March 25, 1924. 1,487,839

L. W. CLAYBOURN

METHOD OF AND APPARATUS FOR FORMING PRINTING PLATES

Filed June 24, 1921 10 Sheets-Sheet 1

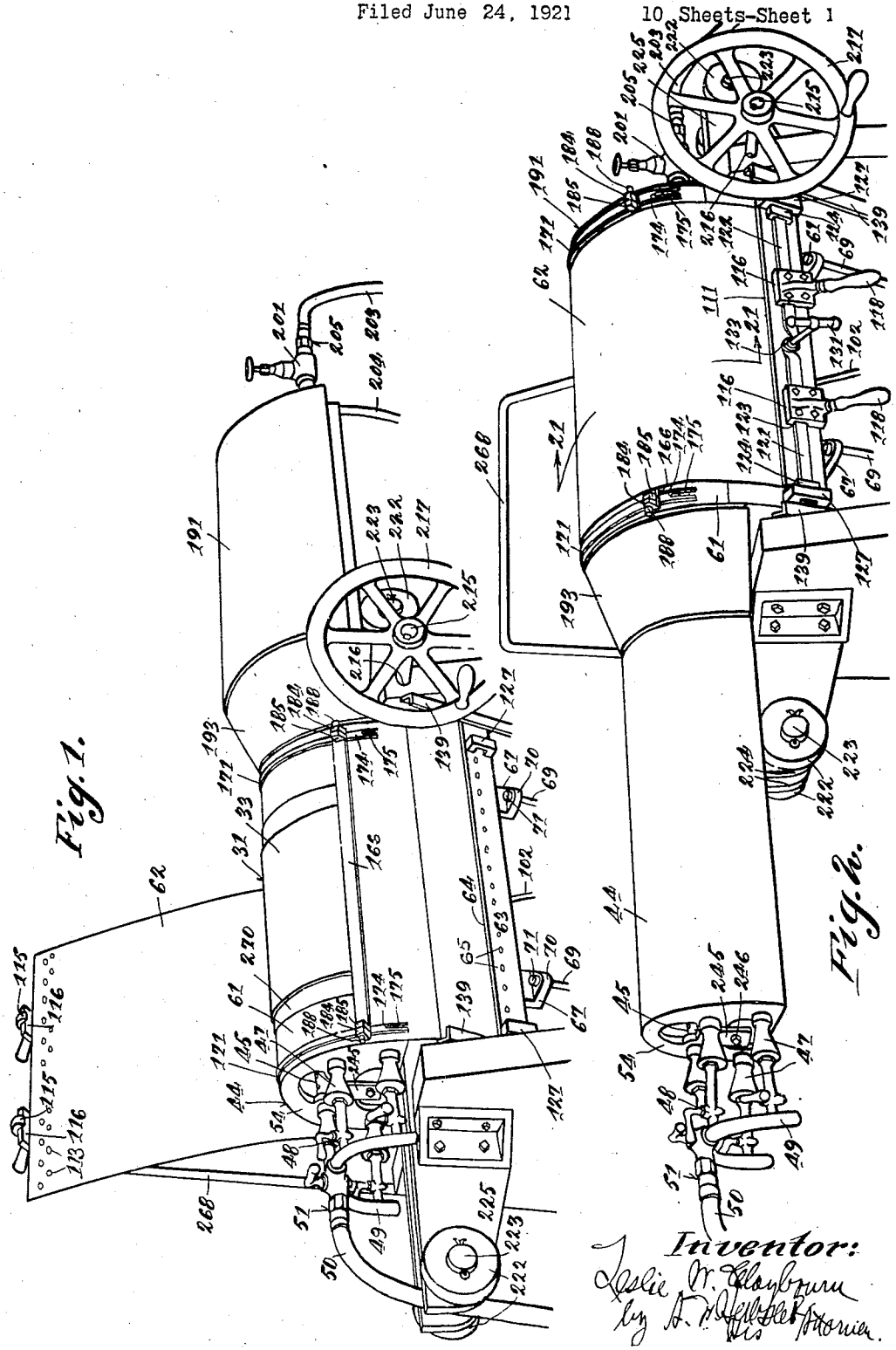


Fig. 1.

Fig. 2.

Inventor:
Leslie W. Claybourn
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METHOD OF AND APPARATUS FOR FORMING PRINTING PLATES

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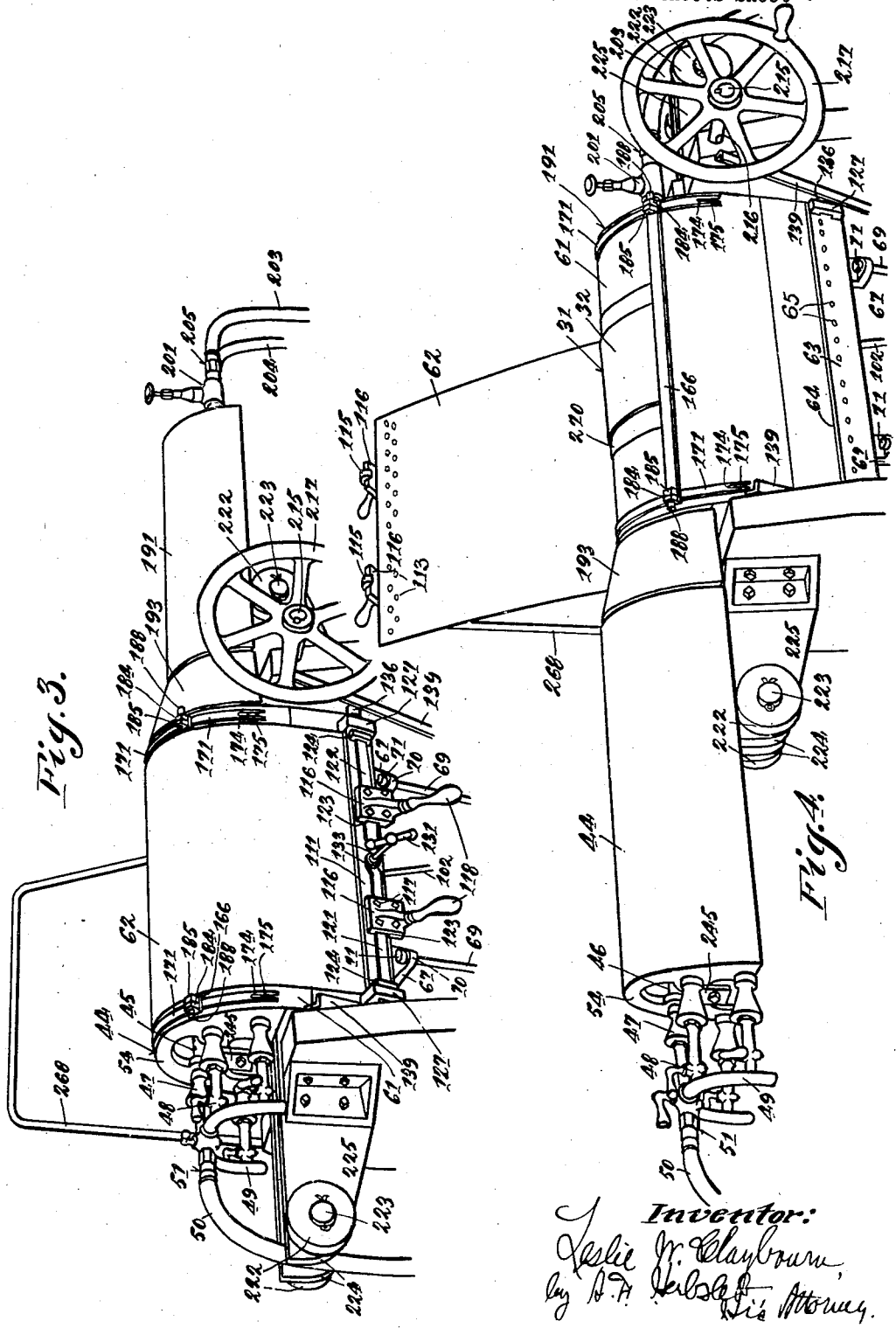


Fig. 3.

Fig. 4.

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March 25, 1924. 1,487,839

L. W. CLAYBOURN

METHOD OF AND APPARATUS FOR FORMING PRINTING PLATES

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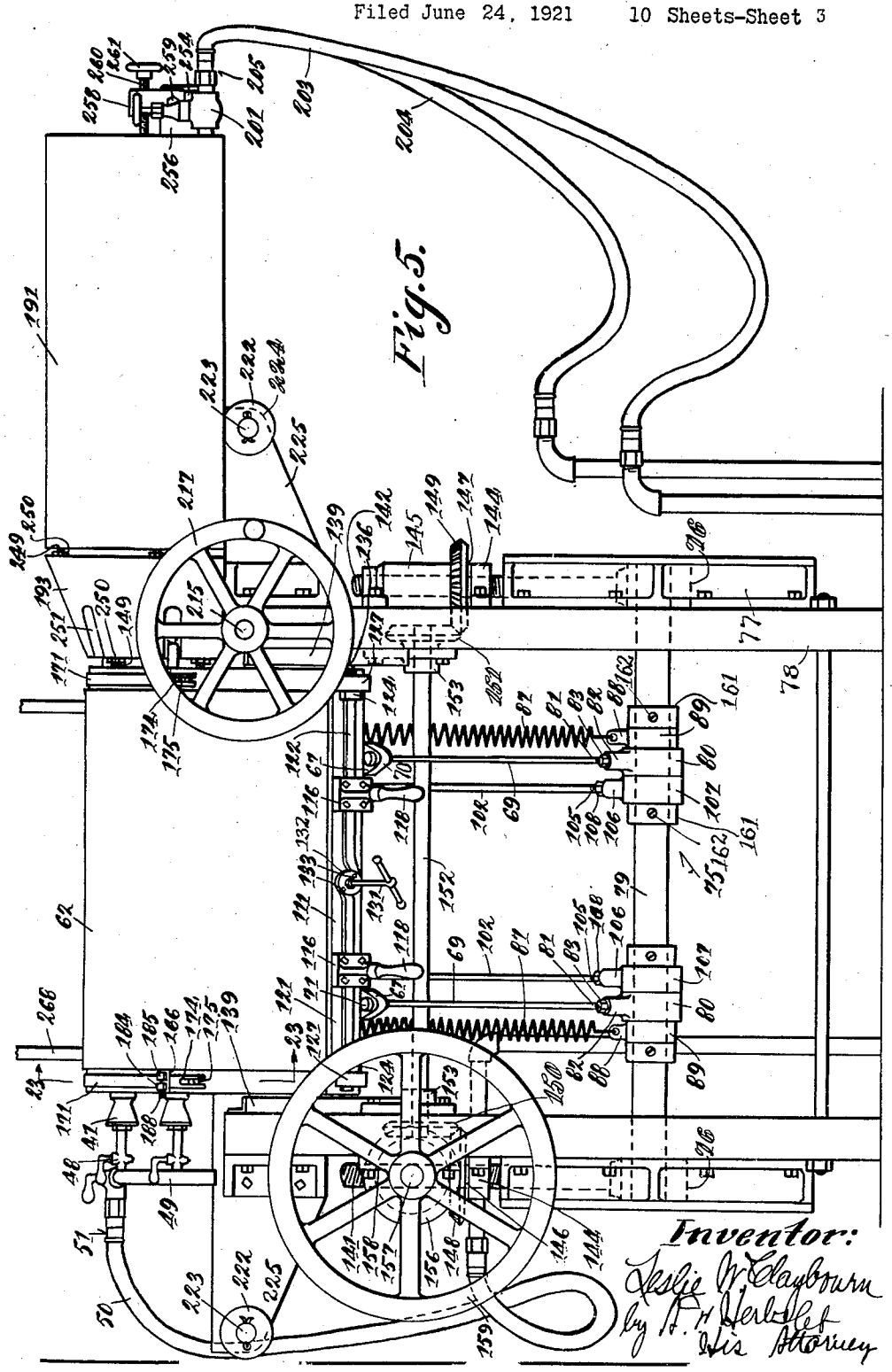


Fig. 5.

Inventor:
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METHOD OF AND APPARATUS FOR FORMING PRINTING PLATES

Filed June 24, 1921 10 Sheets-Sheet 4

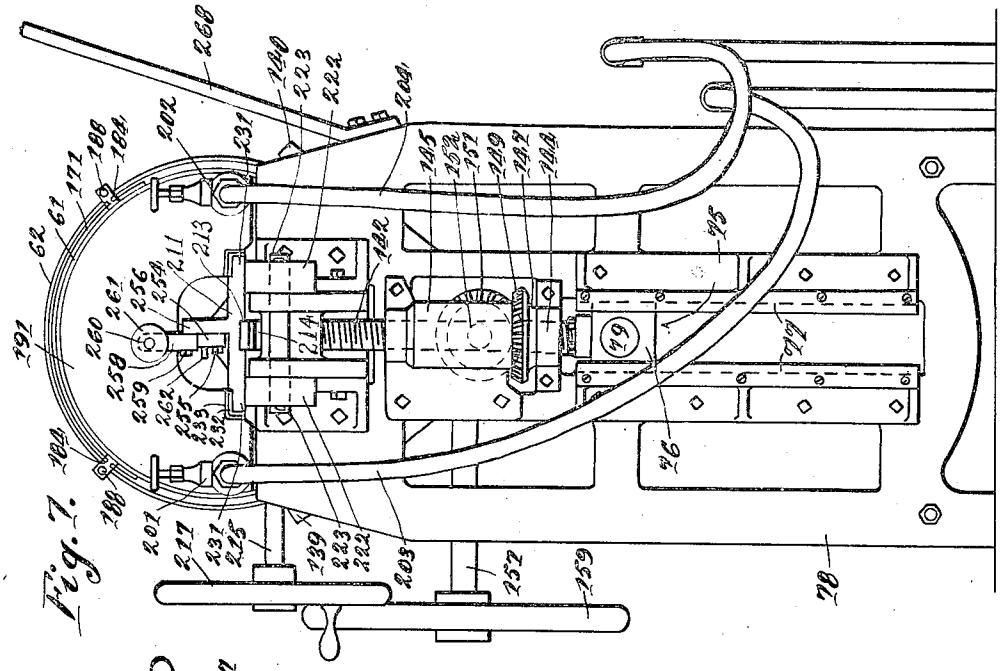


Fig. 7.

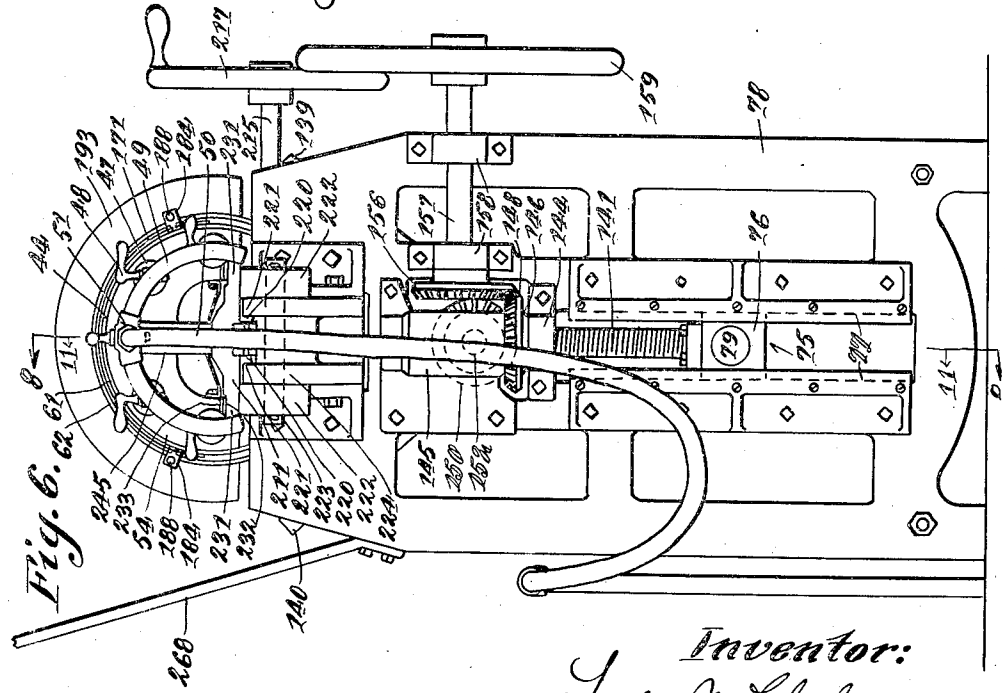


Fig. 6.

Inventor:
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METHOD OF AND APPARATUS FOR FORMING PRINTING PLATES

Filed June 24, 1921 10 Sheets-Sheet 5

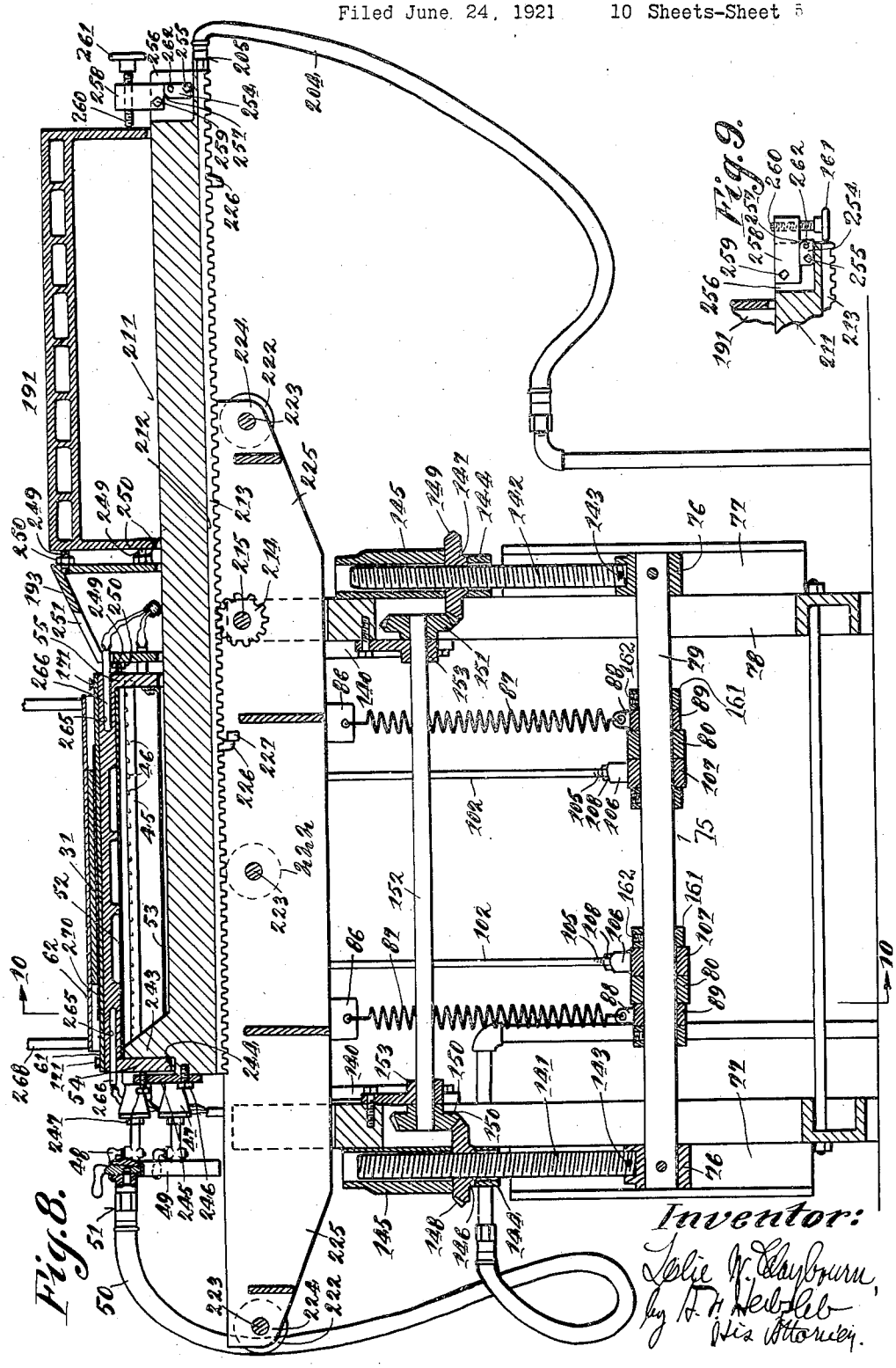


Fig. 8.



Fig. 9.

Inventor:
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His Attorney.

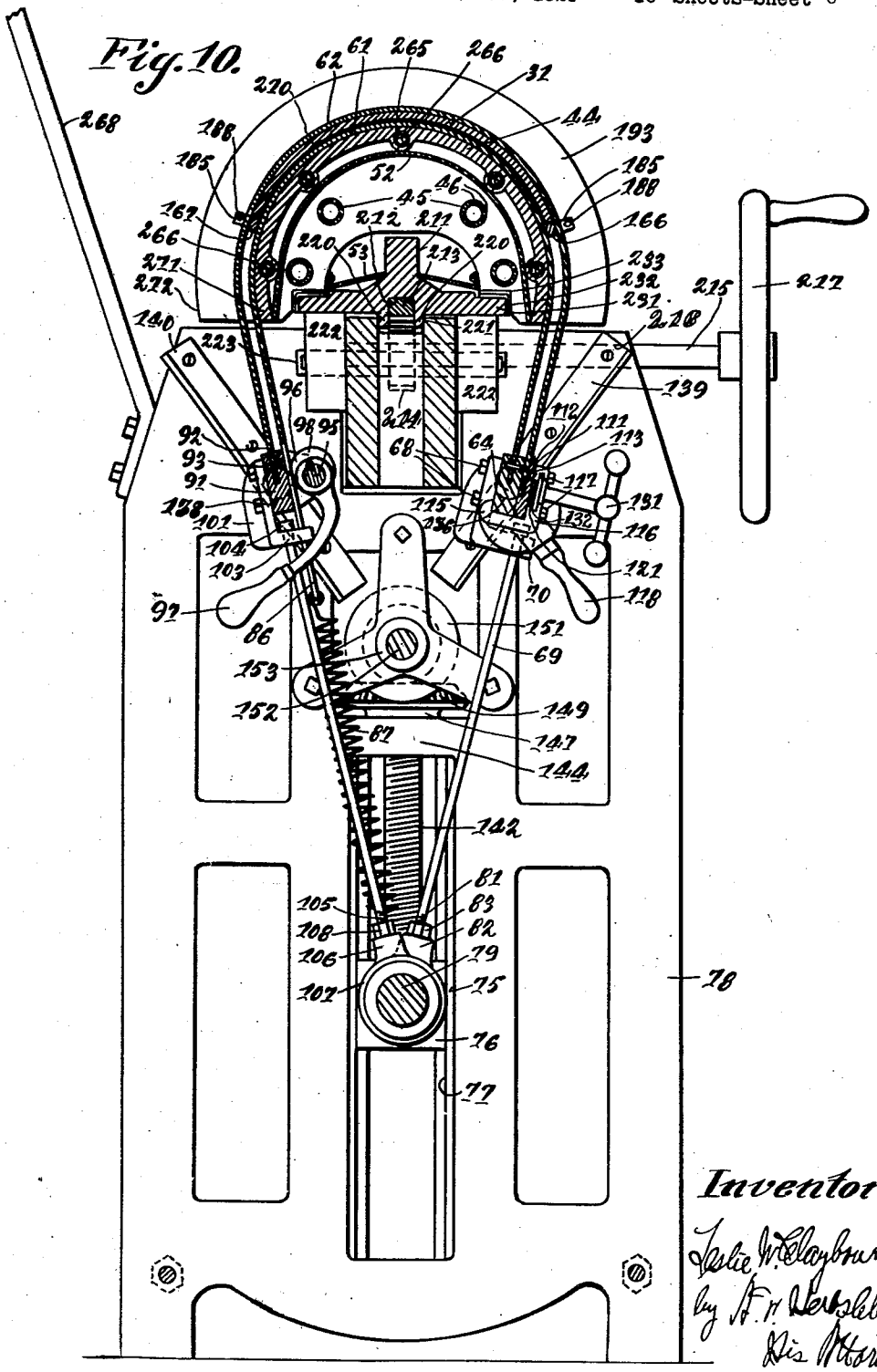
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METHOD OF AND APPARATUS FOR FORMING PRINTING PLATES

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Fig. 10.




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METHOD OF AND APPARATUS FOR FORMING PRINTING PLATES

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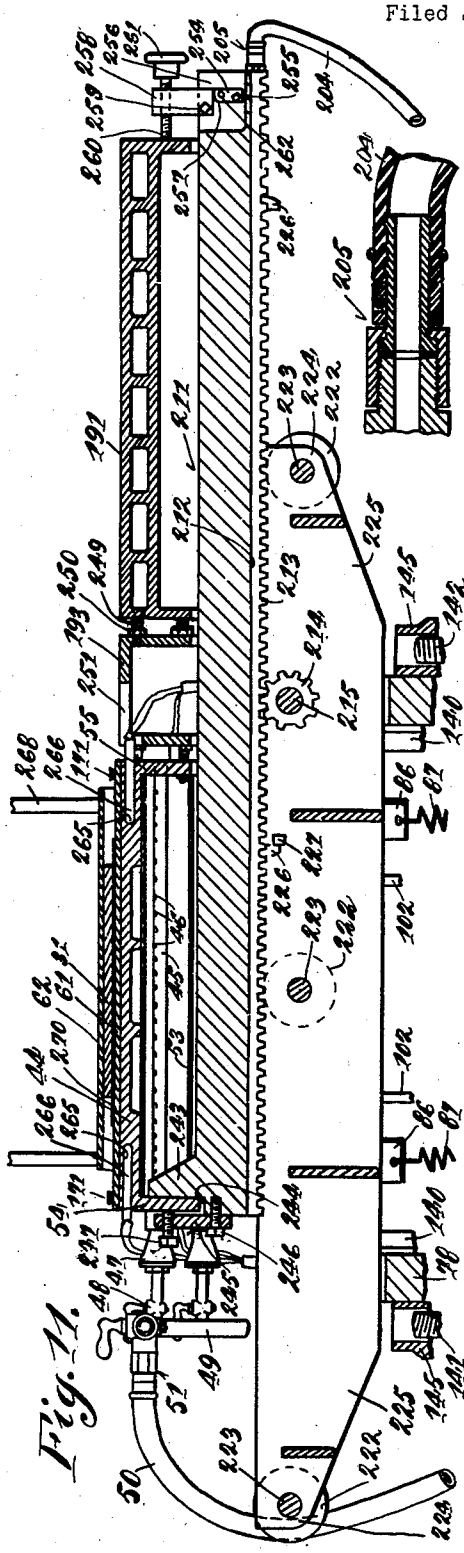


Fig. 11.

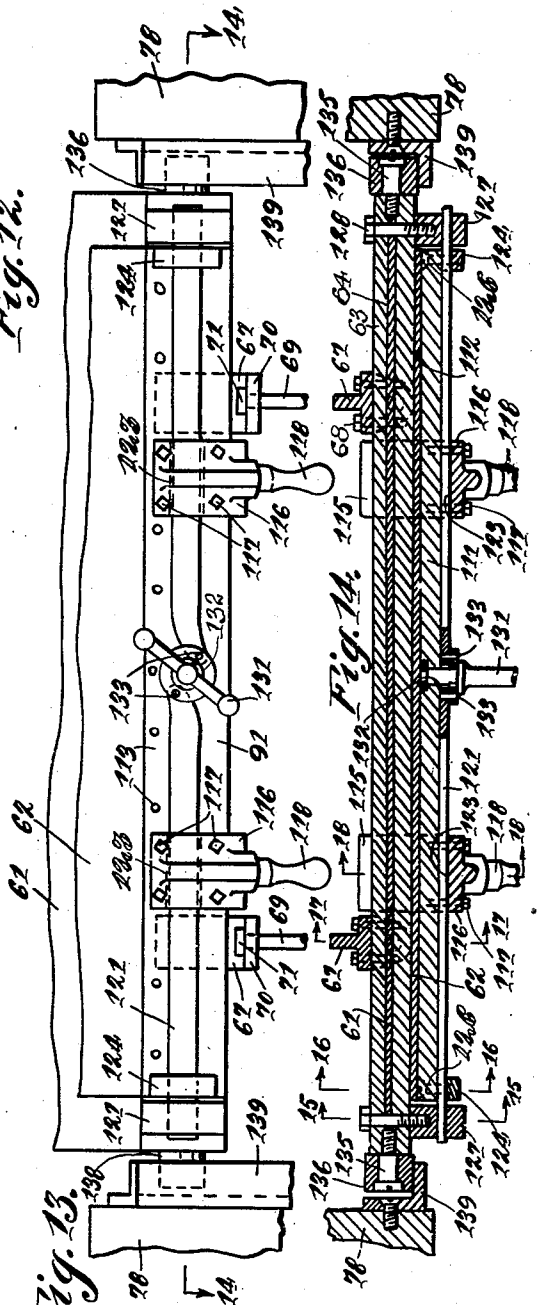


Fig. 12.



Fig. 14.



Fig. 13.

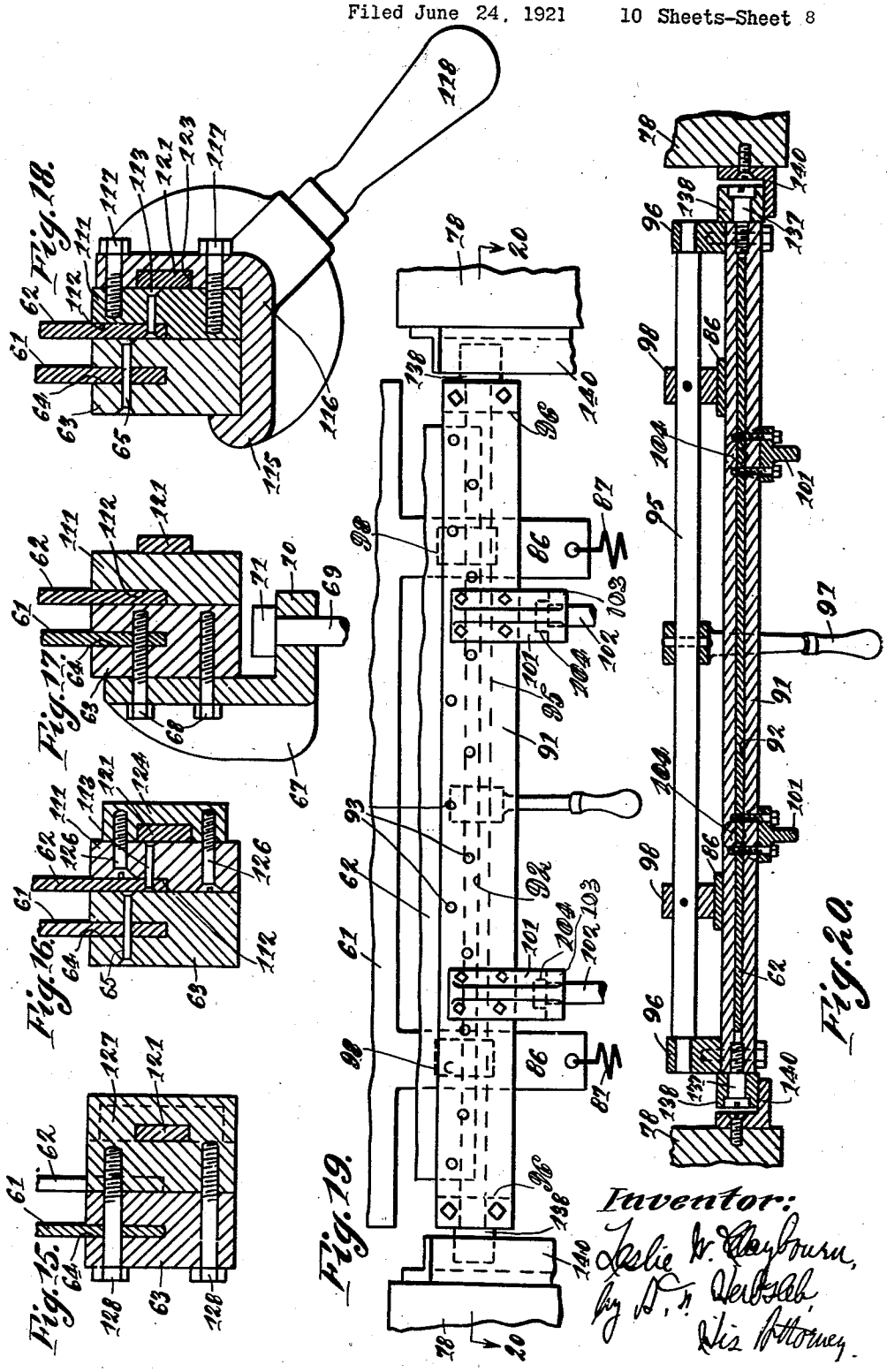
Inventor:
Leslie W. Claybourn,
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March 25, 1924. 1,487,839

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METHOD OF AND APPARATUS FOR FORMING PRINTING PLATES

Filed June 24, 1921 10 Sheets-Sheet 8




Inventor:
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March 25, 1924. 1,487,839

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METHOD OF AND APPARATUS FOR FORMING PRINTING PLATES

Filed June 24, 1921 10 Sheets-Sheet 9

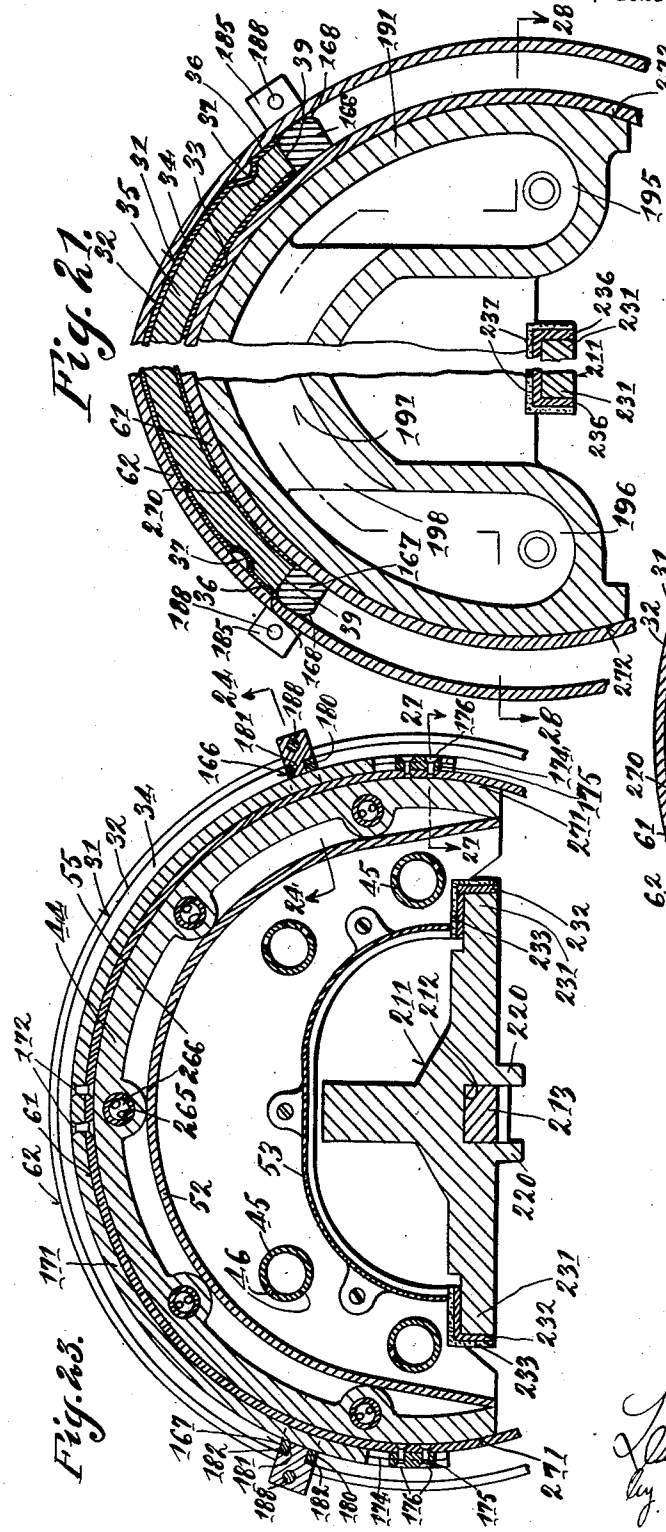


Fig. 2.1.

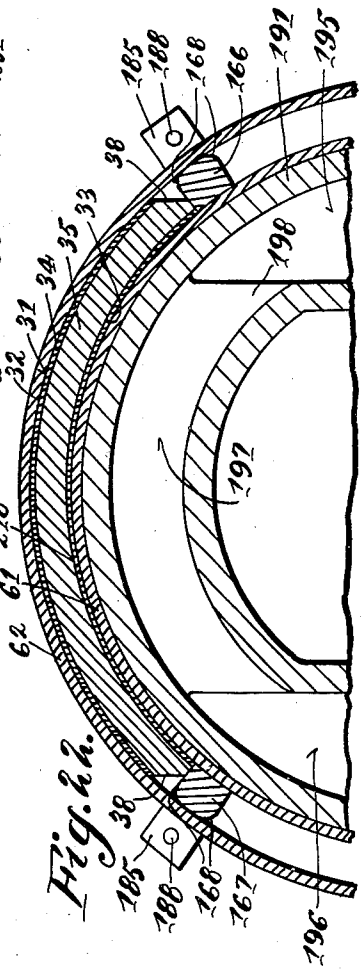


Fig. 2.2.



Fig. 2.3.

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March 25, 1924. 1,487,839

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METHOD OF AND APPARATUS FOR FORMING PRINTING PLATES

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Fig. 2.6.

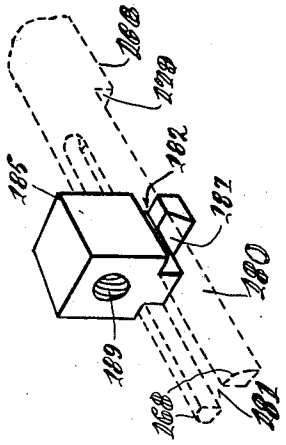



Fig. 2.8.

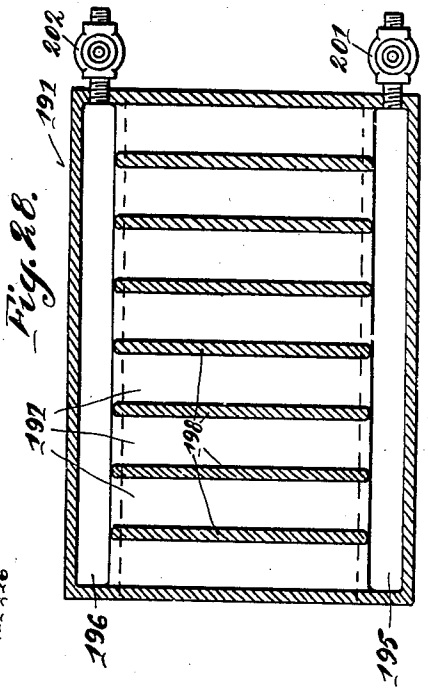



Fig. 2.7.

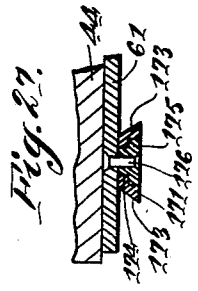



Fig. 2.4.

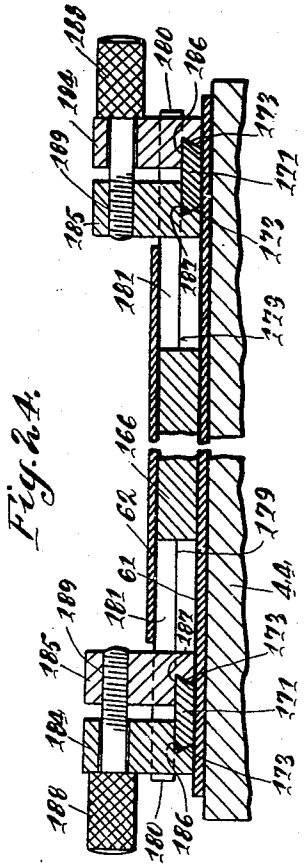
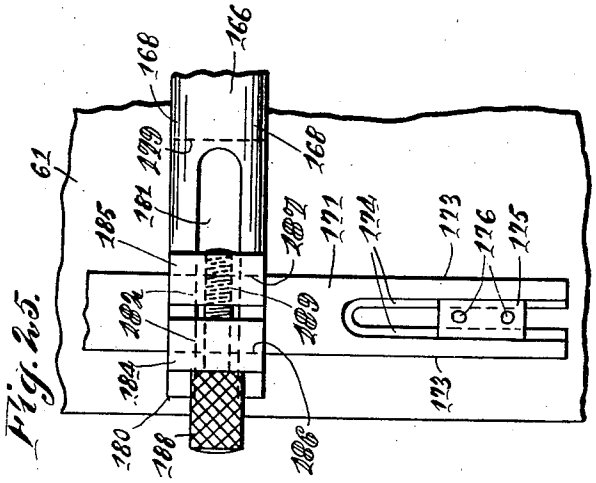



Fig. 2.5.




*Inventor:*

Leslie W. Claybourn

by P. H. Dahlgren

His Attorney.

Patented Mar. 25, 1924. 1,487,839

# UNITED STATES PATENT OFFICE.

LESLIE W. CLAYBOURN, OF MENASHA, WISCONSIN.

## METHOD OF AND APPARATUS FOR FORMING PRINTING PLATES.

Application filed June 24, 1921. Serial No. 480,073.

*To all whom it may concern:*

Be it known that I, LESLIE W. CLAYBOURN, a citizen of the United States, residing at Menasha, in the county of Winnebago and State of Wisconsin, have invented certain new and useful Improvements in Methods of and Apparatus for Forming Printing Plates, of which the following is a specification.

My invention relates to method of and apparatus for forming printing plates into curved form, or for changing the curvature of the printing plates, desirably for adapting them for use upon plate cylinders of different diameters, or for changing their original curvature, or for heat treatment of the curved plates.

My invention is applicable, for instance, in reforming or recurving printing plates previously curved by employment of my inventions in method of curving printing plates and printing plates curved thereby, shown, described and claimed in my Letters Patent of the United States No. 1,318,967, dated October 14, 1919, or by means of the apparatus for curving printing plates shown, described and claimed in my Letters Patent of the United States No. 1,318,968, dated October 14, 1919, and is also applicable for curving or reforming printing plates initially made or formed by other methods and in other manners.

The printing plates to which my invention is particularly applicable are curved printing plates arranged to be attached to plate cylinders in multi-color printing presses, or for printing books, or other printing. The plate cylinders of printing presses are of different diameters, and it is desirable to reform a printing plate of a given radius of curvature into a printing plate having a different radius of curvature so as to employ the same printing plate on rotary plate cylinders having different diameters.

I have further found that curved printing plates, due to the compressive actions thereon during printing, or to corrective methods employed on the printing plates in order to cause proper printing of their printing surfaces, or for other reasons, become hard or crystallized, either as a whole or in spots, or of uneven molecular consistency. It is one of the objects of my invention to so treat printing plates of this character as to anneal the same while retaining their curvatures, or changing their curvatures.

Printing plates to which my invention is particularly applicable, desirably comprise what is known as a printing shell, being usually the electro-deposited metal, for instance, copper, deposited on the matrix in electro-plating, and a backing on which the printing shell is supported. It is to be understood, however, that the invention is not limited to printing plates thus formed, but is applicable to printing plates having printing surfaces regardless of how the same are formed.

It is the object of my invention to curve printing plates in such manner that a stretching or disarrangement of the printing surfaces of the printing plates is avoided, and distances and arrangements between printing lines in the printing surface are maintained, in order that the printing from the printing plates before and after being subjected to my improved method and apparatus is the same, and registry between the printing lines is maintained.

The invention consists in heating the printing plate so as to render the backing material thereof readily pliable, but preferably compressively resistant, and, while heated, curving the same into the desired curvature; further, in heating the printing plate, causing curvature or changing of curvature thereof while heated by resilient pressures exerted throughout both surfaces of the printing plate in opposite directions, and causing forming of the printing plate by an enveloping pulling pressure; further, in applying a cooling agency to the printing plate while the pulling pressure is applied thereon; further, in causing changing curvature of the printing plate between pressure-resistant resilient forces, and, further, in arranging said printing plate during its recurving about a form corresponding to the intended curvature of the printing plate, and exerting enveloping pressure thereon toward said surface; and, further, in applying enveloping pressure upon the printing plate while being heated and enveloping pressure upon the printing plate while cooling.

My invention consists, further, in applying the heat at the inside of the curvature of the printing plate to be operated on, for rendering the printing plate of increasing pliability toward its backing surface, where-

by, in recurving the printing plate, the printing surface of the printing plate is maintained in cooler and in more resistant condition than its backing to maintain the original printing condition of the printing plate; further, in quickly changing the curvature of the printing plate while in such heated condition; further, in applying enveloping drawing pressure upon the printing plate so treated while supported upon the sector of a cylinder of substantially the diameter of the plate cylinder on which the printing plate is to be employed; and, further, in subjecting the printing plate so treated to a cooling agency while under said enveloping drawing pressure.

My invention consists, further, in heating the printing plate while located between curved pressure-resistant resilient bands; further, in changing the curvature of said bands with the printing plate therebetween to change the curvature of said printing plate, and, further, in arranging said bands with the printing plate therebetween about a mold and applying enveloping pressure upon the outer band to force said bands with the printing plate therebetween toward said mold; further, in providing pressure-resistant members of substantially the thickness of the printing plate between said bands to resist crushing of the printing plate; further, in providing pressure-resistant members between said bands upon which to support the edges of said printing plate to resist stretching of said printing plate; further, in providing interchangeable supports or molds of different curvatures; further, in providing molds of diameters representing respectively the original curvature of a printing plate and the desired curvature of the printing plate; further, in providing an intermediate mold, the respective ends whereof correspond to substantially the curvatures of said respective molds, representing respectively the original curvature and the desired curvature of the printing plate; further, in providing intermediate molds of changing dimensions, exemplified as step-up intermediate molds and step-down intermediate molds; and, further, in bending a printing plate having a printing shell of intermediate resistance to flexure and a backing material of less resistance to flexure between pressure-resistant resilient materials, as, for instance, steel bands, of greater resistance to flexure.

My invention consists, further, in novel means for causing transference of coaction between the printing plate and the heating mold and the printing plate and the cooling mold; further, in providing novel mold supporting and operating devices; further, in providing novel interchangeable arrangements of molds; and, further, in novel parts and arrangements and combinations of parts hereinafter more fully described and claimed.

The invention will be further readily understood from the following description and claims, and from the drawings, in which latter:

Fig. 1 represents a perspective view of an exemplifying apparatus illustrating my invention, showing the printing plate in heating position, with the outer band raised, and the apparatus arranged for imparting less curvature to the plate, that is, increasing the length of its radius of curvature.

Fig. 2 is a similar view, showing the apparatus in relation for curving the printing plate and imparting less curvature thereto, and showing the outer band in drawn relation.

Fig. 3 is a similar view, with the parts arranged for heating the plate, the outer band being lowered, and the apparatus arranged for imparting greater curvature to the printing plate, that is, decreasing the length of its radius of curvature.

Fig. 4 is a perspective view of the same arrangement of apparatus, the printing plate being shown curved to greater curvature, and the outer band raised for exposing the printing plate.

Fig. 5 is a front end elevation of the apparatus arranged as shown in Fig. 1, with the outer band lowered and the bands in drawn relation.

Fig. 6 is a front end elevation of the same.

Fig. 7 is a rear end elevation of the apparatus arranged as shown in Fig 2.

Fig. 8 is a central vertical longitudinal section of the apparatus taken on the line 8—8 of Fig. 6.

Fig. 9 is a detail of the clamp for the cooling mold, shown in side elevation in release position.

Fig. 10 is a vertical cross-section of the apparatus, taken on a line corresponding to the line 10—10 of Fig. 8.

Fig. 11 is a central vertical longitudinal section of the apparatus, taken on a line corresponding to the line 11—11 of Fig. 6, but showing the molds of equal diameters.

Fig. 12 is a detail in axial section, showing a releasable connection for the hose.

Fig. 13 is a front elevation representing the means for securing the swinging end of the outer band.

Fig. 14 is a horizontal section of the same taken on the line 14—14 of Fig. 13.

Fig. 15 is a vertical sectional detail of the same, taken on a line, corresponding to the line 15—15 of Fig. 14.

Fig. 16 is a vertical sectional detail of the same taken on a line corresponding to the line 16—16 of Fig. 14.

Fig. 17 is a vertical sectional detail of the same, taken on a line corresponding to the line 17—17 of Fig. 14.

Fig. 18 is a vertical sectional detail of the same, taken on a line corresponding to the line 18—18 of Fig. 14.

Fig. 19 is a rear elevation of the rear ends of the bands and their connections, partly broken away.

Fig. 20 is a horizontal section of the same, taken on the line 20—20 of Fig. 19.

Fig. 21 represents an enlarged cross-section, taken on the line 21—21 of Fig. 2, partly broken away, showing the relation of parts when forming a printing plate provided with marginal bearers.

Fig. 22 is a similar view, partly broken away, showing the operation upon a finished printing plate provided with marginal edges for coaction with usual securing hooks.

Fig. 23 is a cross-section, taken on the line 23—23 of Fig. 5, showing the positioning means for the resistance bars.

Fig. 24 is a longitudinal section of the same, taken on a line corresponding to the line 24—24 of Fig. 23.

Fig. 25 is a plan view detail of the same.

Fig. 26 is a perspective view of one of the clamping members for positioning the resistance bar, in association with the resistance bar shown dotted and partly broken away.

Fig. 27 is a cross-sectional detail, taken on a line corresponding to the line 27—27 of Fig. 23; and,

Fig. 28 is a plan view of one of the cooling molds with the top wall thereof removed, and shown in section on a line corresponding to the line 28—28 of Fig. 21.

In exemplifying my invention, it may be instanced that the printing plate is to be recurved to an arc of less curvature, as exemplified in Figs. 1, 2, 5 and 8, or to an arc of greater curvature, as exemplified in Figs. 3 and 4, or that the arc of curvature is to remain the same, as exemplified in Fig. 11.

The printing plate is exemplified at 31, and may be of any desirable kind or nature, and comprises a printing surface 32 and a backing face 33. It may comprise a printing shell 34, for instance of electro-deposited metal, such as copper, and a backing 35, of backing material of suitable composition. The backing material may be a mixture of lead, tin and antimony, in the proportion of ninety pounds of lead to five pounds each of tin and antimony, the fusing point of the mixture being approximately 600 degrees Fahrenheit. The printing shell when of copper would have a fusing point of approximately 1900 degrees Fahrenheit.

Heat is applied to the printing plate of such a degree and for such duration as will render the printing plate readily flexible but preferably insufficient to render the same readily crushable. The heat is preferably applied from the inside of the arc on which the printing plate is formed, so as to apply the heat from the inside or backing surface of the printing plate toward the outside or printing surface of the printing plate, with the object of rendering the printing plate progressively more pliable toward the backing surface, and leaving that portion of the plate toward the printing surface less pliable, in order to provide less resistance to flexure at the bottom or supporting side of the printing plate, than at the printing side, with the effect that upon curving the printing plate, the distances between printing lines are not disturbed and the printing surface is maintained in its original printing condition.

The printing plate may be exemplified as approximately three-sixteenths of an inch thick, as is usual in printing plates of this character.

I have found that subjecting a printing plate of this character to a temperature of five hundred and fifty degrees Fahrenheit for a duration from four to six minutes by application of the printing plate to a heating element, for instance, a heating mold, of such temperature, and preferably interposing a layer of thin paper, for instance, a thin book paper, which has been previously saturated in an oil, as a usual lubricating oil, between the backing face of the printing plate and the heating element, that a condition of flexibility in the printing plate such as I have described above will be obtained. The heat imparted to the printing plate at its rear face in this manner may be instanced as somewhat less than five hundred degrees Fahrenheit, for example, four hundred and fifty to four hundred and seventy-five degrees Fahrenheit.

The backing material may be other than that above instanced, for instance, gutta percha or other material which is rendered readily pliable by heat without rendering the same readily crushable. The condition of the material for the printing plate desired is one to impart ready pliability, without, however, applying heat either so great or for so long a duration as to render the material readily crushable.

The printing plate, when subjected to my improved method, may at each of its edges have thereon a marginal bearer 36, separated from the printing plate proper by a marginal groove 37, as exemplified in Fig. 21. If desired, the printing plate may be in completely trimmed condition, with its backing face shaved, when subjected to my improved method and apparatus, as by having its marginal bearers removed, and each of its marginal edges provided with a bevel edge 38 for coaction therewith by any usual register hooks, all as more fully shown and described in my aforesaid patent, or the said bevel edges may be omitted and the edges be perpendicular or radial with rela-

tion to the printing plate in its finished form, similar to the edges 39 shown in the unfinished printing plate in Fig. 21. The printing plates operated on may be new printing plates, or may be printing plates previously used in printing, or which have been previously curved or recurved one or more times.

Referring now to the exemplification of mechanism for accomplishing my objects, the printing plate may have an initial curvature and is subjected to the heat of a heating mold 44, preferably from the inside of the arc of the printing plate, for which purpose the heating mold may be provided with fuel pipes 45, extending lengthwise in the interior of the same, having suitable openings 46 for the flames, for instance, of gaseous fuel, fed to the pipes, for instance, through air mixers 47, and regulated by valves 48, communicating with a manifold 49, to which a flexible hose 50 for gas-supply is releasably secured, for instance, by a releasable coupling 51. A sheet-metal plate 52, as of copper, is preferably interposed between the flames and the body of the heating mold, to equalize the heat. A sheet-metal plate 53, as of galvanized iron, is preferably placed under the burners to shield the support or carriage on which the molds are placed, from the heat. The fuel pipes may be supported in the end walls 54, 55, of the heating mold.

The printing plate is preferably supported between an inner band 61 and an outer band 62, arranged to be separated for receiving the printing plate and arranged to be placed in substantially concentric relation with the printing plate therebetween.

Thus the front end of the inner band is fixed to a cross-bar 63, as by being received in a slot 64 therein, and having securing means, as rivets 65, passed through the lower front margin of said band and the walls of said slot. Brackets 67 are secured to said cross-bar, as by bolts 68. Rods 69 are pivoted in bearings 70 of said brackets, the heads 71 of the rods resting on said bearings. The rods have adjustable connection with a slide 75, adjustable for moving the bands toward and from the coacting faces of the molds.

The slide is exemplified as comprising boxes 76 movable up and down in guideways 77 in the ends of the machine frame 78. A cross-trunnion 79 has its ends located in the boxes. Collars 80 are received about the cross-trunnion. The rods 69 have adjustable connection with said collars, as by having their ends threaded, as shown at 81, and received in threaded sockets 82 of the collars, clamp-nuts 83 fixing the parts in adjusted positions.

The rear lower marginal portion of the inner band is provided with tails 86, shown as extensions of the band, to which one of the ends of the springs 87, shown as helical springs, are secured, the other of said ends being fastened to the slide for normally exerting a downward pull upon the rear end of the inner band. This latter connection is shown effected by connecting the lower ends of the springs to lugs 88 on collars 89 on the cross-trunnion.

The outer band has fixed connection with a cross-bar 91, as by having its rear lower edge received in a slot 92 extending lengthwise of said cross-bar, and fixed therein by means of rivets 93.

A rock-shaft 95 is journaled in bearings 96 of this cross-bar, and is provided with an operating handle 97. Eccentrics 98 are fixed to the rock-shaft, and are arranged to clamp the rear lower end of the inner band and the rear lower end of the outer band together, the eccentrics being shown operating upon the rear extensions of the inner band. If it is desired to have free movement of the rear end of the inner band relative to the rear end of the outer band, the eccentrics are unclamped, placing the rear end of the inner band under the action or tension of the springs 87.

If it is desired that the rear ends of the inner and outer bands shall be connected or shall move together, the eccentrics are clamped upon the rear end of the inner band, thereby connecting the said rear ends of the inner and outer bands. The pressure of the eccentrics is, however, such as to permit relative slipping between the rear end of the inner band and the rear end of the outer band upon sufficient drawing action being exerted upon the cross-bar at the rear end of the outer band, or upon undue stress being exerted upon said eccentric connection, as in changing the curvature of said bands with a printing plate therebetween.

This cross-bar is provided with brackets 101, to which rods 102 are secured, the other ends of the rods being secured to the slide 75, there being preferably an adjustment between the slide and the cross-bar. This adjustment is effected by rotatively supporting the rod in a bearing 103 in the bracket, providing the rod with a head 104 above the bearing, and with a threaded end 105 received in a threaded socket 106 of a collar 107 about a cross-trunnion, a jam-nut 108 securing the parts in adjusted positions.

The outer band is arranged to be raised and lowered with relation to the inner band, for access into the space between the bands, accomplished by providing a free end, shown as the forward end of the outer band, with a cross-bar 111 fixed to said free end, as in a rabbet 112 of the cross-bar, by means of rivets 113. The cross-bar 63 and the cross-bar 111 are arranged to be united for combined movements, for instance when

it is desired to simultaneously move the bands.

For this purpose the forward end of the outer band is provided with hooks 115 arranged to hook about the cross-bar 63 at the front of the inner band. These hooks are shown on brackets 116 fixed to the cross-bar 111 by means of bolts 117, and have handles 118 for manipulating the swinging end of the outer band.

I prefer to provide locking means to lock said forward ends of the bands together, for combined movements of said forward ends, shown accomplished by means of bolts 121, 122, respectively slidable in grooves 123 of the brackets 116, being guided in said grooves by the walls of said grooves and the cross-bar 111, and in bearings 124, shown as formed by means of blocks, secured to the cross-bar 111 by means of screws 126, and received in keepers 127, extending from the cross-bar 63 outwardly into range of said bolts, and shown formed on blocks secured to the cross-bar 63 by means of bolts 128.

The bolts 121, 122, are operated by means of a handle 131, rotatable in a bearing 132, fixed to the cross-bar 111, and having eccentric articulations 133 with the proximate ends of said bolts, so that rotation of the handle will move the bolts lengthwise for either locking or unlocking relation.

The bands are preferably crushing-resistant resilient bands, for instance of spring sheet steel, and are arranged in substantially concentric relation when the respective ends of said bands are secured together, with said bands spaced apart substantially the thickness of a printing plate.

The bands are arranged to be raised and lowered with relation to the molds, and means are also preferably provided for causing separating movement between the forward ends and the rear ends of said bands, when the bands are being raised for decreasing the curvatures of said bands, that is, arranging their arcs as the sectors of cylinders having longer radii, the said lower ends approaching each other when said bands are lowered, for imparting greater curvature to the arcs of said bands, that is, arranging them on sectors of cylinders having less diameter, in order to accommodate molds of various diameters and permit ready axial movements between the molds and the bands.

In order to guide the lower ends of said bands, I provide the cross-bar 63 with studs 135, about which rollers 136 are journaled, and provide the cross-bar 91 with studs 137, about which rollers 138 are journaled. The rollers 136, 138, are respectively guided on guideways 139, 140, arranged slantingly so as to slant upwardly and outwardly with relation to the longitudinal middle of the machine, to cause approach between the lower ends of the bands when the bands are lowered, and to cause separation between said lower ends when the bands are raised.

The raising and lowering of the bands are shown accomplished by means of raising and lowering the slide 75, shown accomplished by fixing screw-rods 141, 142, to said boxes, as by pins 143, said screw-rods being shown provided respectively with right-hand threads and left-hand threads. The screw rods are guided in bearings 144, 145, fixed to the machine-frame. Nuts 146, 147, have threaded engagements with the respective screws and are shown formed in the bores of bevel-gears 148, 149, with which bevel-gears 150, 151, respectively, mesh, the latter bevel-gears being secured to a cross-shaft 152, journaled in bearings 153 fixed to the machine-frame.

A bevel-gear 156 is fixed to an operating shaft 157, journaled in bearings 158 fixed to the machine-frame, and meshes with the bevel-gear 148. The operating shaft has a hand-wheel 159 fixed thereon, by means of which the trains of gears, including the nuts, are rotated for raising or lowering the slide 75, whereby the resilient bands are raised or lowered with relation to the molds.

The collars 80, 107, have rocking movement on the cross-trunnion to accommodate the approach or recession between the lower ends of the bands, the rockable collars being held in endwise relation on the trunnion-shaft by means of collars 161, fixed to said cross-trunnion by set-screws 162.

Means are provided for positioning the printing plates between the bands, shown accomplished by means of resistance bars 166, 167, extending parallel with the axis of curvature of the mold and arranged to be positioned so that the marginal edges of the printing plate contact and are supported by said resistance bars, the adjustments being preferably such as to prevent spreading of the printing plate to maintain printing relation of the printing lines and to prevent crushing action upon the printing plate. The resistance bars are also preferably rounded at their upper faces, as shown at 168, so as to avoid the presenting of sharp corners or angles to the outer band and thereby prevent injury to said outer band. The resistance bars are preferably of such thickness as to place their upper faces in the circle of the cylinder in which the printing surface of the printing plate is located when on the mold, representing, for instance, a thickness equal to the thickness of the printing plate plus the oil-sheet under the printing plate.

The positioning of the resistance bars is shown accomplished by providing resilient supporting strips 171 at the respective ends of the inner band, shown fixed to said inner

band at the median portions of said strips, as by rivets 172. These strips flex with the flexure of the inner band, and are shown as of under-cut form for forming dove-tails 173.

As the flexure of the inner band and said strips takes place, there is longitudinal movement between the respective ends of said strips and the band. To permit such longitudinal movement and at the same time cause the strips to remain close to the inner band, the ends of the strips are provided with slots 174 extending lengthwise of the strips, the respective lengthwise walls of said slots being formed as T-slots, as by providing the walls of the same with rabbets. A complemental block, shown as a dove-tail block 175, is received in each of said slots and is fixed to the inner band, as by means of a rivet 176.

The resistance bars are provided at their respective ends with rabbets 179, forming extensions 180 received over the flexure strips 171. These extensions are provided with slots 181 extending lengthwise thereof, forming walls received in grooves 182, of clamping members 184, 185, respectively, provided with grooves 186, 187, received at the respective sides of the under-cut or dove-tail edges of the flexure strips. A clamp screw 188, journaled in one of the mating clamp-blocks and having threaded engagement 189 in the other of said clamp-blocks, clamps the mating clamp-blocks to the flexure strips. The resistance bar is caused to move with the clamps lengthwise of the flexure strips by means of the slot and tongue connection between the slotted ends of said resistance bar and the flexure strips, and is held in position when the clamping members are clamped to the flexure strips.

When it is desired to heat the printing plate, it is placed between the flexible resilient bands and the bands are drawn about the heating mold. When proper heating of the printing plate has been effected, the bands are raised, with the heating mold between them to permit transference of the printing plate to a forming mold 191, which may be arranged on a curvature of greater diameter, less diameter or substantially the same diameter as the heating mold. I have in Figs. 1, 2, 5, 6, 7, 8 and 10, shown the forming mold as of greater diameter than the heating mold, while in Figs. 3 and 4, the forming mold is shown of less diameter than the heating mold, and in Fig. 11 the forming mold and heating mold are shown of equal diameters.

Heating molds of different diameters may be employed, as instanced by comparing the heating molds of Figs. 1 and 2 with the heating molds of Figs. 3 and 4, and forming molds of different diameters may also be employed, as illustrated, by comparing the diameters of the forming molds shown in Figs. 1 and 2 with the forming molds shown in Figs. 3 and 4.

Intermediate molds 193 may also be employed. When the forming mold is of greater diameter than the heating mold, the intermediate mold increases in diameter from its end complemental to the heating mold toward its end complemental to the forming mold, as shown in Figs. 1, 2, 5 and 8. When a forming mold of less diameter than the heating mold is employed, an intermediate mold decreasing in diameter from its end complemental to the heating mold toward its end complemental to the forming mold, is employed, as shown in Figs. 3 and 4, and when the heating mold and forming mold are of equal diameters, an intermediate mold having the same curvature throughout is employed, as shown in Fig. 11.

The forming mold is preferably provided with means for quickly cooling the printing plate formed thereover, shown accomplished by providing the forming portion of the forming mold with a jacket for water or other cooling fluid, comprising longitudinal channels 195, 196, extending lengthwise at the respective sides of the forming mold, and cross channels 197 formed by ribs 198 connecting said lengthwise channels. Valves 201, 202, connect with said respective channels, one of said valves being an inflow valve and the other an outflow valve. Hose 203, 204, have releasable connections 205 with said valves for ready release of the hose in case it is desired that an interchange in the forming molds take place.

I have found it desirable for convenience that both the valves be closed, with the cavity in the forming mold filled with a cooling fluid, before interchange of molds takes place, in order to prevent pocketing of air in the cavities, which pocketing of air may also be prevented by first filling the molds when standing on end, with the valves extending upward.

In order to provide convenient transference of coaction between the molds and the bands, I have provided a carriage 211, arranged to travel back and forth under the bands. The carriage is provided at its under side with a longitudinal groove 212, in which a toothed rack 213 is located. A pinion 214 meshes with the rack, and is fixed to an operating shaft 215, journaled in bearings 216 in the frame, and having an operating hand-wheel 217 fixed thereto. The carriage is guided by ribs 220, coacting with guideways 221 of the main frame, and is preferably supported on rollers 222, journaled on studs 223, fixed in bearings 224 in the main frame. The end pairs of these rollers are shown located in brackets 225 of the main frame. The carriage is provided

with stops 226 arranged to contact stops 227 on the main frame to limit endwise movements of the carriage.

The carriage is provided with shoulders 231 extending lengthwise thereof and forming positioning shoulders for positioning and centering the molds with relation to the carriage and with relation to each other.

The heating molds are provided with angle shoes 232 fixed thereto, and preferably have heat-insulating blocks 233 interposed between the molds and the shoes to heat-insulate the molds from the carriage. The cooling molds are provided with angle shoes 236 fixed thereto, and preferably have heat-insulating blocks 237 interposed between the molds and the carriage. The intermediate molds are provided with similar angle shoes and similar heat-insulating blocks fixed thereto. The said angle shoes coact with the shoulders 231 for positioning the molds on the carriage.

The heating mold is clamped to the carriage preferably at only one end thereof, for accommodating the expansion and contraction due to heating and cooling of the heating mold, shown accomplished by providing the carriage with a lug 243, against which one of the end walls of the heating mold is arranged to be received in a rabbet 244 at the end of the carriage. A bar-clamp 245 is fastened to the end of the carriage, as by a bolt 246, a set-bolt 247 being threaded to the other end of said bar and arranged to contact the end of the heating mold, for pressing said end wall against said shoulder.

The intermediate mold is preferably spaced in its position from the heating mold, and it may also be spaced from the forming mold, to minimize transference of heat from the heating mold to the forming mold. This is shown accomplished by providing the respective ends of the intermediate mold with lengthwise extending set-bolts 249, threaded into the intermediate mold, jam-nuts 250 clamping the set-bolts in adjusted positions. The intermediate mold may also be provided with slots 251 for the passage of air and the discharge of heat.

A releasable clamp is provided for the outer end of the forming mold, shown as a pivoted bar 254, pivoted on a bolt 255 to a lug 256 of the carriage. This bar has a swinging end which is preferably provided at its inner corner with a rounding 257. A pivoted bar 258 is pivoted to said lug on a bolt 259 to form a swinging bar, which is arranged to rest on the bar 254, when the latter bar is in raised position, so as to prevent tilting of the upper bar outwardly. A set-screw 260 is threaded in the latter bar and has a hand-wheel 261 thereon for turning the same. When the heel of the upper bar is in engagement with the upper end of the lower bar, the set-screw may be turned to move toward the forming mold, for holding said mold on the carriage, there being sufficient resilience in the connections to prevent breaking of parts on account of expansion of the molds.

If it is desired to release the mold, the set-screw 260 is turned a couple of revolutions to release clamping engagement between the heels of the pivoted bars, whereupon the upper end of the lower bar may be swung outwardly, as by pulling on the pin 262 extending laterally therefrom, for lowering its heel away from the heel of the upper bar, whereupon the upper bar may be swung outwardly to completely release the forming mold.

If desired, heat testing devices may be employed in connection with the heating mold, shown accomplished by providing the heating mold with holes 265 extending lengthwise therein, and inserting pyrometer tubes 266 of suitable pyrometer reading or recording devices into said holes. The holes at the inner end of the heating mold, adjacent the intermediate mold, may register with the slots in the intermediate mold for ready insertion or removal of the pyrometer tubes.

Heating molds, forming molds and intermediate molds of various diameters respectively may be interchangeably employed.

In operation, when it is desired to curve or reform printing plates, a heating mold 44 is selected conforming to the initial curvature of the printing plates, allowance being made for the thickness of the inner band and oiled sheet. This heating mold is placed on the carriage and secured thereto, and the fuel hose 50 connected therewith, it being understood that the heating devices preferably form parts of the respective heating molds.

An intermediate mold 193 is selected having a curvature at one end corresponding to the curvature of the heating mold, and having at its other end a curvature corresponding to the desired curvature of the backing face of the curved or reformed printing plate, this intermediate mold being placed on the carriage adjacent to the heating mold and in line therewith.

A forming mold 191 having a curvature corresponding substantially to the desired curvature of the inner or backing face of the curved or reformed printing plate, allowance being made for the thickness of the inner band and oiled sheet, is placed on the carriage, in line with the other molds thereon, and the releasable clamp placed in clamping position to retain the mold on the carriage. The slide 75 will have been raised sufficiently to raise the inner band sufficiently high above the carriage to permit the placing

of the molds, the rear end of the inner band having been clamped to the rear end of the outer band.

The locks or bolts 121, 122, and catches or hooks 115 at the swinging end of the outer band having been released, the outer band 62 is raised and caused to rest in up position against a brace 268 extending slantingly rearwardly and upwardly from the frame.

The carriage 211 is then adjusted to place the heating mold under the inner band 61, and the inner band is lowered to be proximate to the heating mold, with, for instance, a half inch space between the inner band and the heating mold. The printing plate to be curved or reformed is then placed on the inner band, and the resistance bars 166, 167, are adjusted to contact the marginal edges at the front and rear of the printing plate, parallel with the axis of its curvature. An oiled sheet 270 is preferably placed between the printing plate and the inner band, for instance, a sheet of ordinary thin book paper which has been saturated with ordinary lubricating oil. This has the effect of aiding in transferring the heat and in uniformity of heat imparted to the printing plate, and preventing or minimizing the likelihood of the fusing of the backing material when subjected to heat.

The heating agency in the heating mold has been placed in heat imparting relation. The swinging end of the outer band is lowered and connected with and locked to the lower forward end of the inner band. The slide 75 is then lowered to cause contact of the inner band with the heating mold. The eccentric clamp 98 is released. Further lowering of the slide causes enveloping drawing pressure of the outer band upon the printing plate, and of the printing plate and the inner band toward the heating mold. This relation is preferably maintained until the printing plate is sufficiently heated to permit ready flexure thereof without, however, being sufficiently heated to permit ready crushing action upon the printing plate by enveloping pressure thereon.

When sufficient pulling pressure has been exerted upon the outer band, the rear ends of the bands are connected together by the operation of the eccentrics 98, clamping of the rear end of the inner band to the rear end of the outer band. In this relation the ends of both bands at the respective sides of the mold are connected together and are under the influence of the slide 75.

As soon as the proper heat has been imparted to the printing plate, the slide is raised to release pressure of the inner band upon the heating mold. If the forming mold 191 is of greater diameter than the heating mold, the slide is raised sufficiently to receive the forming mold under the bands. The raising of the slide and the spreading guides 139, 140, causes separation between the ends of the respective bands and the arranging of the bands on arcs of less curvature, that is, greater radii, with the printing plate in flexible condition between the same, the pressure of the inner band upon the printing plate being outward and the pressure of the outer band being inward, to flex the printing plate upon corresponding curvatures. The raising of the slide is continued until the curvatures of the bands are sufficient to permit reception of the forming mold within the arc thereof. The mold carriage is then moved, to move the forming mold 191 within the bands, the increasing diameter of the intermediate mold 193 aiding in spreading and reforming the bands into proper curvatures for receiving the larger mold.

As soon as the forming mold has been received within the bands, the slide 75 is caused to descend for again exerting pulling enveloping pressure upon the bands, with the printing plate therebetween, about the new curvature of the forming mold for forming the printing plate into its desired curvature. The rigid connections between the slide and the outer ends of the outer band, due to the direct connections of the rods 102 with the rear end of the outer band and the locking connections of the front end of the inner band with the front end of the outer band, causes direct drawing or pulling upon the outer band which envelops the printing plate and the inner band. If the relative curvatures between the inner and outer bands are such, when such enveloping pressure of the outer band is exerted, as to cause undue strain upon the eccentric clamp connection 98 between the rear end of the inner band and the rear end of the outer band, then such clamp connection will permit yielding between said ends for causing intimate pressure between the outer band and the printing plate, and the smooth arrangement of the printing plate and the inner band about the forming mold. If desired, the clamp connections may be released when the inner band has been drawn down upon the forming mold.

If on the other hand the cooling mold is of less diameter than the heating mold, a raising of the slide sufficient to permit the sliding movement of the carriage thereunder only will be necessary for permitting the placement of the forming mold under the bands, whereupon the slide is caused to descend, for causing changing curvature of the bands while descending, which is communicated to the printing plate between the bands by the opposing forces of the resilient bands at the respective sides of the printing plate communicated to the printing plate in the manner just described. The bands communicate less curvature to the printing plate, which is then in hot and

flexible condition, the bands being then lowered to cause enveloping pressure of the outer band upon the printing plate. Yielding of the eccentric clamping connection between the rear end of the inner band and the rear end of the outer band is also permitted, or release of said clamping connection is effected, as described in connection with an arrangement where the forming mold is of greater diameter than the heating mold.

If the forming mold is of equal diameter with the heating mold, then the raising of the slide 75 will be sufficient only to release friction between the inner band and the heating mold, whereupon the mold carriage is moved lengthwise for placing the forming mold under the bands, and the slide is caused to descend for causing enveloping pressure, as hereinbefore described, of the bands and of the outer band upon the printing plate. This latter form is employed especially when it is desired to anneal printing plates, which have become hardened or crystallized as a whole or in spots, due to the compressive actions of the printing operations or corrective methods for imparting proper printing surfaces to the printing plates. The annealing of the printing plates also takes place when changing the curvature thereof from a given curvature to another desired curvature.

The arc on which the contact face of any of the molds is formed represents an arc equivalent to the arc of curvature of the plate cylinder upon which the printing plate has been used or is to be used, less the thickness of the oil sheet and the thickness of the inner band.

The enveloping pressure of the outer band is maintained until the printing plate has been set or fixed in its new curve, which setting or fixing is hastened by the application of the cooling liquid in the forming mold. With water circulating in the cooling mold at a temperature of forty to fifty degrees Fahrenheit, the printing plate will be cooled sufficiently in from three to four minutes.

When the forming of the printing plate has been completed, the free end of the outer band is released. The releasing is readily accomplished upon a slight raising of the slide 75, the eccentrics having been released, in order to relieve the locks and hooks from pressure. The locks and hooks having been released, the swinging end of the outer band may be thrown upwardly to rest on the rest 268, whereupon the curved printing plate is removed.

The carriage is then moved lengthwise to again place the heating mold under the bands, the slide 75 being manipulated either prior to or subsequent to such movement, to place said inner band in desired proximity to the contact face of the heating mold, the movement and time of movement of the slide depending on whether the heating mold is of greater or less diameter than the forming mold. The parts will thereby be placed in position for repeating the operation.

The guides 139, 140, guide the paths of the lower ends of the bands and maintain the curvatures of the bands concentric to the curvatures of the molds. The spreading of the guides at the respective sides of the molds outwardly as they approach the plane of the molds and the resiliency of the bands cause the bands to change their curvatures as their bowed median portions approach and recede from the molds to accommodate themselves to molds whose contact surfaces are sectors of cylinders of less or greater diameters, and to form spaces within the bands in which the molds are readily received.

In practice, curved printing plates are sectors of cylinders less than half cylinders. I prefer that the mold shall be in the form of a sector of a cylinder greater than the usual sectors represented by the plates and preferably greater than a half cylinder, so as to aid in shaping the resilient bands beyond the ends of the curved printing plates upon which they act, as shown at 271, 272, in Fig. 10. I prefer further that the opposite ends of the respective resilient bands be projected toward the vertical plane in which the axis of the cylinder and the median line of the crown of the mold are located; that the path of the slide exerting the pulling force to draw or pull upon the bands be substantially coincident with or parallel to said vertical plane; and that the point of application of said force be outside of and distanced from the circle of the cylinder upon which the molds and printing plates are formed. I have found that such relations of parts aids in proper curving of printing plates.

Having thus fully described my invention, what I claim as new, and desire to secure by Letters Patent, is:

1. The method of curving a curved printing plate having an inner backing surface and an outer printing surface which consists in applying heat to said curved printing plate from the inside of the curvature thereof toward said printing surface in a manner to render the printing plate progressively more pliable toward said backing surface and less pliable toward said printing surface, and then applying enveloping pressure upon the heated plate in curved form.

2. The method of curving a printing plate comprising a backing surface and a printing surface which consists in applying heat to said printing plate from the backing surface thereof toward the printing surface

thereof to render the printing plate progressively more pliable toward said backing surface and less pliable toward said printing surface, and then applying the enveloping pressure of a flexible band under tension upon said heated printing plate about a rigid curved resistance surface of substantially the desired curvature of the printing plate, whereby said heated printing plate is curved with its backing surface about said curved resistance surface.

3. The method of curving a printing plate which consists in locating a printing plate between bands, bending said bands while the printing plate therebetween is in heated state for imparting progressive curvatures by said bands to said printing plate, and then causing enveloping pressure upon said heated printing plate about a resistant curved surface by substantially equal pulling forces exerted across the respective ends of said printing plate upon the median portion of said printing plate.

4. The method of curving a curved printing plate comprising a backing surface and a printing surface which consists in applying heat to said curved printing plate from the inside of the curvature thereof in a manner to render the printing plate progressively more pliable toward said backing surface and leaving said printing surface less pliable, then applying enveloping pressure upon the heated plate in curved form, and cooling said printing plate from the inside of the curvature thereof.

5. The method of curving a curved printing plate which consists in supporting the curved printing plate between substantially concentric resilient bands, applying heat to said printing plate while so supported, continuing the supporting of said printing plate between said bands subsequent to said heating, and causing enveloping pressure upon the outer of said bands to curve the printing plate.

6. The method of treating a curved printing plate which consists in supporting the curved printing plate between curved crushing-resistant resilient bands, applying heat to the curved printing plate from the inside of its curvature, continuing the supporting of said curved printing plate between said bands, and causing enveloping pressure by the outer band about said printing plate and a curved pressure-resistant surface within the curvature of said printing plate.

7. The method of recurving a curved printing plate which consists in supporting the curved printing plate between substantially concentric curved crushing-resistant resilient bands, applying heat to the curved printing plate, continuing the supporting of said heated curved printing plate between said bands and initially recurving said printing plate by flexure of said bands while so supported, and causing enveloping pressure by the outer band about said initially curved printing plate and a curved pressure-resistant surface within the curvature of said printing plate.

8. The method of recurving a curved printing plate which consists in supporting the curved printing plate between substantially concentric curved crushing-resistant resilient bands, applying heat to the curved printing plate, continuing the supporting of said heated curved printing plate between said bands and initially recurving said printing plate by flexure of said bands while so supported, causing enveloping pressure by the outer band about said initially curved printing plate and a curved pressure-resistant surface within the curvature of said printing plate, and causing cooling of said printing plate.

9. The method of recurving a curved printing plate which consists in supporting the curved printing plate between curved crushing-resistant resilient bands, applying heat to the curved printing plate from the inside of its curvature, continuing the supporting of said curved printing plate between said bands and initially recurving said curved printing plate by flexure of said bands while so supported, causing enveloping pressure by the outer band about said printing plate and a curved pressure-resistant surface within the curvature of said printing plate, and cooling said recurved printing plate from inside its curvature outwardly.

10. The method of curving a printing plate which consists in heating the printing plate, and causing enveloping pressure thereon about a resistant curved surface by substantially equal pulling forces exerted across the respective ends of the printing plate upon the median portion of the printing plate.

11. The method of recurving a curved printing plate which consists in heating the printing plate between substantially concentric resilient bands, flexing said bands for causing pressure at both sides of said printing plate in opposite directions to initially change the curvature of said curved printing plate, and causing enveloping pressure by the outer of said resilient bands upon the initially recurved printing plate about a curved surface of substantially the desired curvature of the recurved printing plate.

12. The method of recurving a curved printing plate which consists in heating the printing plate between substantially concentric resilient bands, flexing said bands for causing pressure at both sides of said printing plate in opposite directions to initially change the curvature of said curved printing plate, and causing enveloping

pressure by the outer of said resilient bands upon the initially recurved printing plate about a curved surface of substantially the desired curvature of the recurved printing plate, while the ends of said printing plate are supported against separation between said flexible bands.

13. The method of recurving a curved printing plate which consists in heating the printing plate between substantially concentric resilient bands, flexing said bands for causing pressure at both sides of said printing plate in opposite directions to initially change the curvature of said curved printing plate, and causing enveloping pressure by the outer of said resilient bands upon the initially recurved printing plate about a curved surface of substantially the desired curvature of the recurved printing plate, while said resilient bands are held apart at the edges of said printing plate distances corresponding to the thickness of the printing plate by pressure-resistant members interposed between said bands.

14. The method of recurving a curved printing plate which consists in heating the curved printing plate, supporting said heated curved printing plate between substantially concentric resilient bands, changing the curvature of said resilient bands with said heated printing plate therebetween to initially change the curvature of said curved printing plate, and applying recurving pressure to said initially changed curved printing plate.

15. The method of recurving a curved printing plate which consists in heating a curved printing plate by pressing the same toward a heated mold of one curvature, transferring said heated curved printing plate about a mold of different curvature, and pressing said curved printing plate about said last-named mold.

16. The method of recurving a curved printing plate comprising a printing surface and a backing material, which consists in heating said curved printing plate to a degree approaching the fusing point of said backing material but sufficiently lower than said fusing point to render said backing material readily pliable while retaining substantially its crushing-resistant properties, and applying enveloping pressure upon said heated printing plate toward a curved resistance surface of substantially the desired curvature of the recurved printing plate.

17. The method of recurving a curved printing plate comprising a printing surface and a backing material, which consists in heating said curved printing plate to a degree approaching the fusing point of said backing material but sufficiently lower than said fusing point to render said backing material readily pliable while retaining substantially its crushing-resistant properties, initially recurving said curved printing plate by the opposing pressures thereon at opposite sides of said curved printing plate of substantially concentric flexible bands between which said heated curved printing plate is located while changing the curvature of said bands, and pressing said initially recurved printing plate toward a curved resistance surface of substantially the desired curvature of the recurved printing plate.

18. In a printing plate apparatus of the character described, the combination of a heating mold, a forming mold, and an intermediate mold complemented at its respective ends respectively to said heating mold and said forming mold, said molds arranged in end to end relation.

19. In a printing plate apparatus of the character described, the combination of a heating mold, a forming mold, and substantially concentrically arranged resilient bands between which the printing plate is received about said molds.

20. In a printing plate apparatus of the character described, the combination of a heating mold, a forming mold, substantially concentrically arranged resilient bands between which the printing plate is received about said molds, and means to cause change of cross-sectional relation between said molds and bands.

21. In a printing plate apparatus of the character described, the combination of a heating mold, a forming mold, substantially concentrically arranged resilient bands between which the printing plate is received about said molds, and means to change the longitudinal relation between said molds and bands.

22. The method of curving a printing plate which consists in locating a printing plate between bands and curving said bands while the printing plate therebetween is in heated state for imparting progressive curvatures to said heated printing plate by said bands, and then causing enveloping pressure upon the heated printing plate throughout the area of the printing plate about a resistant curved surface by pulling forces about said heated printing plate and said resistant curved surface.

23. The method of curving a printing plate which consists in locating a printing plate between bands and curving said bands while the printing plate therebetween is in heated state for imparting progressive curvatures to said heated printing plate by said bands, then causing enveloping pressure upon the heated printing plate throughout the area of the printing plate about a resistant curved surface by pulling forces about said heated printing plate and said resistant curved surface, and then cooling said printing plate.

24. In a printing plate apparatus of the character described, the combination of a mold, flexible bands about said mold, the respective ends of said bands located at the respective sides of said mold, means positively connecting said ends at one side of said mold, and means frictionally connecting said ends at the other side of said mold.

25. In a printing plate apparatus of the character described, the combination of a mold, resilient bands about said mold, the respective ends of said bands located at the respective sides of said mold, a slide, means for moving said slide toward and from said mold, means connecting opposite ends of said respective bands to said slide, and means connecting the other ends of said bands to said first-named ends of said bands.

26. In a printing plate apparatus of the character described, the combination of a mold having a surface substantially the form of the sector of a cylinder, resilient bands thereabout, a slide movable in a plane substantially coincident with a plane in which the axis and the crown of said sector of said cylinder is located, and connections between said slide and said resilient bands.

27. In a printing plate apparatus of the character described, the combination of molds having surfaces substantially the forms of sectors of cylinders and arranged end to end, resilient bands received about said molds, means causing approach and recession between said surfaces and said bands, and means causing movement between said molds and bands lengthwise of the axes of said sectors.

28. In a printing plate apparatus of the character described, the combination of a pair of resilient bands arranged for having a printing plate received between them, a mold about which said bands is received, and pressure-resistant members between said bands for said printing plate.

29. In a printing plate apparatus of the character described, the combination of a pair of resilient bands arranged for having a printing plate received between them, a mold about which said bands is received, pressure-resistant members between said bands for said printing plate, and means for adjusting said pressure-resistant members between said bands about said mold.

30. In a printing plate apparatus of the character described, the combination of a heating mold, a forming mold, an intermediate mold whose respective ends are complemental respectively to said heating mold and said forming mold, resilient bands between which a printing plate is arranged to be received, means for causing movements lengthwise of the axes of said molds and crosswise of said axes between said molds and said bands, and means for separation between said bands for reception and removal of said printing plate between them.

31. In a printing plate apparatus of the character described, the combination of a heating mold and a forming mold arranged in endwise relation, resilient bands between which a printing plate is arranged to be received, means for causing movements lengthwise of the axes of said molds and crosswise of said axes between said molds and said bands, and means connecting the ends of said bands at the respective sides of said mold, said last-named means including a yielding connection.

32. In a printing plate apparatus of the character described, the combination of a heating mold and a forming mold arranged in end to end relation, a carriage on which said molds are supported, resilient bands forming bows in which said molds are arranged to move, a slide movable toward and from said carriage, and connections between said slide and said resilient bands.

33. In a printing plate apparatus of the character described, the combination of a heating mold and a forming mold arranged in end to end relation, a carriage on which said molds are supported, resilient bands forming bows in which said molds are arranged to move, separating means between said bands complemental to the forming faces of said mold, a slide movable toward and from said carriage, and connections between said slide and said resilient bands.

34. In a printing plate apparatus of the character described, the combination of a heating mold having a supporting surface arranged substantially as the sector of a cylinder, forming molds having forming surfaces arranged substantially respectively as the sectors of cylinders of different diameters, a resilient band complemental to said various molds, and means causing movements between said molds and said band.

35. In a printing plate apparatus of the character described, the combination of heating molds having supporting surfaces arranged substantially respectively as the sectors of cylinders of different diameters, a forming mold having a supporting surface arranged substantially as the sector of a cylinder, a resilient band complemental to said various molds, and means causing movements between said molds and said band.

36. In a printing plate apparatus of the character described, the combination of a heating mold having a supporting surface arranged substantially as the sector of a cylinder, a forming mold having a forming surface arranged substantially as the sector of a cylinder of different diameter, and an intermediate mold having a surface ar-

ranged on the sector of a frusto-cone whose ends are respectively complemental to said respective sectors of cylinders of said heating mold and said forming mold.

37. In a printing plate apparatus of the character described, the combination of a heating mold having a supporting surface arranged substantially as the sector of a cylinder, a series of forming molds arranged substantially as the sectors of cylinders of greater and smaller diameters than the diameter of said first-named cylinder, and a series of intermediate molds arranged as the sectors of frusto-cones whose respective ends are complemental to said first-named sector and to said series of sectors.

38. In a printing plate apparatus of the character described, the combination of a carriage, a heating mold, means releasably securing one end of said heating mold to one end of said carriage, a forming mold, means releasably securing the other end of said carriage to said forming mold, an intermediate mold on said carriage, a pair of resilient bowed bands about said molds, means moving said carriage lengthwise, and means moving said bands toward and from said molds.

39. In a printing plate apparatus of the character described, the combination of a carriage, a heating mold, a forming mold and an intermediate mold releasably secured to said carriage, means providing cooling space between said heating mold and said intermediate mold, and a resilient band complemental to said molds.

40. In a printing plate apparatus of the character described, the combination of a carriage, a heating mold, a forming mold and an intermediate mold arranged in endwise relation on said carriage, and means providing cooling space between said heating mold and said intermediate mold, said heating mold provided with a recess for a heat-registering device.

41. In a printing plate apparatus of the character described, the combination of a mold having a supporting surface substantially in the form of the sector of a cylinder, an inner resilient band and an outer resilient band about said mold, the respective ends of said bands located at the respective sides of said mold, a slide, means connecting one end of said inner band and the opposite end of said outer band to said slide, releasable means connecting the other end of said outer band to said one end of said inner band, and slippage means connecting the other end of said inner band to said opposite end of said outer band.

42. In a printing plate apparatus of the character described, the combination of a mold having a supporting surface substantially in the form of the sector of a cylinder, an inner resilient band and an outer resilient band about said mold, the respective ends of said bands located at the respective sides of said mold, a slide, connections between said slide and said respective ends causing said ends to move determined by the movement of said slide, and spring means between said slide and one of said ends to cause relative movement between said ends.

43. In a printing plate apparatus of the character described, the combination of a mold having a surface substantially in the form of the sector of a cylinder, an inner resilient band and an outer resilient band about said mold, a slide, means connecting opposite ends of said respective bands with said slide, latching means connecting the proximate ends of said bands at one side of said mold, and connecting means connecting the proximate ends of said bands at the other side of said mold, said last-named means including a yielding connection.

44. In a printing plate apparatus of the character described, the combination of a mold having a surface substantially in the form of the sector of a cylinder, an inner resilient band and an outer resilient band about said mold, a slide, means connecting opposite ends of said respective bands with said slide, latching means connecting the proximate ends of said bands at one side of said mold, connecting means connecting the proximate ends of said bands at the other side of said mold, said last-named means including a yielding connection, and means normally drawing said inner band toward said mold.

45. In a printing plate apparatus of the character described, the combination of a mold having a surface substantially in the form of the sector of a cylinder, an inner resilient band and an outer resilient band about said mold, a slide having a path of movement substantially coincident with the plane in which the axis of said cylinder and the crown of said sector are located, the ends of said bands located at the respective sides of said sector, and slanting guides for said respective ends, said guides slanting with one of their ends toward said plane and their other ends toward the periphery of said cylinder.

46. In a printing plate apparatus of the character described, the combination of a mold having a surface substantially in the form of the sector of a cylinder, an inner resilient band and an outer resilient band about said mold, bars for the edges of a printing plate, said bars located between said bands, and means between one of said bands and said bars for adjusting said bars about the arc of said sector.

47. In a printing plate apparatus of the character described, the combination of a mold having a surface substantially in the

form of the sector of a cylinder, an inner resilient band and an outer resilient band about said mold, means connecting the ends of said bands, resilient guide-strips on said inner band, bars for the edges of a printing plate, and adjustable connections between said bars and said resilient guide-strips.

48. In a printing plate apparatus of the character described, the combination of a mold having a surface substantially in the form of the sector of a cylinder, an inner resilient band and an outer resilient band about said mold, means connecting the ends of said bands, resilient guide-strips, the middle portions of said guide-strips secured to the crown portion of said inner resilient band, the ends of said guide-strips having slide-connections with said inner resilient band, bars for the edges of a printing plate, and adjustable connections between said bars and said resilient guide-strips.

In testimony whereof, I have hereunto signed my name in the presence of two subscribing witnesses.

LESLIE W. CLAYBOURN.

In presence of—
C. A. WESTBERG,
PETER C. JUNG.