No. 662,859. Patented Nov. 27, 1900.

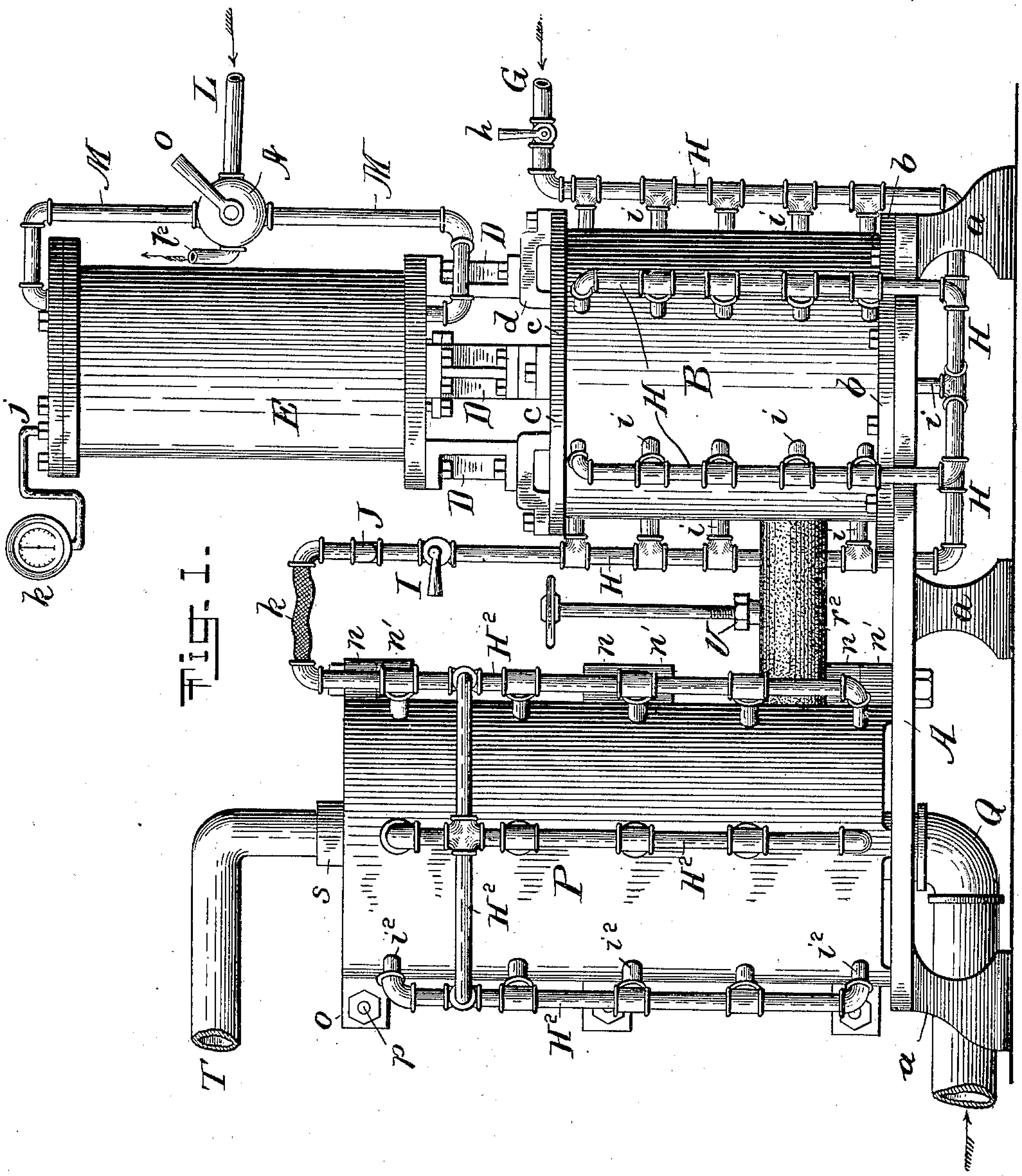
E. HETT.

PRINTING CYLINDER.

(Application filed Apr. 6, 1899.)

(No Model.)

7 Sheets—Sheet 1.



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(No Model.) 7 Sheets—Sheet 2.

Fig. 2.

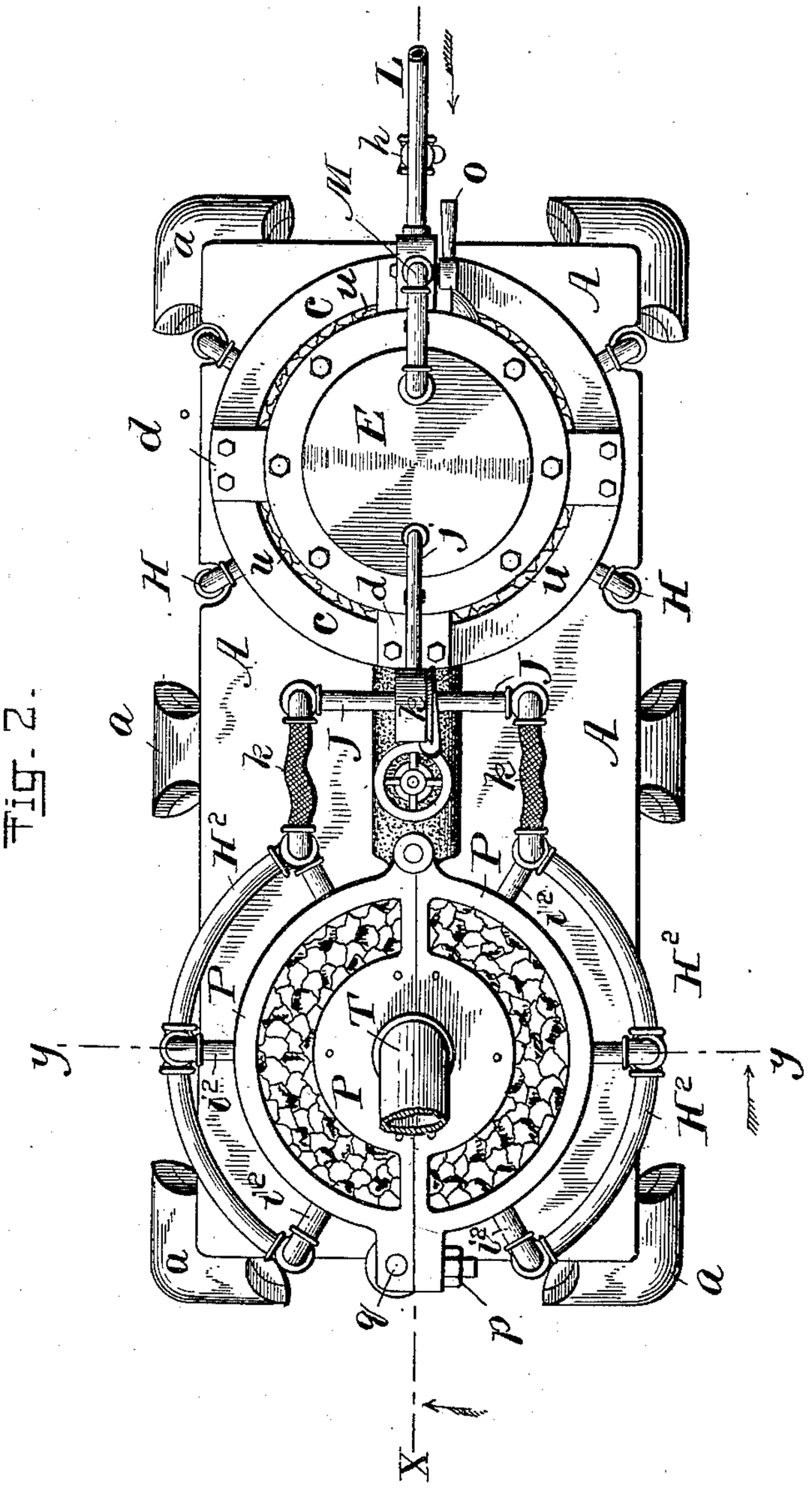

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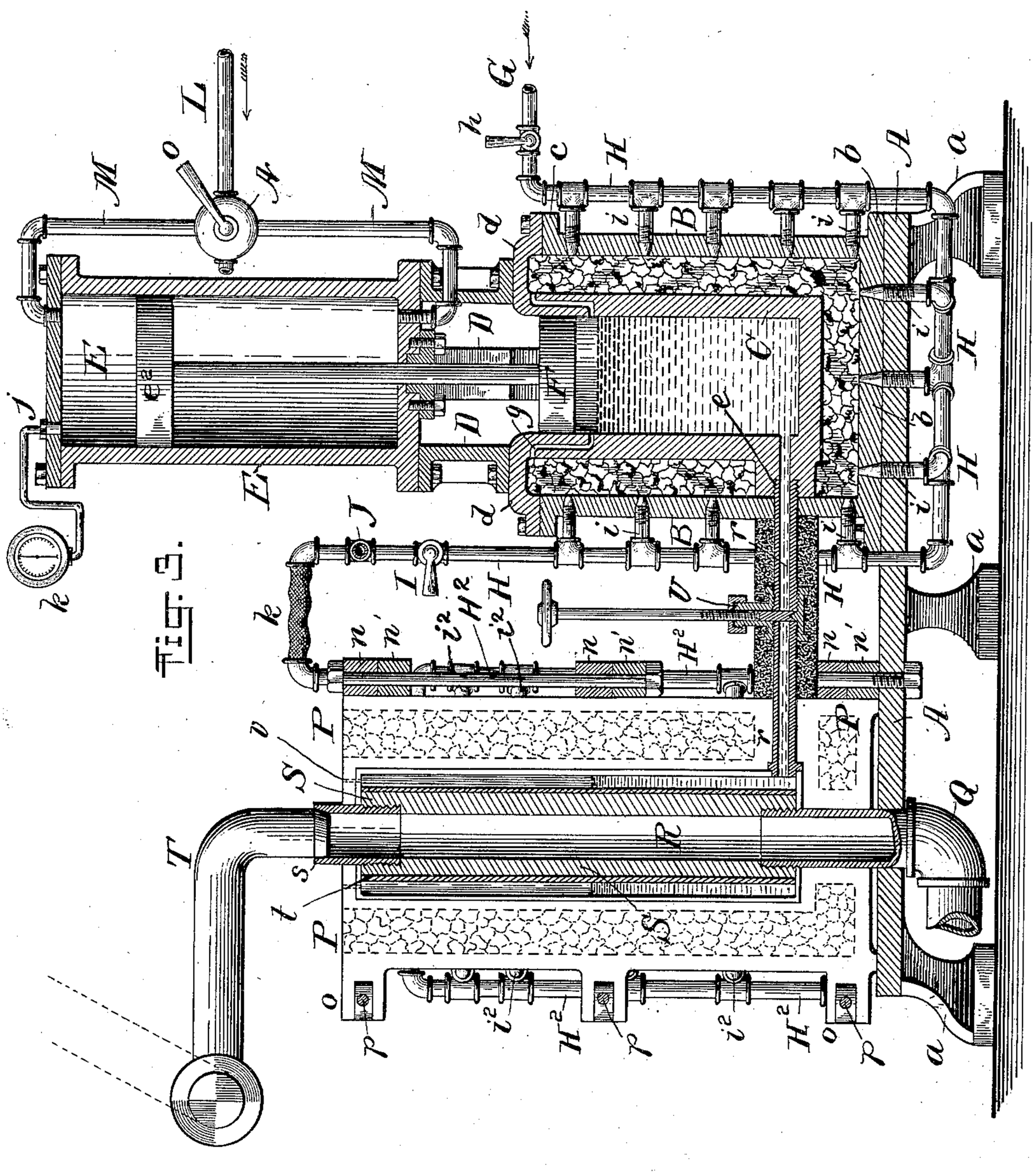
FIG. 3.



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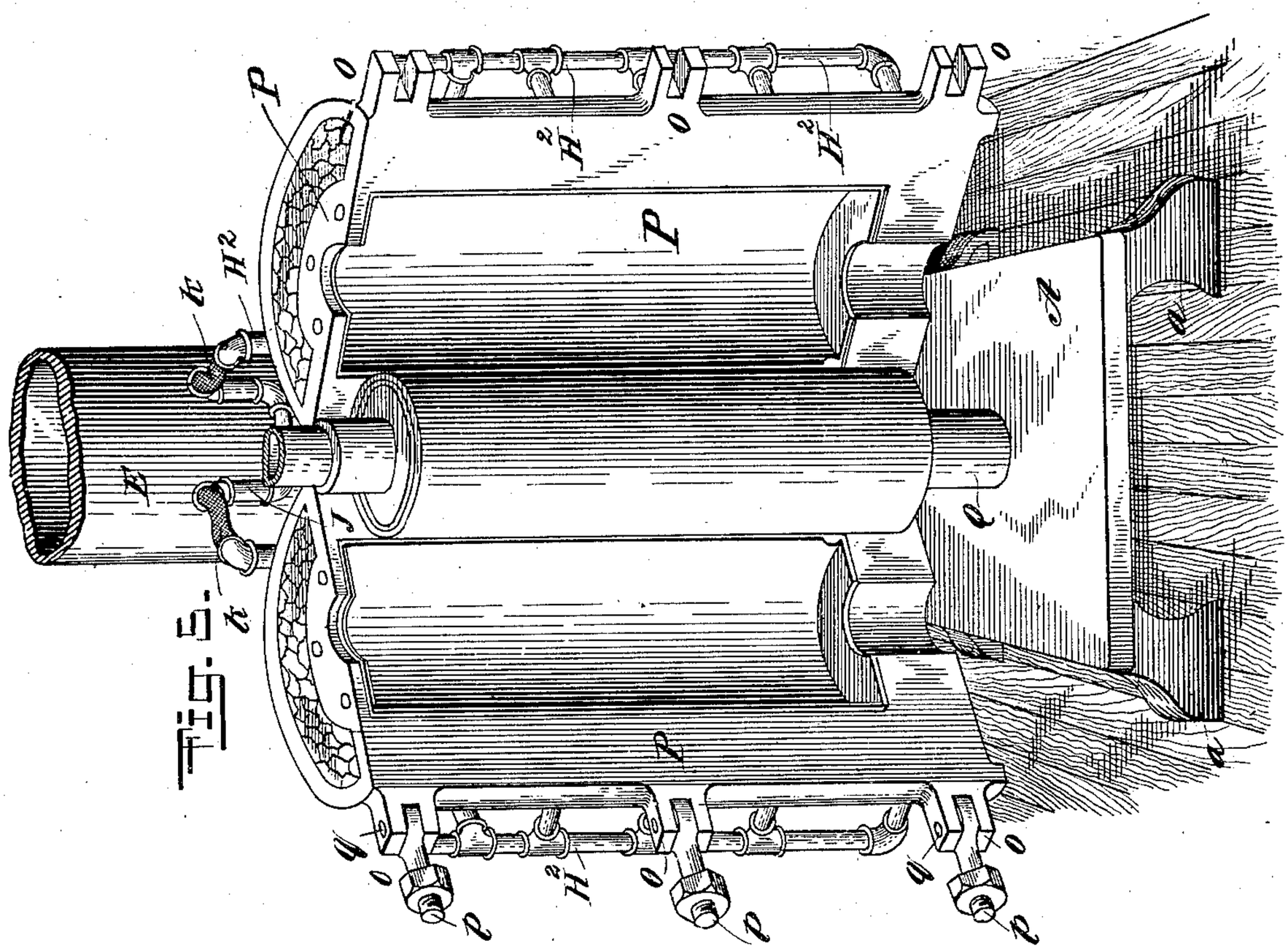

FIG. 5.

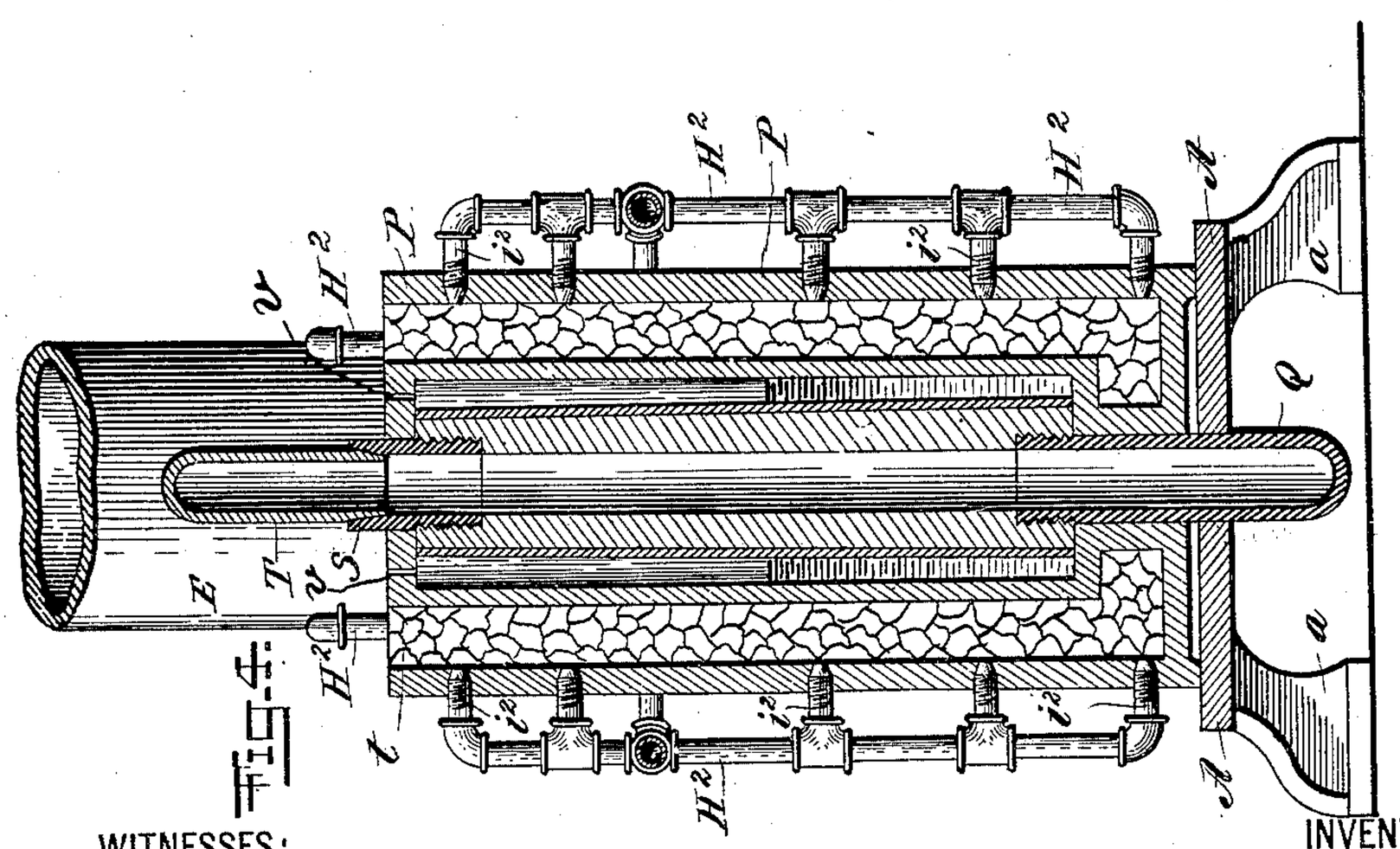

FIG. 4.

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(No Model.) 7 Sheets—Sheet 5.

FIG. 5.

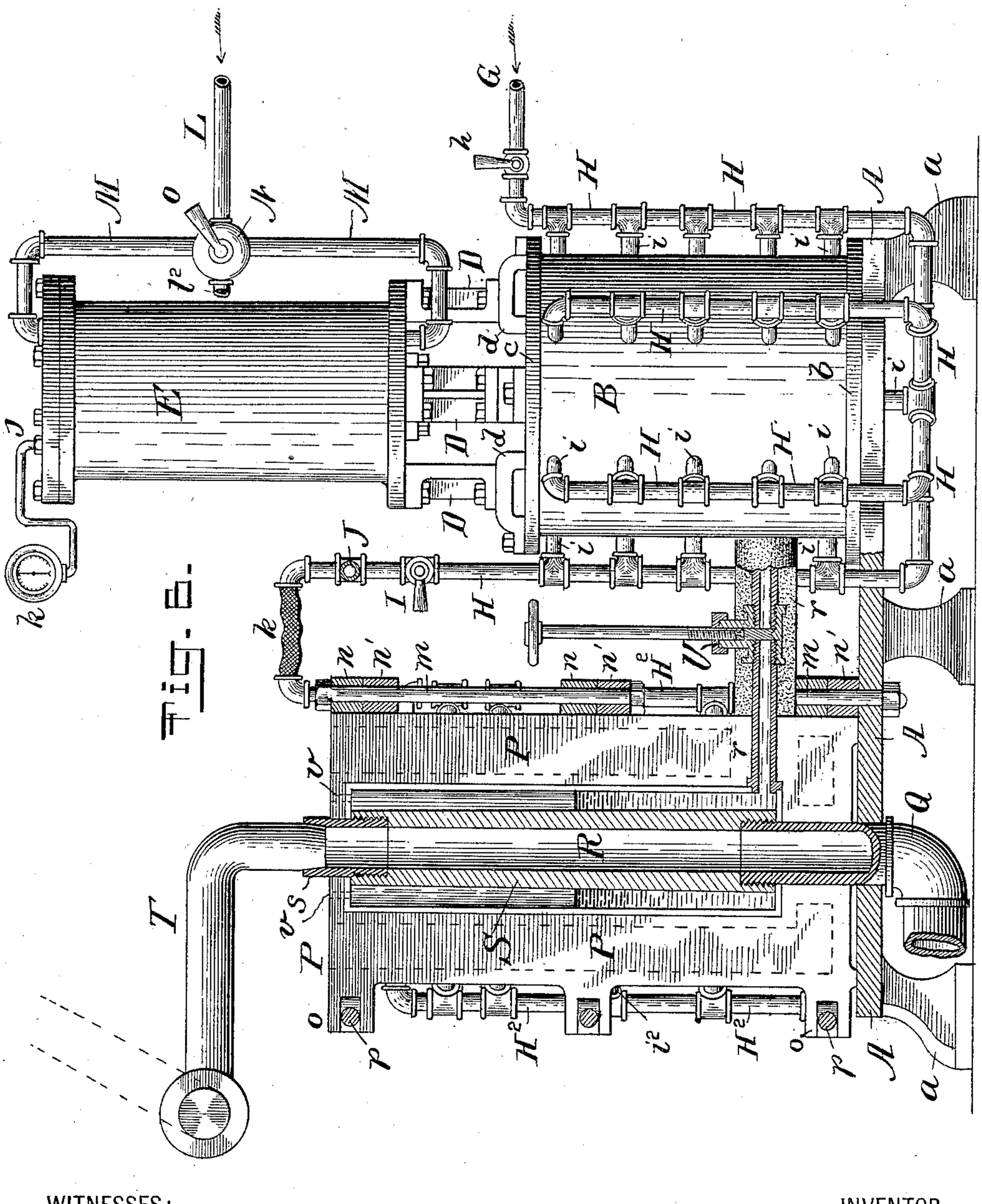

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Fig. 6.

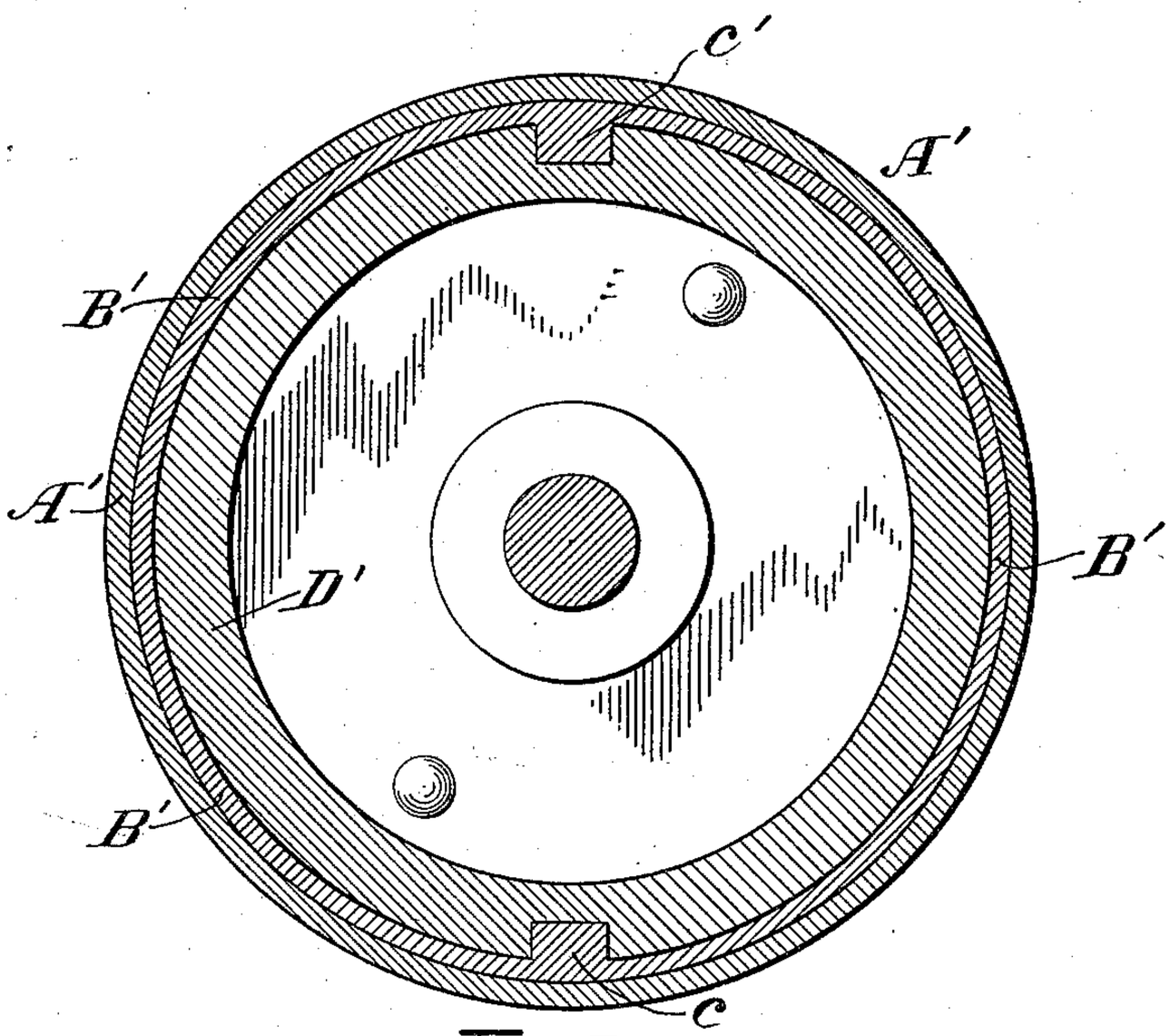

Fig. 7.

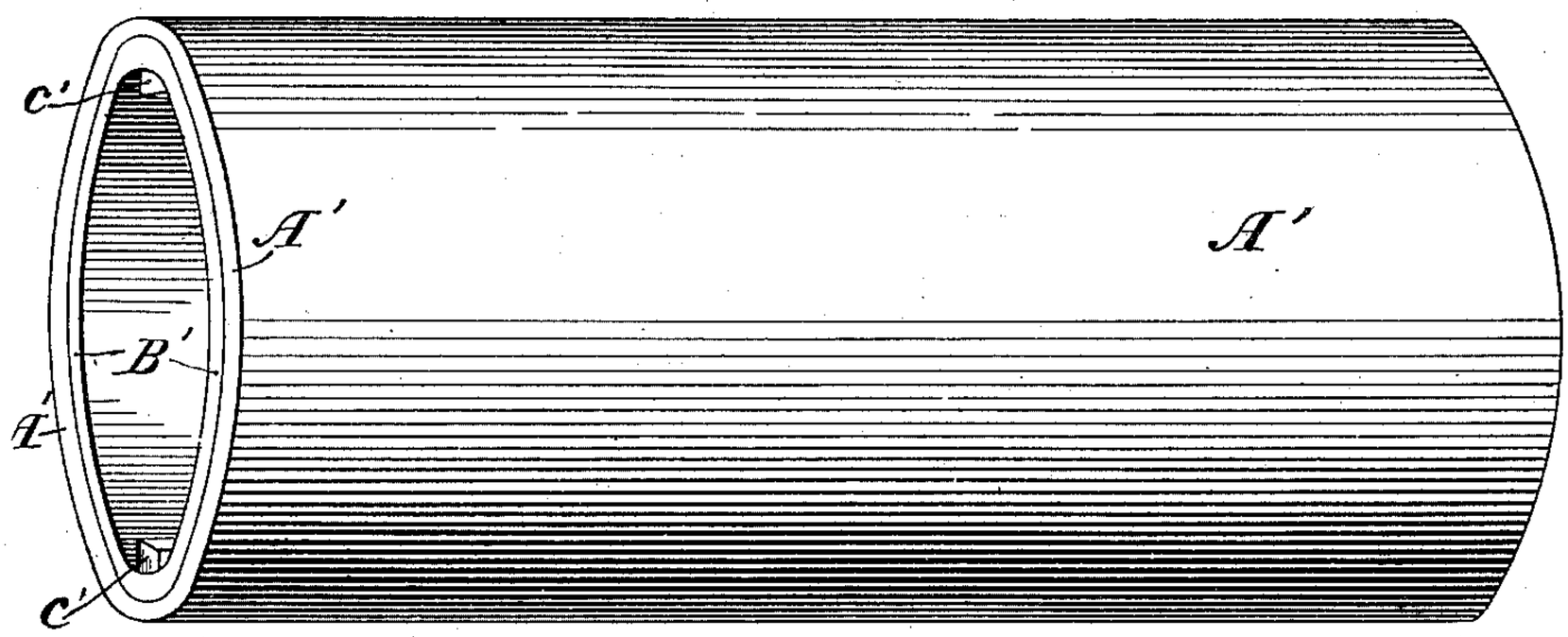

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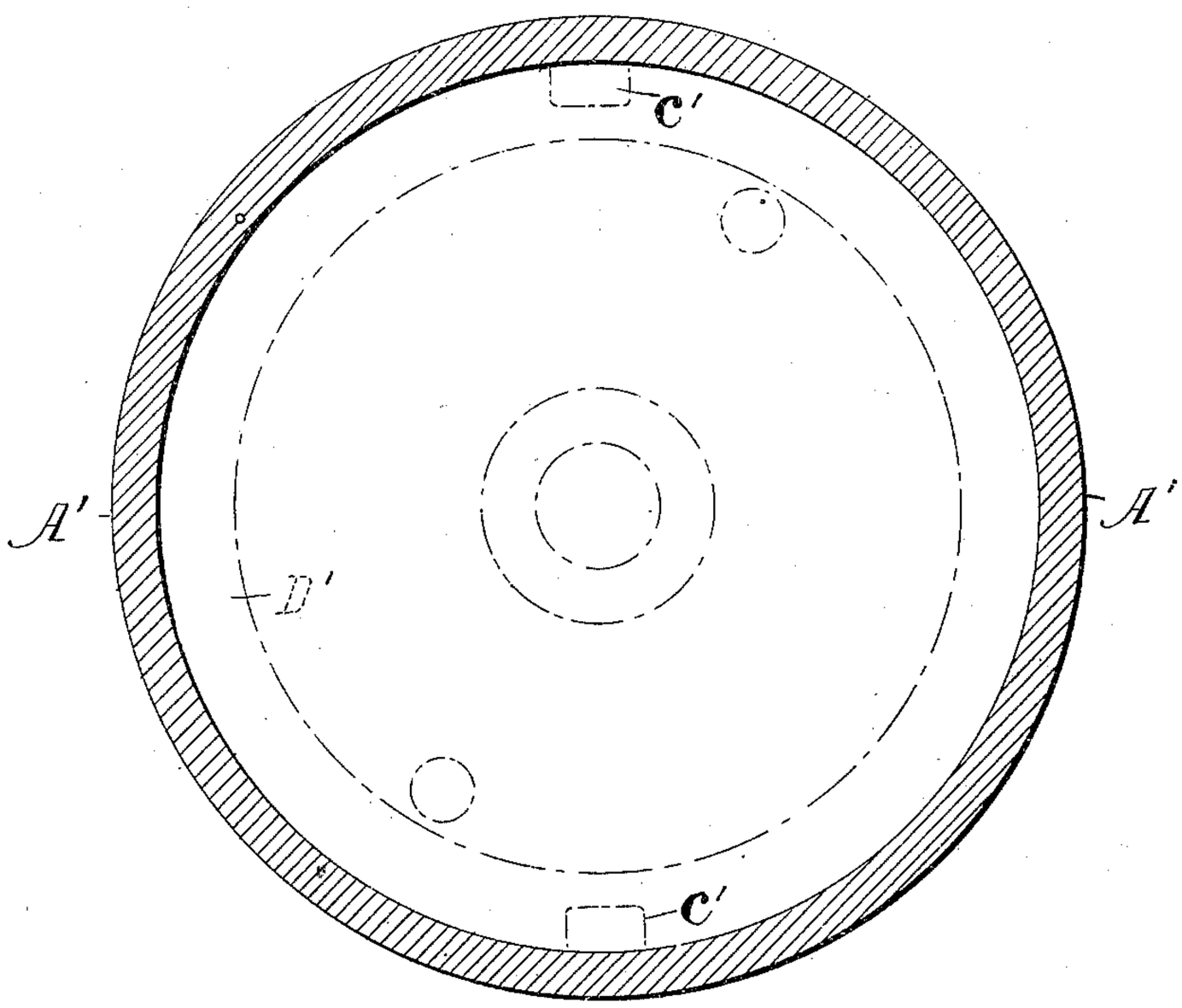
Fig. 9.



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UNITED STATES PATENT OFFICE.

EDWARD HETT, OF NEW YORK, N. Y.

PRINTING-CYLINDER.

SPECIFICATION forming part of Letters Patent No. 662,859, dated November 27, 1900.

Original application filed January 5, 1899, Serial No. 701,196. Divided and this application filed April 6, 1899. Serial No. 711,993. (No model.)

To all whom it may concern:

Be it known that I, EDWARD HETT, a citizen of the United States, and a resident of New York, (New Dorp,) in the county of Richmond and State of New York, have invented certain new and useful Improvements in Printing-Cylinders, of which the following is a specification.

My present invention relates to a printing-cylinder or a printing-tube designed to be applied to the form-support of a printing-press and adapted to the purposes of relief, planographic, or intaglio work in the art of printing. It is related to the inventions of my application, Serial No. 701,196, of which this is a divisional application, (Division C.)

My invention has for its main objects to cheapen and also improve such printing, especially with reference to an accurate and economical construction or preparation of the printing devices or surfaces; and to these main ends and objects my invention consists, essentially, in a novel printing tube or cylinder, which will be found hereinafter fully described as to its structural features or characteristics, and which will be most particularly pointed out in the claims of this specification.

To enable those skilled in the art to fully understand and practice my invention, I will now proceed to more fully describe it, referring by letters to the accompanying drawings, which form part of this specification. In order, however, to do this so that any one ordinarily skilled in the art can from this specification make and use a printing cylinder or tube embodying, either wholly or partially, my said invention it will be necessary to describe the best way now known to me of making or producing the printing-cylinder of my invention, and I have therefore shown in the accompanying drawings and will first proceed to fully describe an apparatus devised by me and made the subject-matter of another divisional application for Letters Patent by me—to wit, Division B—adapted to produce my new product—*i. e.*, the printing-cylinder I have invented.

In the accompanying drawings, Figure 1 is a side elevation of a machine or apparatus in the best form known to me suitable for the purpose of making my new product. Fig. 2 is a top view of the same. Fig. 3 is a vertical section of the same, taken on a plane indicated by the broken line $x\ x$ of Fig. 2. Fig. 4 is a cross-sectional view in a plane indicated by the line $y\ y$ of Fig. 2 looking in the direction indicated by the half-arrow at said figure. Fig. 5 is a perspective view mainly of the molding-chamber, showing the same with its hinged parts opened out. Fig. 6 is a view partly in elevation and partly in vertical central section of the machine or apparatus seen in the other views, with a slight modification illustrating, mainly, the absence of a copper lining from the cast tubular printing device, and as a result the production of such printing device without any lining. In these several figures the same parts will be found always designated by the same letter of reference. Fig. 7 is a perspective view of one of my new tubular printing devices in its preferred form. Fig. 8 is a cross-sectional view of the same on an enlarged scale, illustrating also the combination of the same with the interior form-supports of the press. Fig. 9 is a view similar to Fig. 8, but showing my new printing-cylinder made without any interiorly-arranged strengthening lining or shell.

Mounted upon a sufficiently strong rigid base-plate A that is preferably supported by integrally cast feet or footpieces *a* is a melting-pot cylinder or chamber B, the annular foot-flange of which is securely bolted to the said base-plate A, and within the said cylindrical chamber is concentrically arranged the cylindrical melting-pot or metal-receptacle C, which is so arranged concentrically within the chamber B as to leave an annular space between its exterior and the interior of said chamber and also a space between the exterior of its bottom and the bottom of said chamber B, which space is filled in with some suitable refractory material, by preference fire-clay, as clearly shown in the drawings, (see particularly Fig. 3,) and the said melting-pot or receptacle C is firmly supported or held in place concentrically within the fire-chamber B by means, as shown, of four (more or less) radially-projecting integral arms *d*, the outer ends of which rest upon and are securely bolted to

the annular top flange *c* of the chamber B. The said melting-pot C is provided at one point with a radially-projecting tubular part *e*, which contacts at one point with the inner surface or wall of the chamber B, (see particularly Fig. 3,) which is perforated at this point for the accommodation of a tubular conduit *r*, which communicates with the part *e* of the melting-pot and serves to conduct the melted metal therefrom in a manner and for a purpose to be presently described.

Above the fire-chamber B, with its combined melting-pot C, is arranged a cylinder E, which is supported, as shown, upon a series of metallic stands D, the foot-flanges of which are securely bolted to the parts *d* of the metallic melting-pot and the upper flanged ends of which are in like manner secured to the foot-flange of the said cylinder E. This cylinder is provided with a piston-rod *f*, at one end of which, working within the cylinder, is a piston e^2, while the opposite and lower end of said piston-rod *f* is provided with a piston or plunger F, which fits and works vertically within the cylindrical melting-pot C, all as clearly shown. The said cylinder is of course provided with the necessary and proper stuffing-box devices in its lower head, through which the said piston-rod works, and it is also provided with a gage *k*, suitably connected by a tube *j* with the upper head of the cylinder for the purpose of indicating the degree of pressure exerted by any medium which may be used to drive the piston e^2 of said cylinder.

L is a supply-pipe communicating through the medium of a suitable valvular device N, provided with a handle C, with a vertical pipe M, the upper and lower branches of which communicate, respectively, at the upper and lower heads of the cylinder E with the interior of the latter, and through the medium of these last-named devices said cylinder may be supplied with a proper medium for driving its piston e^2 in either direction, as may be required and for a purpose to be presently explained. In the case shown this cylinder E, with its connections and appliances, operates as a hydraulic engine to move upwardly and downwardly at the pleasure of the attendant of the machine, and with any requisite power, the plunger F of the melting-pot C, but in carrying into effect my invention some other medium than hydraulic pressure may of course be employed for the purpose of moving this plunger.

I have shown by broken lines the supply of molten zinc in the pot or chamber C, which supply, as illustrated, should not reach a higher level than the lower ends of the escape ports or passages *g* (see Fig. 3) of said melting-pot, which ports communicate at their upper ends with the annular fire-chamber or space between the melting-pot and the inclosing cylinder B, which annular space is more or less open at the upper end, as seen at *u*, Fig. 2, to permit the escape of the gaseous productions of combustion from the said annular fire-chamber. G is a pipe for the supply to the said annular fire-chamber of combined gas and atmospheric air, the supply being regulated by an ordinary valvular device or cock at *h* and passing from the said supply-pipe to a network of vertically and horizontally arranged piping H, from which project through the side walls and also through the bottom of the cylindrical chamber B a series of burners *i*, from which flames are injected into the mass of fire-clay which fills the space around and beneath the melting-pot C, as shown, and which is kept by the said burners *i* in the properly incandescent state to sufficiently heat the charge of zinc within the said melting-pot. On the same metallic base-plate A, upon which is mounted, as above described, the chamber B, with its melting-pot and overhead compression-cylinder, is arranged a molding-chamber P, which is made in two parts, hinged together at the point nearest to the said chamber B by means of female articulate members *n* and *n'*, projecting from the respective portions of said two-part molding-chamber and properly combined, as shown, with the vertical male members or pintle-like devices *m*, the lower one of which is securely fastened to the base-plate A, from the top surface of which it projects upwardly, as shown, and the two portions of this molding-chamber P are provided at points diametrically opposite the hinges thereof with a set of radially-projecting lugs *o*, with one set of which are pivotally connected, as shown, locking or clamping bolts *p*, by means of which the hinged parts of said molding-chamber are securely fastened together, as seen at Figs. 1, 2, 3, and 6, and by the loosening and swinging out of which clamping-bolts, as shown at Fig. 5, the hinged parts of said molding-chamber may be swung apart, as illustrated at the last-mentioned figure, for the purpose of extricating from the chamber the casting which may have been made therein. Each of the parts of this molding-chamber is made, as shown, with hollow vertical walls and a cellular bottom portion, the said hollow spaces being filled in with fire-clay, as illustrated in the drawings, for a purpose to be presently described, and the interior of said molding-chamber P is connected at its lowermost portion through the medium of the conduit *r*, hereinbefore referred to, with the interior of the melting-pot C, as plainly shown, (see Fig. 3,) and the said connection or communicating tube *r* is provided near its middle with a cut-off or valvular device U (operated, preferably, by a screw-stem and hand-wheel, as seen at Figs. 3 and 6) for the purpose of permitting or preventing the flow of molten metal from the melting-pot to the interior of said molding-chamber, as occasion may require. Around the said molding-chamber P is arranged a network of piping H^2 very similar to that used in connection with the fire-chamber B, but connected only with the

movable part of said molding-chamber and flexibly connected, as seen at K, with the said system of piping H through a branch pipe J, a short distance below which branch pipe is located a suitable valvular device or cock I, by means of which the supply of combined air and gas afforded from the piping H may be at pleasure turned onto or off from the piping H^2 of the molding-chamber, and from the said piping H^2 projects radially only into said molding-chamber a series of burners i^2, which discharge their flame-jets into the annular spaces or cellular portions of the molding-chamber, which, as clearly illustrated in the drawings, are filled with fire-clay to be heated up by the flame-jets to any desired degree for the purpose of keeping the interior of the mold hot, for a purpose to be presently explained.

S is a cast-iron core which is mounted centrally in the mold. It is accurately shaped exteriorly to exactly reproduce in the mold the exterior shape and size and dimensions of the interior supporting parts of the press designed later to support the tubular printing devices in the press. As shown in the drawings, the core S is tapered from end to end as the form-supports of the press are tapered, the upper end of the core being the smaller in diameter.

Q is a cold-water-supply pipe which is permanently arranged in the base-plate A of the machine, with its upper end projecting slightly up within and tapped into the cast-iron core S of the mold, (see specially Figs. 3 and 4,) which core S has an axial bore or passage-way R running through it, the upper portion of which bore is provided with a bushing *s*, screwed into the core and formed with a tapering upper orifice, within which fits the corresponding tapered lower end of an exit-pipe T, which, as shown, is preferably formed with an elbow, the outer arm of which is pivotally connected with a waste-pipe, so that the said bent exit-pipe T may be either set in communication with the bushing *s*, as shown in full lines, or may be swung up out of connection with said bushing, as illustrated by the dotted lines at Figs. 3 and 6. By means of this arrangement of devices a supply of cold water may at pleasure be afforded to the cast-iron core S of the molding-chamber, the said supply of water being let on preferably at the lower end of the supply-pipe Q, as indicated by the half-arrow at Fig. 1, under sufficient pressure to keep up a circulating supply, thence through the bore R of the core S, and thence upwardly and away from the machine through the connected exit-pipe T and a suitable waste or discharge pipe.

In the molding-chamber, (illustrated in Figs. 1 to 5 of the drawings, *t* is a copper tube which is to constitute the inner strengthening-shell of the composite tubular printing device of my invention. It is accurately prepared internally to fit the interior supporting parts or form-supports of the press. Consequently it fits accurately and snugly onto core S of the molding apparatus and is supported internally by said core and from end to end and at all points. The exterior of the copper tube is preferably made perfectly cylindrical and circumferentially continuous, (so that said copper tube is of slightly-greater thickness at its upper end or mouth than at the lower end,) and the arrangement and proportions of the parts are such, as shown, that between the exterior of said copper tube, thus fitting exactly onto the tapering core S, and the inner cylindrical and continuous wall of the two-part molding-chamber P there occurs an annular space equal in thickness to the designed or proposed thickness of the zinc tube to be cast in said molding-chamber, into which tubular space the molten metal is forced, as will be presently explained. At Figs. 3 and 4 this annular space is represented by the broken lines as being occupied by the molten zinc up to the same level as the molten mass in the pot C. The inner walls of the molding-chamber P are carefully and uniformly finished to a uniform and planographic surface and to the exact character and texture of surface desired on the outer or printing surface of the casting.

In the general operation of the apparatus illustrated in the drawings and thus far herein described with reference to its construction and the arrangement of its several parts the melting-chamber C having been supplied with the proper charge of zinc or zinc alloy or other suitable metal, such as is adapted to produce a surface having the quality or texture necessary to receive a design after the lithographic manner of transferring and to be thereafter developed into a printing-surface for that design of the character desired, and said charge heated up to the proper degree by the appliances already explained, the gaseous and other products of combustion of the fire-chamber escaping from the open portions of the annular space containing the fire-clay, and the molding-chamber having had its parts securely fastened together after the proper application to the cast-iron core of the copper tube or cylinder, before mentioned, and the supply of cold water having been put in circulation through the core of the molding-chamber, when the molten mass in the melting-pot shall have reached the proper liquid state for the casting operation and the molding-chamber been properly heated by the appliances hereinbefore mentioned, the valvular device or gate at U in the connecting-pipe *r* having been opened, the molten metal flows or is forced from the melting-pot through said conduit *r* into the annular space between the inner uniformly and carefully finished wall of the molding-chamber P and the external surface of the copper tube in the mold and is forced to ascend through said annular space and fill the same by reason of the plunger F of the hydraulic or other cylinder being forced down within the melting-pot to a sufficient

extent not only to force the molten metal upwardly within the molding-space of the chamber P, but to also force and hold the molten metal within said chamber under a sufficiently-high degree of pressure to insure the molding of a perfect zinc tubular device of even density throughout the cast mass without any irregular superficial or other porosity and of such surface texture as is desirable and necessary for the purpose for which I make these hollow tubes.

As will be seen by reference to Fig. 3, any air or combined air and gases which may be contained in the small cylindrical space between the top of the molten metal in the melting-pot and the base of the plunger F will be caused by the initial descent of said plunger to pass upwardly and out of the melting-pot through the escape ports or passages *g*, and after the periphery of the plunger shall have passed the lower ends of said ports and come into contact with the top surface of the mass of molten metal further communication between said ports and that part of the melting-chamber which contains the molten material will be cut off and the mass of metal forced dowardly within the chamber C and upwardly within the molding-chamber P under any desired degree of pressure. In practice I hold the metal in the molding-chamber thus under hydraulic or other considerable pressure (by means of the plunger F) until the metal within the mold shall have partially or completely solidified, whereupon by manipulating the cut-off gate U, thus closing communication between the mold and the melting-pot, the pressure on the metal in the latter may be removed. At the same time by keeping the molding-chamber hot by the appliances hereinbefore described the cast zinc tube is not permitted to solidify or cool too rapidly, especially at the vicinities of its exterior or peripheral surface. Inasmuch as the core S is kept comparatively cool by the cold-water-circulating device the copper cylinder which is to ultimately constitute the lining of the composite printing-tube is not so much heated as the mass of molten metal and is sooner cooled, and therefore in the final cooling and necessary contraction of the molten metal into a zinc tube the latter will practically be shrunk onto the copper tubular lining, at which time the copper tube is firmly supported at every point against collapse or distortion. Thus is effectuated a strong and perfect union and integration between these two separate tubular devices, which is of course of great advantage. It will be understood, of course, that in the manipulation of the different devices of the machine shown and described the supply of heat both to the fire-chamber for melting the zinc and to the molding-chamber in the process of casting the zinc cylinder is to be controlled and regulated according to the judgment and experience of the operator of the machine or contrivance. During the casting process or operation to permit the escape from the interior of the mold of air or gas or impurities that may be forced out by the rising metal I have provided at *v* a valvular vent which may be opened and closed as occasion may require, and it will be seen that in the use of a machine I have shown and described in the manner set forth the result is the production of a zinc tube or hollow cylinder which, though of comparatively slight thickness, (usually a little more than an eighth of an inch,) will be perfect in form or outline and with a surface of a uniform degree of density, so that it has to be neither turned, bored out, nor exteriorly prepared to possess a fit condition for use for the purpose for which I design such zinc tubes—namely, to constitute the cylindrical printing-surface for relief or planographic or intaglio printing—for which purpose the uniform surface of the cast tube has only to receive the impression or design and then to be properly etched according to the usual method or process of etching or routed out or properly developed otherwise into the character of printing-surface desired. After the casting shall have sufficiently cooled or solidified within the molding-chamber the latter has its hinged parts swung open (after having released the clamping bolts or devices) into the condition illustrated at Fig. 5, whereupon after cutting off the supply of cold water circulation and swinging up and out of the way the exit-pipe T the sprue or connection between the lower end of the finished casting and the stock of zinc in the contiguous end of the supply-tube *r* may be sawed or cut off and thereafter the finished casting, with its firmly-attached copper lining, may be readily removed with the slightly-tapering core S of the molding apparatus and the latter then slipped out from the composite tube. Thus it will be seen I can produce numerous tubes with continuous cylindrical printing-surfaces which will all perfectly fit on the form-supports of the press while the casting of the tubes or printing-cylinders can be cheaply done and having been used can, if made wholly of zinc, be melted up and the stock recast in the making of similar new tubes, and if made with the copper or other metallic lining or interior shell B (see Figs. 7 and 8) can have the zinc portion wholly or partially turned off (or removed) in a lathe or by acids or otherwise and the lining-shell can be replaced on the core S of the casting-machine, wherein a new zinc cylinder can be molded onto said previously-used shell.

Thus when my printing cylinder or tube may be made as seen at Figs. 7 and 8 the copper part of the composite tube can be used and reused an indefinite number of times, and hence becomes a permanent part of a series of successively made and used printing-cylinders, while the outer zinc portion (or printing-surface) becomes, on the contrary, a removable and renewable envelop integral

with the inner strengthening-shell when in use and presenting by renewal fresh and unused printing-surfaces for new designs to be successively printed.

It will be understood that when the cylinder is made with the copper lining, as shown in Figs. 7 and 8, said lining is carefully made, interiorly to begin with, at great expense, so as to absolutely fit on the form-supports of the press and likewise onto the core S of the casting-machine, and preferably it tapers evenly from end to end to correspond exactly with the taper of the form-supports of the press.

When the tube is made wholly of zinc, it is wholly melted up after each printing job is completed and reliance is placed for the accurate internal as well as external shaping of the tube upon the method of and apparatus for casting herein shown, (see particularly Figs. 6 and 9,) the core S shaping the tube internally and the inner walls of the mold P shaping the tube externally and determining its surface, character, and texture.

Figs. 7 and 8 show the improved tubular printing device in its preferred form. Referring to those figures, A′ is the removable and renewable outer cast part of the composite tube and constitutes the printing-surface, and B′ is the permanent inner strengthening-shell, which accurately fits the interior form-supports of the press and on which the outer shell A′ is cast and shrunk, the two being integrally united. c' c' are inwardly-projecting lugs adapted and fitted to take into grooves in the outer surface of the form-supports of the press. These lugs c' c' may be made integral with or in any desired way securely fastened to the inner shell B′. The shell B′ is internally tapered from end to end to correspond to the external taper on the form-supports of the press and on the core S and so as to be at all times and at every point suitably supported internally, not only during the casting operation, but also during the developing and printing operations. The form-support of the press is shown in section in Fig. 8 at D. In practice the composite tubular device is removable from and replaced on the form-supports of the press and is adjustable in both directions on such form-supports or with such supports in the press, as set out fully by me in applications heretofore filed by me. Fig. 8 illustrates the mounting of my tubular printing device upon a form-support of the press.

In carrying out my invention with the copper-lined form of tube I first permanently and with painstaking care draw and turn and bore and shape internally with an internal taper running from end to end the copper tube that is to constitute the hollow inner strengthening-shell of the composite tubular printing-form, so as to permanently adapt the form to the interior form-supporting devices of the press, preferably making the copper tube cylindrical exteriorly. I then integrally apply to the outer surface of the copper tube a separate printing-surface by casting, as heretofore set out, the mold having internally a peripheral uniformly and carefully finished planographic surface adapted to come into contact with and give shape and texture to the outer surface of the cast metal and so to shape the composite printing-form exteriorly, the mold being accurately shaped and finished to that end, so as to adapt this outer or printing-surface of the printing-form to the coöperating printing parts of the press. In the making of the other form of tube, such as seen at Fig. 9, I carefully make the core of the casting-machine to perfectly match or correspond with the tapering form-supports of the press, and proceeding in all respects as explained with reference to the copper-lined cylinders I cast the printing-cylinder wholly of zinc, and after its removal from the core of the casting-machine it is adapted for use in the press, as I have hereinbefore explained.

What I claim as new, and desire to secure by Letters Patent, is—

1. As a new product, a printing-form cast of metallographic metal in a mold which is heated at the part serving to shape the printing-surface of the form and cooled at the part serving to shape the back of the form, said form having a uniform planographic surface accurately formed exteriorly both as to shape and as to surface character and texture in the mold so as to adapt said printing-form to receive a design after the lithographic manner of transferring, to be transformed into a printing-surface for that design of the character desired, and to coöperate with the other parts of the press in printing.

2. As a new product a printing-form cast of metallographic metal under pressure and in a mold which is heated at the part serving to shape the printing-surface of the form and cooled at the part serving to shape the back of the form, said form having a uniform outer planographic surface accurately formed exteriorly both as to shape and as to surface character and texture in the mold so as to adapt said printing-form to receive a design after the lithographic manner of transferring, to be transformed into a printing-surface for that design of the character desired, and to coöperate with the other parts of the press in printing.

3. As a new product, a planographic printing-form cast of metallographic metal under pressure and in a mold which is heated at the part serving to shape the printing-surface of the form and cooled at the part serving to shape the back of the form, said form having a uniform outer planographic printing-surface accurately formed exteriorly both as to shape and as to surface character and texture in the mold so as to adapt said printing-form to receive a design and be developed into a lithographic printing-surface for that design and to coöperate with the other parts of the press in printing.

4. As a new product, a tubular printing-form cast of metallographic metal under pressure and in a mold which is heated at the part serving to shape the printing-surface of the form and cooled at the part serving to shape the back of the form, said form having a uniform continuous cylindrical planographic surface accurately formed exteriorly both as to shape and as to surface character and texture in the mold so as to adapt said printing-form to receive a design after the lithographic manner of transferring, to be transformed into a printing-surface for that design of the character desired, and to cooperate with the other parts of the press in printing.

5. As a new product, a composite tubular printing-form having a permanent inner strengthening-shell accurately prepared internally to fit the supporting parts of the press, and a suitable envelop integrally cast on the outer side of the inner strengthening-shell, which envelop may be removed from the shell and be renewed thereon to present a fresh surface of predetermined size for each new design, the envelop having a uniform outer planographic surface accurately formed exteriorly in the casting-mold so as to adapt said surface to the coöperating printing parts of the press, substantially as described.

6. As a new product, a composite tubular planographic printing-form having a permanent inner strengthening-shell accurately prepared internally to fit the supporting parts of the press, and a suitable envelop integrally cast under pressure on the outer side of the inner strengthening-shell, which envelop may be removed from the shell and be renewed thereon to present a fresh surface of predetermined size for each new design, the envelop having a uniform outer planographic printing-surface accurately formed in the casting-mold so as to adapt said printing-surface to the coöperating printing parts of the press, substantially as described.

7. As a new product, a composite tubular printing-form having a permanent inner strengthening-shell accurately prepared internally to fit the supporting parts of the press, and an envelop integrally cast on the outer side of the inner strengthening-shell and shrunk on said shell, which envelop may be removed from the shell and be renewed thereon to present a fresh surface of predetermined size for each new design, the envelop having a uniform outer printing-surface accurately formed exteriorly in the casting-mold so as to adapt said printing-surface to the coöperating printing parts of the press, substantially as described.

8. As a new product, a composite printing-form having a permanent inner strengthening-shell of copper accurately prepared internally to fit the supporting parts of the press, and a zinc envelop integrally cast on the outer side of the inner strengthening-shell, which envelop may be removed from the shell and be renewed thereon to present a fresh surface of predetermined size for each new design, the envelop having a uniform outer planographic printing-surface accurately formed exteriorly in the casting-mold so as to adapt said printing-surface to the coöperating printing parts of the press, substantially as described.

9. As a new product, a composite tubular printing-form having a permanent inner strengthening-shell of copper accurately prepared internally to fit the supporting parts of the press, and a zinc envelop integrally cast under pressure on the outer side of the inner strengthening-shell, which envelop may be removed from the shell and be renewed thereon to present a fresh surface of predetermined size for each new design, the envelop having a uniform outer planographic printing-surface accurately formed exteriorly in the casting-mold so as to adapt said printing-surface to the coöperating printing parts of the press, substantially as described.

10. As a new product, a composite tubular printing-form having a permanent inner strengthening-shell of copper accurately prepared internally to fit the supporting parts of the press, and a zinc envelop integrally cast under pressure on the outer side of the inner strengthening-shell and shrunk on said shell, which envelop may be removed from the shell and be renewed thereon to present a fresh surface of predetermined size for each new design, the envelop having a uniform outer planographic printing-surface accurately formed exteriorly in the casting-mold so as to adapt said printing-surface to the coöperating printing parts of the press, substantially as described.

11. As a new product, a composite tubular printing-form having a permanent inner strengthening-shell accurately prepared internally with a tapering bore tapering from end to end to fit the supporting parts of the press, and a metal envelop integrally cast on the outer side of the inner strengthening-shell, which envelop may be removed from the shell and be renewed thereon to present a fresh surface of predetermined size for each new design, the envelop having a uniform outer planographic printing-surface accurately formed exteriorly in the casting-mold so as to adapt said printing-surface to the cooperating parts of the press, substantially as described.

12. As a new product, a composite tubular printing-form having a permanent inner strengthening-shell accurately prepared internally to fit the supporting parts of the press, and a circumferentially-continuous cast-metal envelop integrally cast on the outer side of the inner strengthening-shell, which envelop may be removed from the shell and be renewed thereon to present a fresh surface of predetermined size for each new design, the envelop having a uniform circumferentially-continuous outer planographic printing-surface accurately formed exteriorly in

the casting-mold so as to adapt said printing-surface to the coöperating printing parts of the press, substantially as described.

13. As a new product, a composite tubular printing-form having a permanent inner strengthening-shell accurately prepared internally with a tapering bore tapering from end to end to fit the supporting parts of the press, and a circumferentially-continuous cylindrical cast-metal envelop integrally cast on the outer side of the inner strengthening-shell, which envelop may be removed from the shell and be renewed thereon to present a fresh surface of predetermined size for each new design, the envelop having a uniform and circumferentially-continuous cylindrical outer planographic printing-surface accurately formed exteriorly in the casting-mold so as to adapt said printing-surface to the cooperating printing parts of the press, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

EDWARD HETT.

Witnesses:
EDWIN SEGER,
GEO. W. MILLS, Jr.