper plunger is taken off by a series of perforations *r*, through the shell of the upper plunger-chamber *d*, (as indicated in Figs. 1 and 9) as near as possible to the bottom of said chamber, and in a common horizontal plane. In these perforations are secured short tubes having their inner ends covered by screens of fine wire gauze brought flush with the inner surface of the chamber, and provided outwardly with stop-cocks *r'*, having their operating handles connected to a common operating rod r^2, at each side. As the facing plates are of thickness approximately from one-half to one inch, and as their sliding fit with the interior surfaces of the plunger-chambers is not absolutely close, the drainage water at the upper side of the facing-plate under consideration, finds easy vent outwardly during compression, and the parts are so arranged and proportioned that, at the position of final compression, the channels of the upper plunger facing-plate are in direct communication with the perforations *r*.

The core D', is an imperforate hollow casting, which, when covered with its facing-plates, is externally co-extensive with the interior of the casket body, and is attached to a platen *t*, of similar horizontal form with the marginal opening of the casket body. Surrounding the platen *t*, is a ring R, of similar form, resting, by means of an inner ledge, upon an outer shoulder of the platen. When the platen *t*, stands at its upper limit of movement, the upper surface of the ring is flush with the bottom surfaces of the horizontal plunger chambers, and it thus forms and defines the upper margin or edge of the casket body, being of a corresponding thickness with the shell of the casket at such margin.

Brackets *u*, are secured to the standards *a*, below and in the path of the ring R, so that, as the platen *t*, is moved downward, the ring reaches a resting support upon the brackets, where it remains as the platen is further depressed, and until it is again lifted with the platen, when the ring is again elevated.

In plunger machines heretofore, the walls of adjacent plunger-chambers meet at a sharp edge *f*, as illustrated by dotted lines in Fig. 4 in which *d' d'* designate the meeting walls of adjacent chambers, and *f*, their meeting edge, (*f*, also designating, in the case of a product having angular corners, a corner of the compressed body.) Now, in the compressive movement of the plungers P', P^2, from the position shown, to their limit of movement (the outer face of the casket body T) it will be seen that the action tends to produce, in the compressed product, a line of division between the compacted fibers extending into the shell T, diagonally from the corner *f*, and the greater proportion of the fibers at the end of the mass in one compression chamber, are, by the conditions of structure, held apart from those of the adjacent compression chamber; and, excepting those of the inner layer of the casket, they are given no opportunity to coalesce or interlock, but are simply brought together, as compression proceeds with less and less force to the extreme outer layer of the shell in which the ultimate movement of the plungers simply brings the fibers to the point of contact without any compression together. These defects exist also in circular or other structures produced by radially arranged compression plungers. As a result of this inherent structural defect in this general type of machines, a defective product is produced because the subsequent shrinkage of the material opens the corners or weak places in the periphery where the described action took place; and, as a result, machines of this class have commonly been regarded as failures. The constructive features incident to this part of the improvement, are illustrated in Fig. 4; that is to say, I chamfer away the meeting edge or corner formed by the walls of adjacent plunger-chambers to a line *f'*, thus forming a triangular space f^2, extending the entire length of the meeting walls, and outside the normal limits of the plunger action. As the plungers P', P^2, move inward, the pulp in this space becomes so far compacted with the main body of pulp in the chambers, that, as the plungers reach the points and move toward their meeting point *f*, the pulp of the triangular space is carried forward diagonally and forced into the body of pulp on either side, and bent to form the actual corner of the casket body; and in so doing, its fibers are forced into interlocking relations with those on either side. By this means, and by the additional material thus forced into the mass, the corner of the casket is rendered even stronger and more dense and perfect than the rest of the casket body, and there is no break in the interlocking continuity of the fibers.

The operation is as follows:—The plungers having been withdrawn to their ultimate

limit, as determined by the adjustable stops S, and the core being elevated to its highest position, pulp is admitted into the plunger-chambers *d*, in front of the plungers P, completely filling the space around the core D, and above the ring R, (preferably under some pressure to exclude air and fill the recesses of the facing plates forming the relief ornaments of the casket body.) The motor-fluid is then admitted (from the reservoir or pumping apparatus), through the distributer M, and pipes *m*, to the compression cylinders *c*, and the pistons *p*, are moved forward carrying the plungers P, in the chambers *d*, also forward and compressing the pulp around the core D, to form shell A'. (Shown in heavy black line in Figs. 1 and 3.) As the compression proceeds, water is excluded and drained outward through the drainage plates as before explained, and the fibers of the material become more and more compacted. Before the plungers reach their ultimate forward limit, the water is practically excluded, so far as can be done by reasonable pressure; and steam is then admitted into and through the hollow plungers and core by the hose S; and the metal parts in contact with the pulp layer are thus brought to a temperature sufficient to vaporize the remaining moisture, which finds vent through the drainage channels before described. The desiccation thus takes place at both sides of the pulp layer uniformly and proceeds inward, while compression still continues, following up the shrinkage induced by heat and desiccation, until the plungers reach the final limit of movement as previously adjusted, and produce an extraordinarily dense and compact structural product, which, by reason of the mode of compression (compacting the fibers without displacement in the overlying and interlocking positions naturally assumed) and the mode of applying heat together with pressure, (at both sides of the shell, desiccating the outer layers uniformly, and following up the natural shrinkage by forced compression,) is of extremely compact structure and practically without tendency to warp, and has all the good qualities of an "indurated" product without any of the defects incident to indurating processes.

The so called drainage plates also possess another function, namely: they constitute also removable design-plates which may be removed and others substituted in the machine to produce caskets having other ornamental designs. A suitable series of such plates being provided, changes may be quickly effected for such variety of production by the same machine; and repairs of any kind effected with the equal facility. They also embody a latent function as design plates, in this respect, viz: that as they present irregular recesses or "pockets," in the general flat surface of the compression face the impediments to drainage and liability to imprison air, thus preventing the pulp material from properly filling the recesses thus created, would, without special provision for drainage, render it impracticable to produce the raised designs upon the surface of the pulp layer with any degree of perfection. For this reason, in addition to the perforations through the general surface of the plate as described, minute drainage perforations are in all cases made through the plate, in the recesses more particularly in the deeper portions, which enable the air and moisture to find vent as compression proceeds. By this feature of construction the spongy and imperfect character of the raised portions of the ornament upon the product otherwise produced, is entirely avoided, and the ornamental portions as produced of hard and dense structure and perfect contour.

If desirable, external drainage apertures (as illustrated in Fig. 9) may also be made through the side plunger chambers.

I claim as my invention and desire to secure by Letters Patent of the United States—

1. In pulp compression apparatus, the combination of a homogeneous imperforate core co-extensive with the entire inner surface of the layer to be produced, a homogeneous imperforate compression plunger co-extensive with the entire outer surface of said layer and provided with means to operate directly against the layer held upon said core surface,—both core and plunger being hollowed to admit a heating agent directly against the entire compression surfaces,—and minutely perforated drainage and facing plates for both plunger and core also co-extensive with the compression surfaces, substantially as described.

2. In pulp compression apparatus for the production of plane sided hollow articles, the combination of a fixed, homogeneous imperforate hollow core co-extensive with the interior of the article to be produced, a series of minutely perforated drainage and facing plates fitted to the exterior of the core co-extensive with the inner sides and bottom of the article to be produced, each to each, a series of hollow imperforate plungers co-extensive with the outer sides and bottom of the article to be produced respectively, and similar minutely perforated drainage facing plates upon the plunger, whereby equal and uniform drainage is afforded and heat applied, at both sides of the layer under compression, substantially as described.

3. A compression apparatus embodying substantially a base, a series of standards seated in and rising therefrom, an intermediate plate supported by and upon said standards, a series of compression chambers seated on said intermediate plate in radial axes, vertically and horizontally about a central opening in the plate, means attached to said plate for operating plungers in the horizontal chambers, and means attached to upward extensions of the standards for operating the plungers of

the vertical compression chamber, substantially as described.

4. In a compression apparatus of the character indicated, a supporting frame embodying a base, a series of standards rising therefrom, an intermediate supporting plate for carrying the compression chambers and the means for operating the horizontal plungers, and an upper frame carried upon extensions of the central group of standards for supporting the means for operating the vertical plunger, substantially as described.

5. In compression apparatus of the character indicated, the combination of the centrally open supporting plate; the compression chambers radially arranged about said opening; the compression plungers and means of operation; a platen normally filling said opening; the core supported on said platen; the screw-shafts (one or more) supporting said platen; and the disks threaded upon said screw-shafts and furnishing a bearing for the same upon the base and by their rotation elevating or lowering the platen and core, substantially as described.

6. In compression apparatus, the combination of the core-supporting platen, the embracing ring surrounding and supported upon said platen, means for raising or lowering the platen, and bracket stops projecting in the lower path of the ring independently of the platen to engage and retain the ring and allow the platen to descend through and clear of the same, substantially as described.

7. In compression apparatus of the character indicated, in combination with a plunger operating in a compression chamber, an actuating cylinder in the rear-projected axis of the compression plunger with its piston rod connected to and operating the plunger, and adjustable regulating stops in the cylinder to limit the stroke of the piston, substantially as set forth.

8. In compression apparatus of the plunger type, in combination with two adjacent plunger chambers, a chamfered meeting edge of the junction walls, whereby a vacant space is left outside the path of the plungers as and for the purpose set forth.

9. In pulp-compression apparatus of the plunger type, the combination with imperforate plungers, of facing plates carried directly upon the plunger faces—said plates having smooth dressed outer surfaces and perforated at approximately uniform distances apart by minute drainage apertures sunk without disturbing the surrounding outer face, and connected at the rear of the plate by shallow channels, substantially as set forth.

10. In a pulp-compression apparatus, in combination with a series of centripetally acting plungers, a central imperforate core provided with facing plates fitted each to each to exactly define the interior of the body produced, each plate having a smooth dressed outer surface, and perforated at approximately uniform distances apart by minute apertures sunk without disturbing the surrounding outer surface, and connected at the rear by shallow channels, substantially as set forth.

11. In compression apparatus of the character indicated, the combination of a plunger chamber, a plunger moving therein, a perforated drainage plate facing said plunger, and a series of openings through the chamber wall in a plane perpendicular to its axis as and for the purpose set forth.

12. In pulp-compression apparatus, in combination with a compression plunger or die, a removable facing plate having an intaglio design recessed therein to form a relief design upon the compression pulp layer, and a series of minute perforations carried through the plate in the recessed portions to a drainage space at the rear of the plate, substantially as set forth.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

GEORGE E. SHAW.

Witnesses:
L. M. HOSEA,
L. C. HOSEA.