No. 652,808. Patented July 3, 1900.

# J. E. PARKER.

## PIPE BENDING MACHINE.

(Application filed Mar. 23, 1900.)

(No Model.) 8 Sheets—Sheet 1.

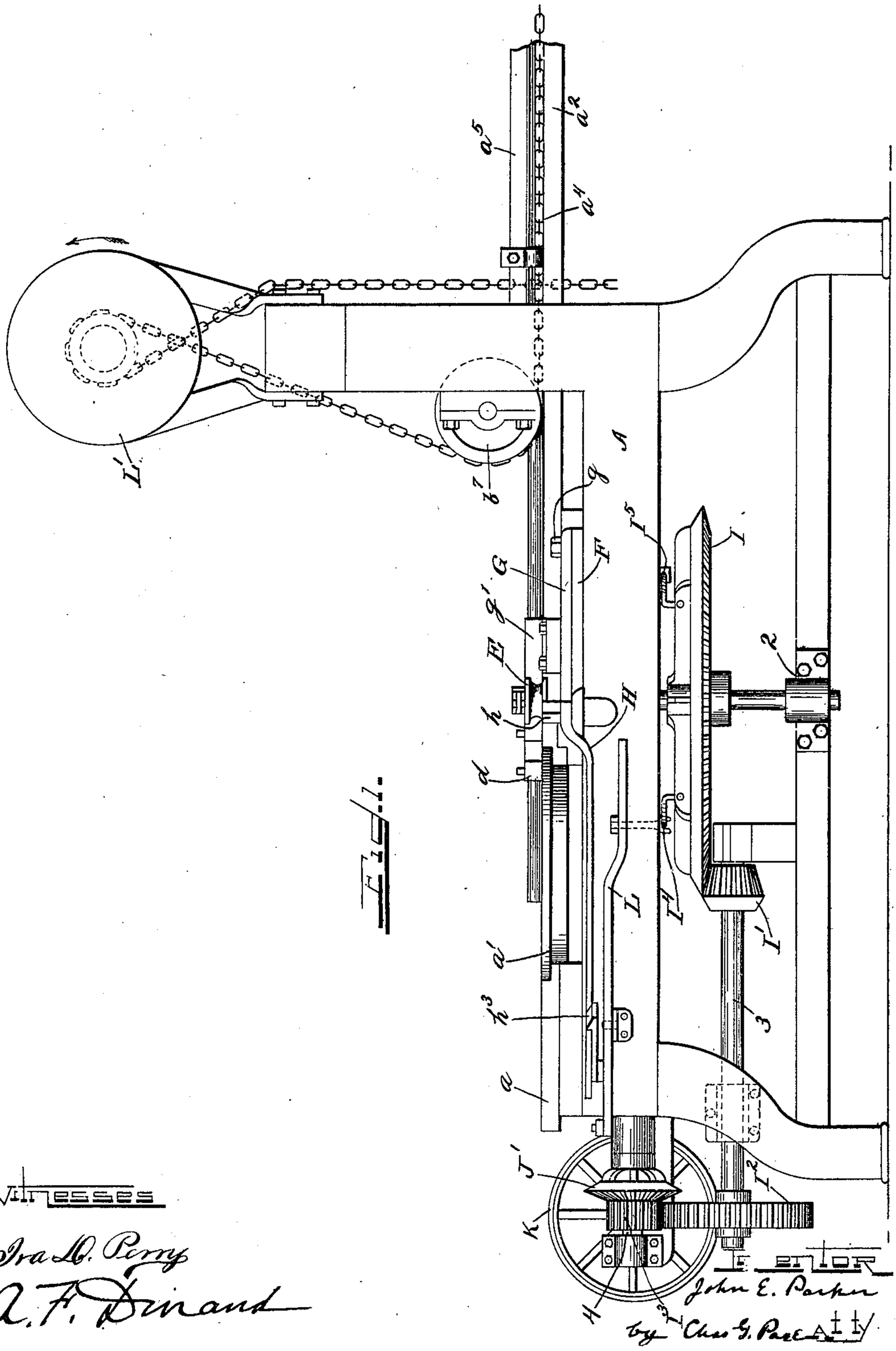

Fig. 1.

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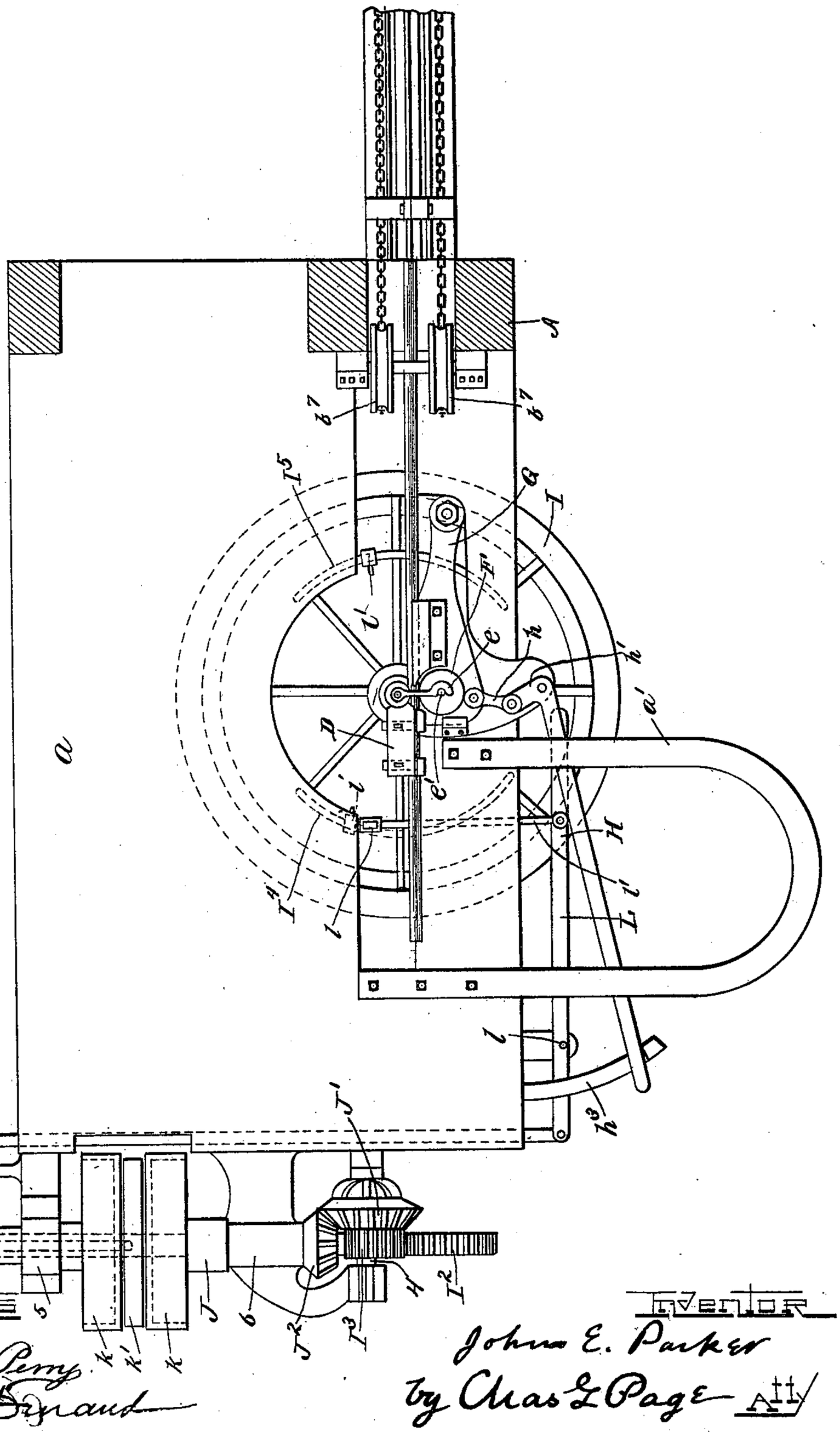
(No Model.) 8 Sheets—Sheet 2.

Fig. 2.

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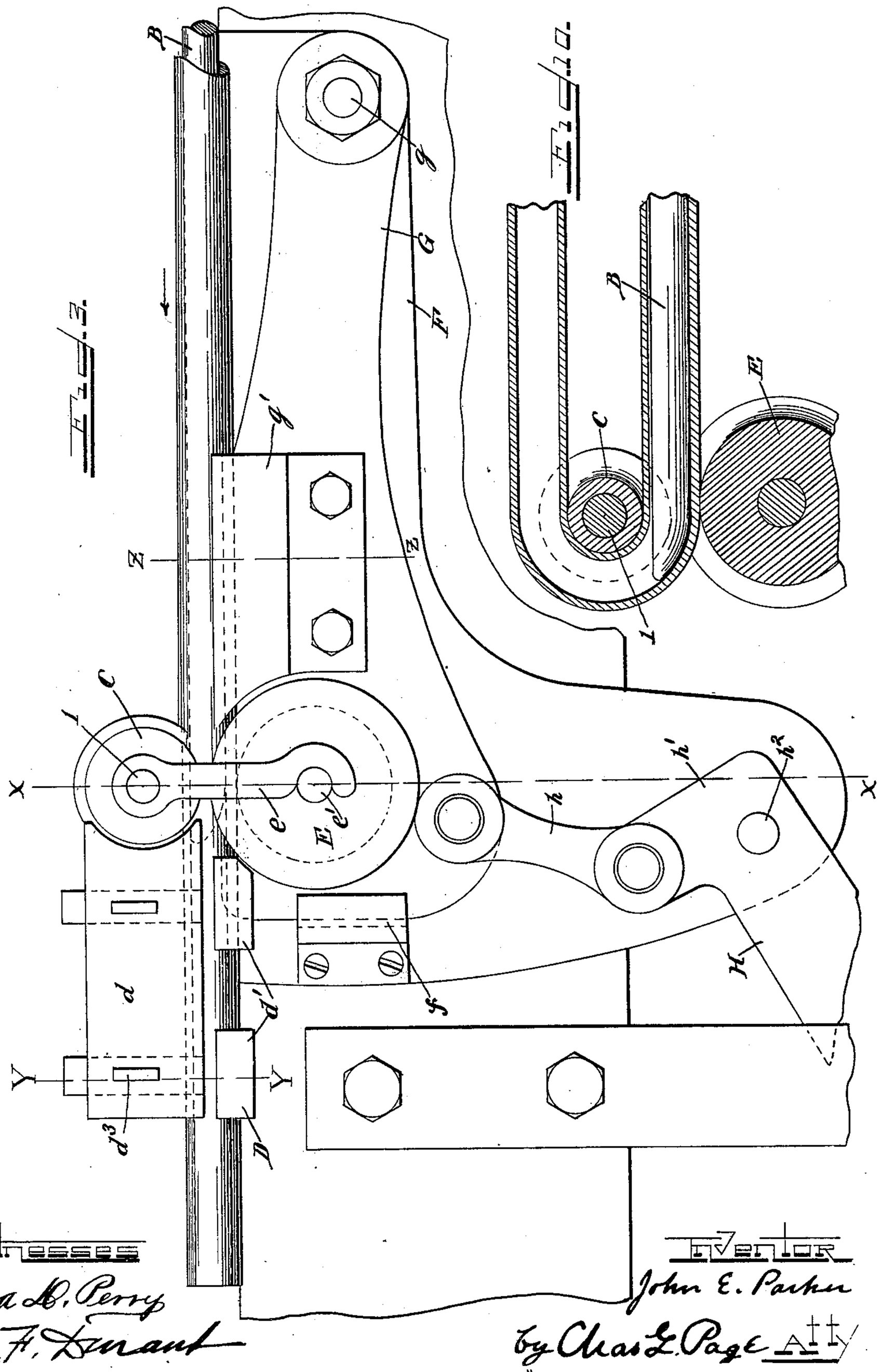
(No Model.) 8 Sheets—Sheet 3.

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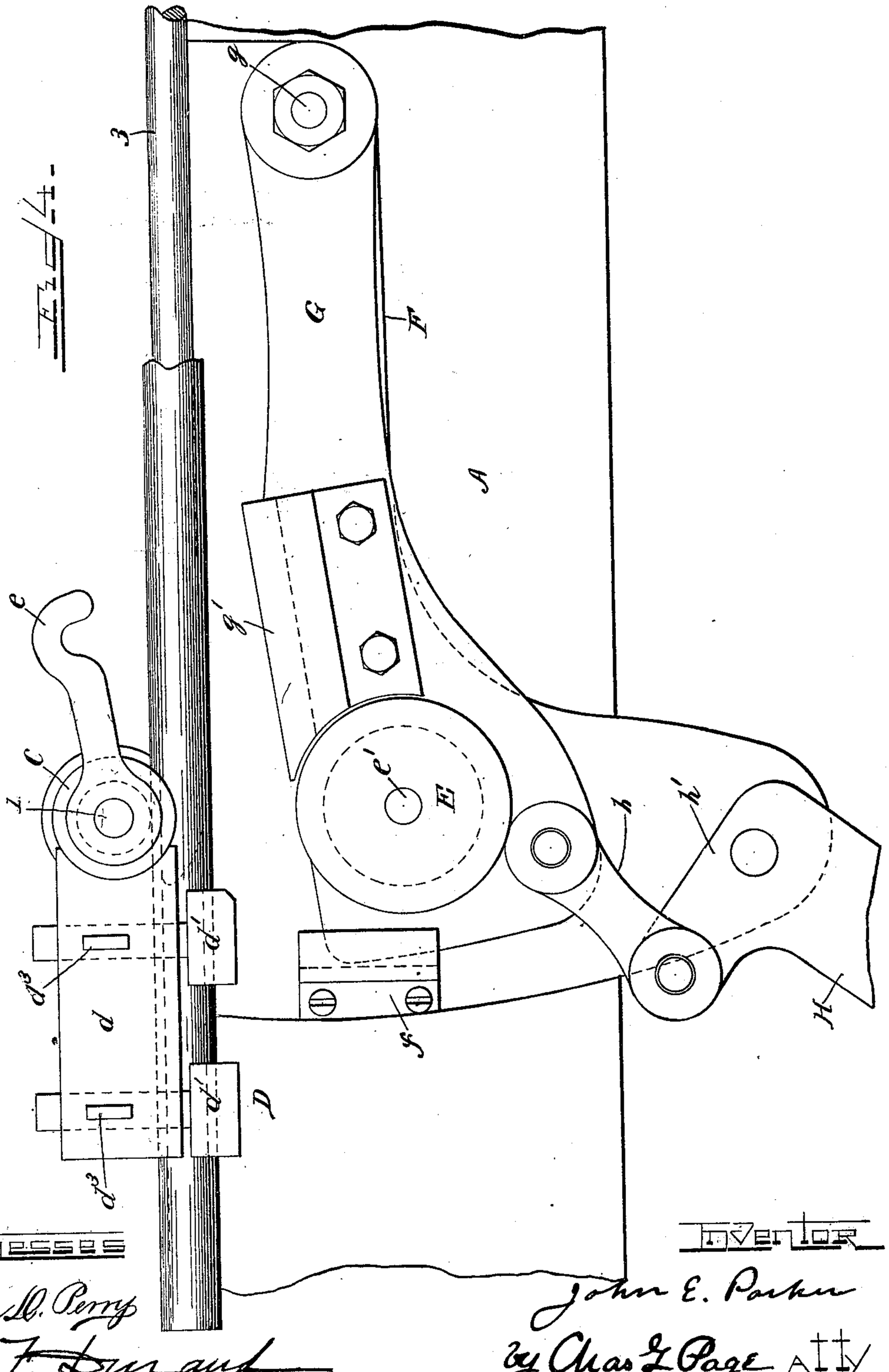
(No Model.) 8 Sheets—Sheet 4.

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PIPE BENDING MACHINE.

(Application filed Mar. 23, 1900.)

(No Model.) 8 Sheets—Sheet 5.

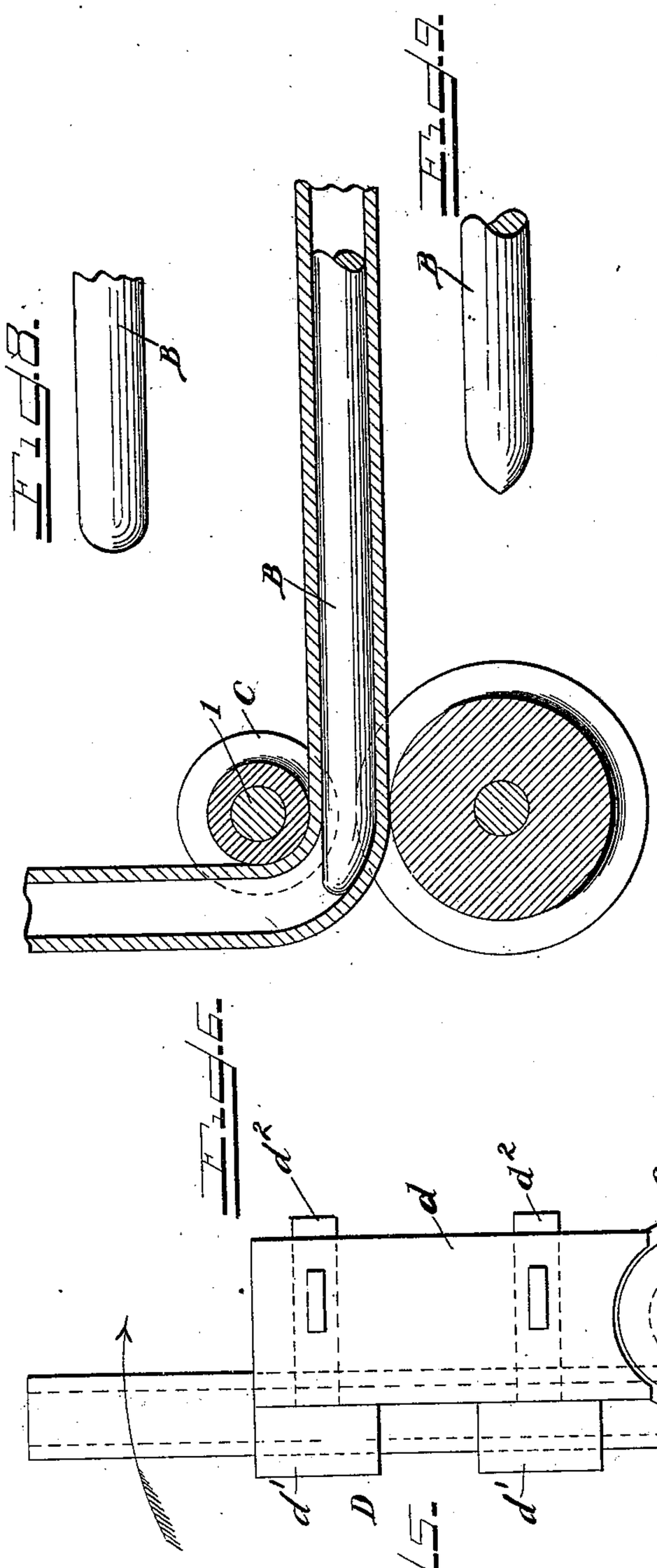


FIG. 8.

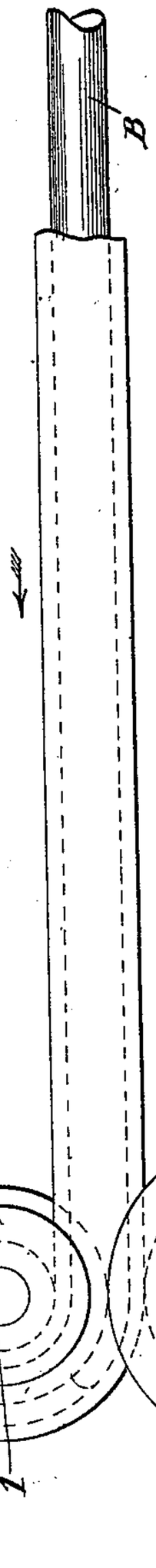


FIG. 9.

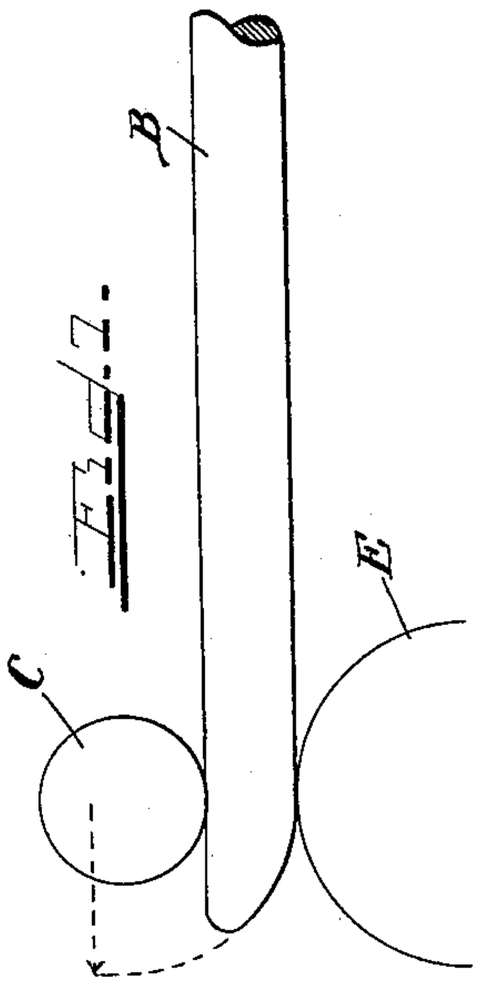


FIG. 7.




FIG. 5.

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## PIPE BENDING MACHINE.

(Application filed Mar. 23, 1900.)

(No Model.) 8 Sheets—Sheet 6.

Fig. 11.

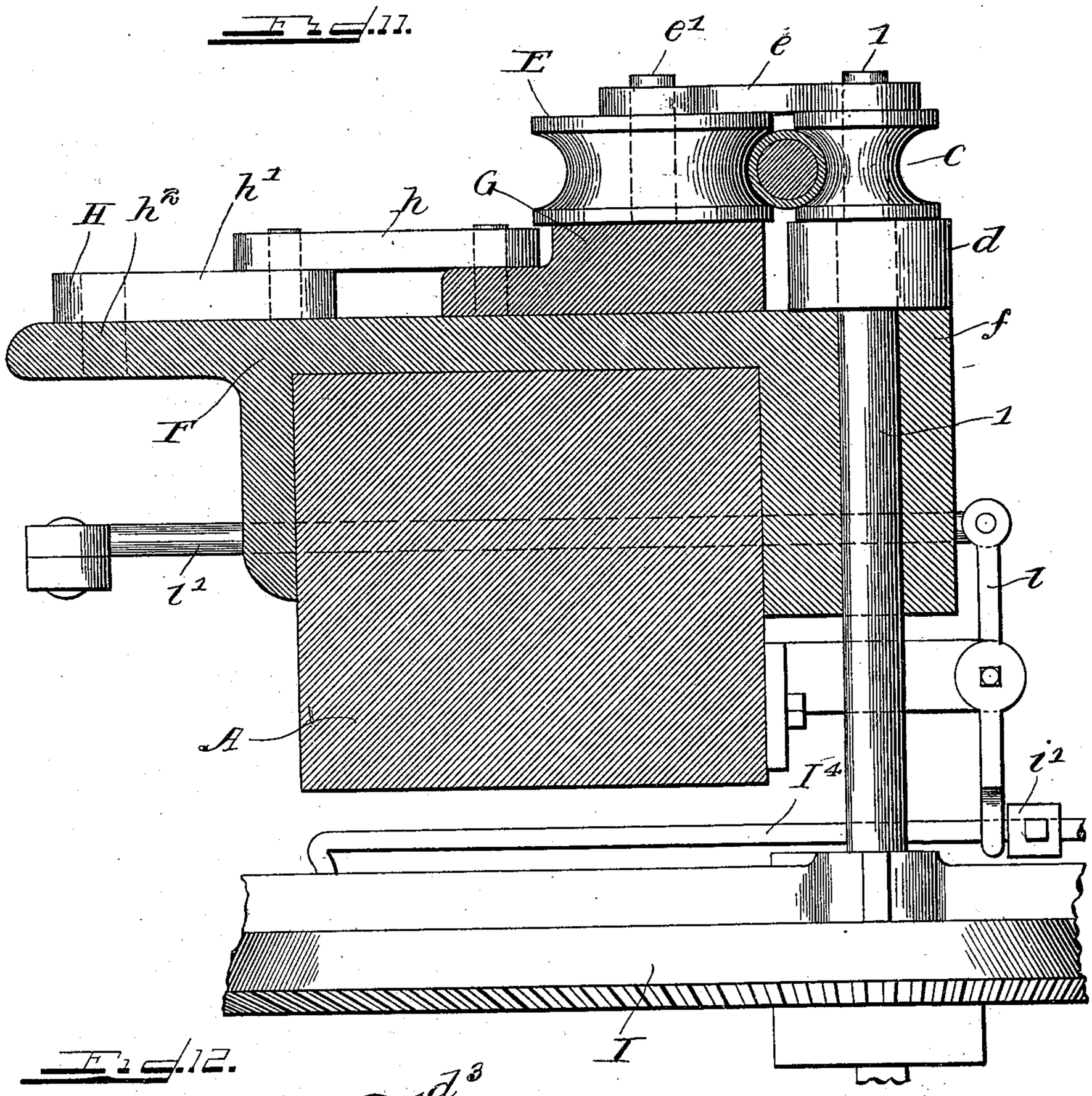



Fig. 12.

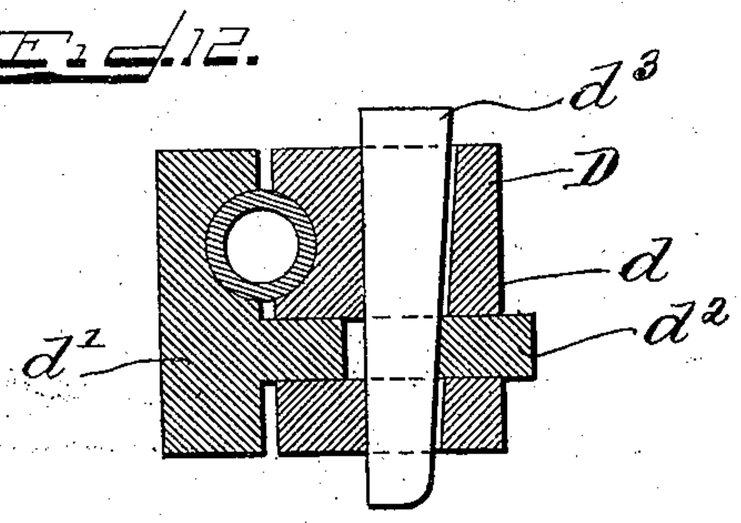
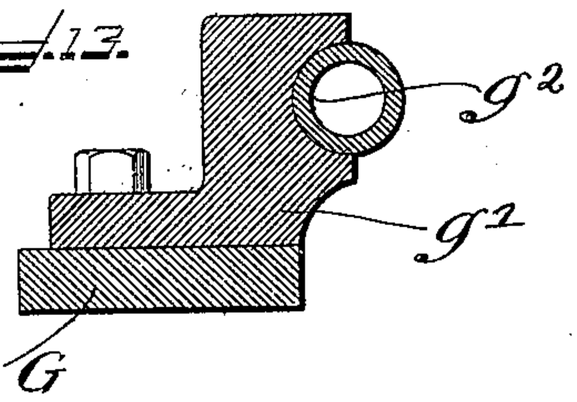



Fig. 13.

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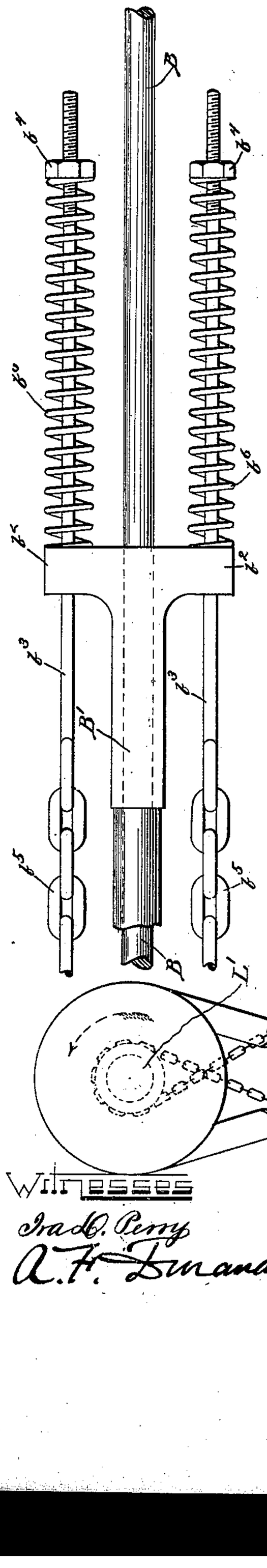

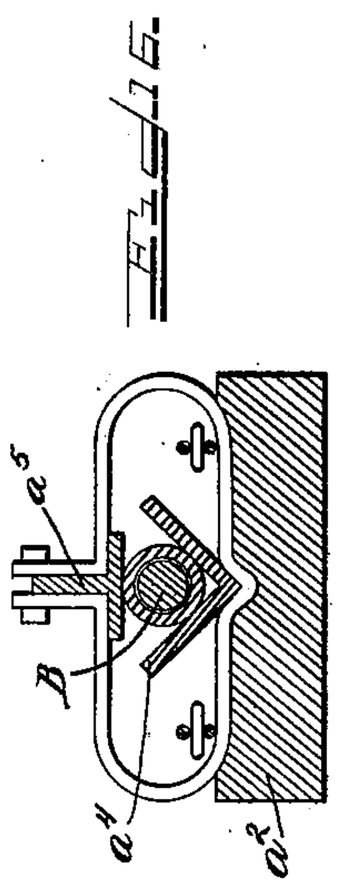

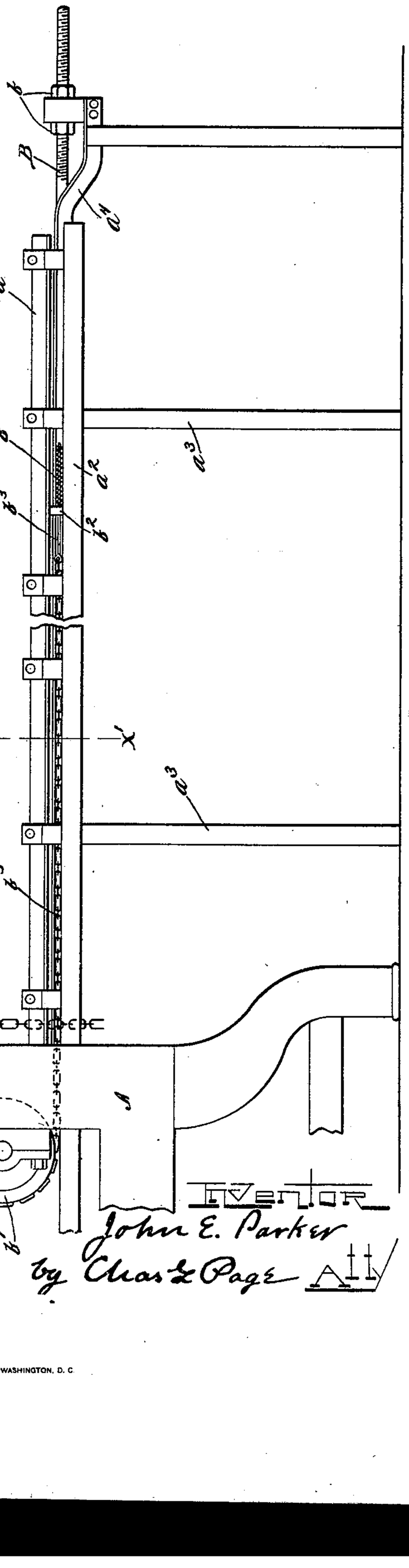



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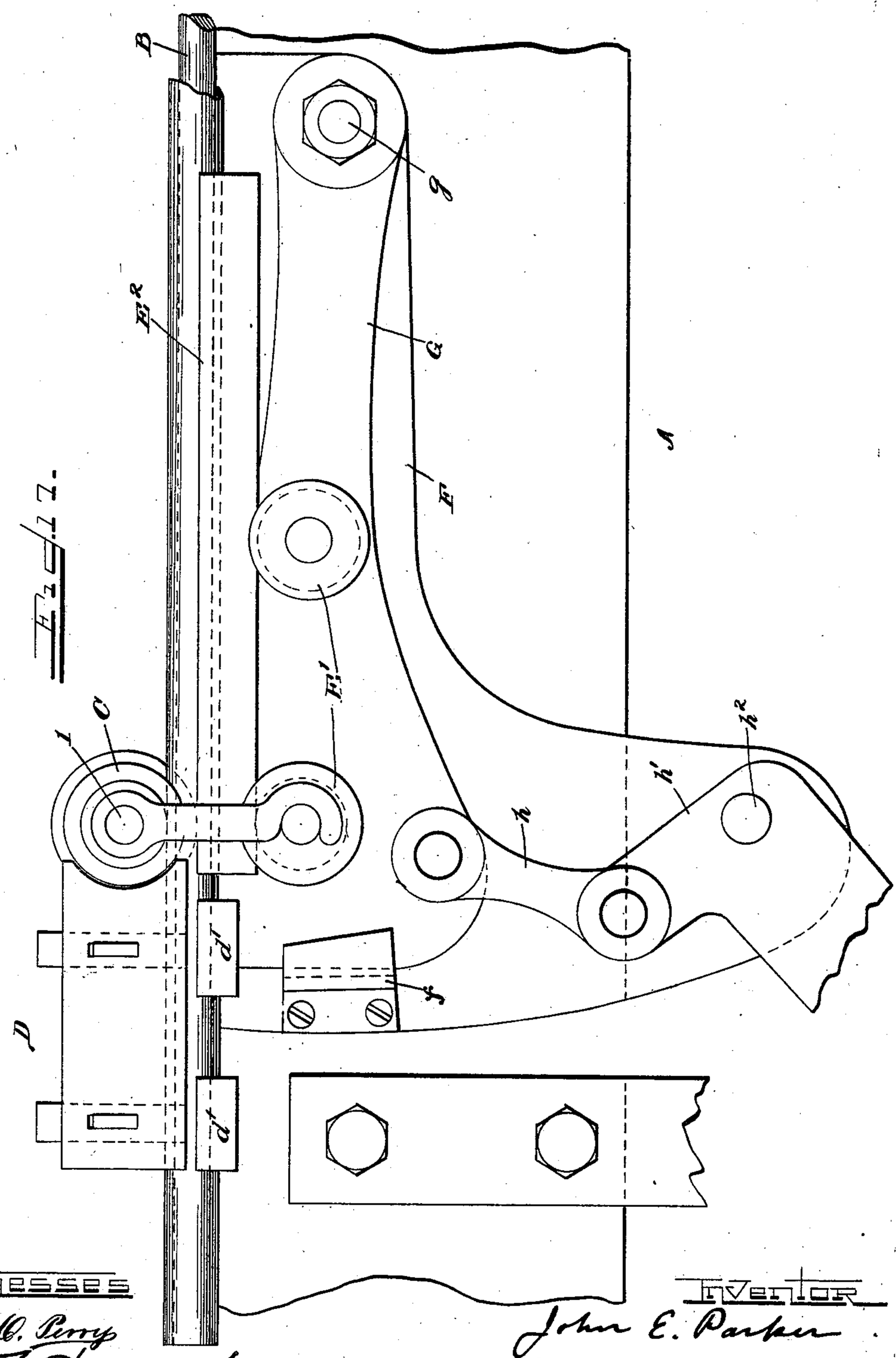


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# UNITED STATES PATENT OFFICE.

JOHN E. PARKER, OF CHICAGO, ILLINOIS.

## PIPE-BENDING MACHINE.

SPECIFICATION forming part of Letters Patent No. 652,808, dated July 3, 1900.

Application filed March 23, 1900. Serial No. 9,866. (No model.)

*To all whom it may concern:*

Be it known that I, JOHN E. PARKER, a citizen of the United States, residing at Chicago, in the county of Cook, State of Illinois, have invented a certain new and useful Improvement in Pipe-Bending Machines, of which the following is a specification.

The principal objects of my invention are to provide a simple, improved, and highly-effective machine by which metal pipe or tubing may be bent without any liability of the same collapsing at the bending-point; to provide a machine capable of operating upon various lengths of pipe or tubing and in which such pipe or tubing can be bent at all points in its length with equal facility; to provide a bending-machine whereby tubing can be quickly and accurately bent into various forms and involving in its construction certain features tending to facilitate the adjustment of the pipe into position for bending; to facilitate the bending by applying pressure to the rear end of the pipe in the same direction in which the pipe is moved by the bending mechanism; to provide a machine capable of operating upon either light or heavy tubing and upon tubing made of either hard or soft metal; to provide a novel, serviceable, and highly-effective form of mandrel for supporting the tube internally at the bending-point; to provide a machine whereby tubing may be bent cold without weakening or impairing the metal; to avoid the use of all flexible devices for supporting the pipe internally at the bending-point, and to provide certain details tending to increase the general efficiency and to render a machine of this character serviceable, effective, and thoroughly reliable.

To the attainment of the foregoing and other useful ends my invention consists in the matters hereinafter set forth and claimed.

In the accompanying drawings, Figure 1 represents, in side elevation, the main or forward portion of a pipe-bending machine embodying the principles of my invention. Fig. 2 is a plan of the machine shown in Fig. 1. Fig. 3 is an enlarged plan of the mechanism for gripping and bending the pipe, the forward portion of the mandrel, and the movable roll for holding the pipe against the rotary former. Fig. 4 is a view similar to Fig. 3, but showing the roll swung back from the pipe. Figs. 5, 6, and 7 are diagrammatic views illustrating the manner in which the pipe is bent and the way in which the mandrel prevents the pipe from collapsing at the bending-point. Figs. 8 and 9 are modified forms of the mandrel. Fig. 10 is a view similar to Fig. 6. Fig. 11 is a section on line $x\,x$ in Fig. 3. Fig. 12 is a section on line $y\,y$ in Fig. 3. Fig. 13 is a section on line $z\,z$ in Fig. 3. Fig. 14 is a side elevation of the rear portion of the machine. Fig. 15 is an enlarged plan of the cross-head by which pressure is applied to the rear end of the pipe. Fig. 16 is a transverse section through the pipe, mandrel, trough, &c., on line $x'\,x'$ in Fig. 14. Fig. 17 shows a preferred form of bending mechanism.

As thus illustrated, my improved bending-machine comprises a stand or body-frame A, which is preferably of a height to support the various operative parts in suitably-elevated positions. The upper portion of the said frame may be adapted to provide a table $a$, whereon the curved or bent portion of the pipe may rest at certain stages in the operation, and for a like purpose the frame can be provided with an extension $a'$, having its upper surface flush with the upper surface of the said table.

My invention is particularly adapted for bending or operating upon long sections of pipe or tubing, and in order to properly support the pipe or tubing and also the long mandrel B, I construct the body-frame with a long rear extension $a^2$, which is upheld by a number of props or uprights $a^3$. (See Fig. 14.)

Referring now to Figs. 2 to 13, the mechanism and means by which the pipe is bent comprise a former C, a swinging clamping device D, adapted to grip the pipe and bend it about the former, and an adjustable roll or sheave E for holding the pipe firmly against the said former. The said clamping device is keyed to the upper end of a rotary shaft 1 and may consist of a block $d$ and a couple of clamping-jaws $d'$. Each jaw may be provided with a stem or shank $d^2$, and the block and jaws can be held together by a couple of tapered keys $d^3$, which are driven transversely

through the block and the stems $d^2$. Both the jaws and the block have their meeting surfaces grooved to receive the pipe, and with such arrangement the forward end portion of the pipe can be firmly clamped between the block and the jaws in the manner shown in Figs. 3 and 12. The former C is peripherally grooved, as shown in Fig. 11, and is also mounted upon the upper end of the vertically-disposed shaft 1; but while the clamping device is, as stated, keyed to this shaft the former is preferably loosely mounted thereon and is, in case the pipe slips slightly from the grip of the clamping device, free to turn upon the end of the said shaft. A plate or casting F, having a flat upper surface and having its inner portion adapted to provide a bearing $f$ for the shaft 1, is secured to the body-frame, as shown in Figs. 3 and 11, and upon this plate or casting is arranged the swinging plate G, which carries the roll or sheave E and which swings about its point of pivotal connection $g$ with the casting F. The forward portion of this swinging plate may be curved on the line of a circle struck from the pivotal point $g$, and such curved portion can be covered by a guide or guard $f'$, which is secured to the casting F and which serves to hold or maintain the swinging plate down in place. While various devices may be employed to shift or adjust the plate which thus carries the roll E, I prefer, as a matter of special improvement, to provide a hand-lever H and to connect the same with the plate by means of a link $h$. The said lever is preferably bell-crank in form, being provided with a short arm $h'$, which is connected with the plate G by means of the aforesaid link $h$ and is pivoted to the casting F at $h^2$. With this arrangement the roll E can be brought to bear against the pipe, as shown in Figs. 2 and 3, and in which case the lever is locked by a spring-catch $h^3$, and also the roll and plate can be swung outward to release the pipe, as shown in Fig. 4. In addition to the roll the said swinging plate G is provided with a block $g'$, having a groove $g^2$, adapted to receive the pipe and arranged to bear against the pipe immediately in the rear of the said roll. The long mandrel B, previously referred to, has its rear end suitably secured or held and its forward end adapted to support the pipe internally at the bending-point. This mandrel is preferably of a diameter to permit its ready insertion within the pipe and is adjusted forward to an extent to bring its forward end somewhat beyond the rotary former G, and, as stated, this forward end of the mandrel is adapted to support the pipe internally at the bending-point, and for such purpose is preferably curved or rounded in the manner shown in Figs. 3, 5, 6, 7, and 10. Theoretically this curvature of the mandrel is on a circle struck from the center or axis of the rotary former; but in practice I find it best to curve the mandrel on the line of a circle having a somewhat-greater radius and to in this way allow for the slight spring or flexibility of the mandrel. (See Fig. 7.) As a matter of fact, however, the mandrel may be simply rounded at its forward end, as shown in Fig. 8, or even curved on both sides, as shown in Fig. 9, and it is obvious that still further modifications may be employed without departing from the spirit of my invention. I prefer, however, to simply round or curve the end of the mandrel at its outer side only, as shown in Figs. 6 and 7, for the reason that such formation affords a longer bearing-surface for the pipe and is therefore more effective in preventing the latter from caving in or collapsing. It is also desirable to make some provision for maintaining the roll E in position against the pipe. Accordingly I provide the hook $e$, which is mounted to swing about the upper end of the shaft 1 and which is adapted at its opposite end to engage the stud $e'$, upon which the roll E revolves. In this way the said roll can first be brought into position against the pipe and can then be locked in such position for the purpose of holding the pipe tightly against the periphery of the rotary former. (See Figs. 3 and 4.)

With a mandrel and bending mechanism thus arranged for coöperation the operation of bending a length of pipe or tubing is as follows: First, the pipe is slipped over the mandrel and adjusted back along the same until its forward end projects the desired distance beyond the forward end of the mandrel. Next, this forward end portion of the pipe is gripped by the clamping device D and the roll E then adjusted into position to hold the pipe firmly against the periphery of the former C. After this the shaft 1, and consequently the clamping device and the former, is rotated in the direction indicated by the arrow in Fig. 5 and with the result that the forward portion of the pipe is bent about the periphery of the said former. The shaft 1 is preferably capable of a half-turn, and consequently the bending may be carried to any extent desired—that is to say, the forward portion of the pipe may be bent either at an angle to or parallel with the balance of the pipe. (See Figs. 5 and 10.) During this operation the pipe moves forward along the mandrel and is bent as fast as it comes in contact with the periphery of the former. It will be seen, therefore, that the curved or rounded end of the mandrel serves to prevent the pipe from caving in or collapsing at the point where all the bending occurs and that the pipe is subject to no flexure whatever after leaving the end of the mandrel. With a mandrel and bending mechanism of this description either thick or thin tubing may be bent, and the device has the further advantage of being able to operate upon either hard or soft metal. It will also be seen that the mandrel when in use is subject to an end pressure—that is to say, the pressure of the pipe upon the for-

ward end of the mandrel is in a rearward direction—and that consequently there will be no tendency on the part of the mandrel to work forward.

The shaft 1 may be turned in any desired manner and by any suitable device. As a matter of special improvement, however, I provide the shaft with a bevel-gear I and also with a bearing 2. At the forward end of the machine I arrange a shaft J and connect the same with the bevel-gear I through the medium of a bevel-pinion I′, shaft 3, gears $I^2$ and $I^3$, and bevels J′ and $J^2$, it being observed that the gear $I^3$ and the bevel J′ are mounted upon a short shaft 4, which extends at right angles above the shaft J, and also that the latter is mounted in bearings 5 and 6. The said shaft J is power-driven and is reversible for the purpose of reversing the shaft 1. Various devices may be employed for effecting such reversal, and I do not limit myself to any particular means for so doing. For instance, the shaft J may be provided with a friction-clutch K, consisting of the usual loose pulleys *k k* and a shiftable member *k′*, adapted to engage either one of the said pulleys. The said shiftable member may be keyed to the shaft in any suitable manner and can be shifted or operated by means of a rod $k^2$. The two pulleys thus loosely mounted upon the shaft are driven in opposite directions, and with this arrangement it will be readily seen that the rotation of the shaft J, and consequently that of the shaft 1, may be reversed at will by simply shifting the member *k′* into engagement with one or the other of the said two pulleys. As a simple arrangement for thus operating the said clutch I have provided a hand-lever L and have connected the same with the rod $k^2$ by means of a lever $k^3$ and a rod $k^4$. In this way the operator is given full control of the machine and can by shifting the lever L start or stop the rotation of the shaft 1 at will. It is, however, preferable that the stopping of the rotation of the shaft 1 be automatically accomplished, and to such end I have connected the lever L with the bevel I in the following manner: Upon the upper surface of the said bevel are secured a couple of oppositely-arranged and segmental rods $I^4$ $I^5$, and adjustably mounted upon the same are a couple of trippers *i i′*. Pivotally supported at a point just forward of the bending mechanism is a vertically-disposed lever *l*, the upper end of which is connected with the lever L by means of a rod *l′*. The lower end of the said lever *l* is preferably fork-shaped and arranged in position to straddle the rods $I^4$ and $I^5$—that is to say, the two rods travel or pass between the prongs of the fork-shaped lever when the bevel I is rotated. (See Fig. 11.) With this arrangement the operation of the machine is as follows:

After first adjusting the pipe in place, as shown in Fig. 2, the lever L is then pushed inward by the attendant for the purpose of operating the clutch K, and thereby rotating the bevel I and the shaft 1 in the direction indicated by the arrow. Such rotation of the said shaft operates to bend the pipe in the manner previously described, and the movement of the bevel and shaft in this direction will continue until arrested by reason of the tripper *i′* striking the lever *l*, for it will be seen that the tripping of the said lever in this manner serves to shift the lever L and to thereby operate the clutch K—that is to say, serves to disengage the member *k′* from one of the pulleys *k*, and consequently to stop the rotation of the shaft J. The pipe can now be released from the clamping device D and the latter then returned to its original position by simply operating the said clutch in such manner as to cause the shaft J to rotate in an opposite direction. The rotation of the said shaft in this direction is then terminated by reason of the tripper *i′* striking the lever *l*, and the clamping device D is in this way brought to a standstill in the exact position from which it started. The extent of the bending or, in other words, the arc of the circle in which the clamping device travels is easily varied or changed, as both trippers are adjustable along the segmental rods upon which they are mounted. To illustrate, the tripper *i′* is shown in a position which will permit the forward portion of the pipe to be bent or swung around to a position parallel with its portion which still remains upon the mandrel; but by properly adjusting the said tripper the movement can be arrested at any particular point and the forward portion of the pipe in this way bent at any desired angle to its rear portion.

As a matter of further and special improvement and with a view to reducing or minimizing the friction between the pipe and the rounded end of the mandrel and also for the purpose of counteracting the tendency or liability of the pipe to stretch at the bending-point, I provide means whereby pressure may be applied to the rear end of the pipe in the same direction in which the pipe is moved along the mandrel by the action of the bending mechanism. By thus constantly crowding the pipe forward during the bending operation I secure a partial upsetting of the metal—that is to say, an upsetting of sufficient extent to counteract the tendency of the pipe to stretch at the bending-point—and, furthermore, I relieve the pressure upon the forward end of the mandrel, and thereby facilitate the bending of the pipe to a considerable extent. Ordinarily pipe or tubing when bent or curved about an annular former such as the one shown and described has a tendency to stretch and become thin at the periphery or outside of the bend, and consequently to become weakened and perhaps unfit for service; but by crowding the pipe forward to an extent to partially upset the metal at the bending-point, or at least to an extent to counter-

act this tendency to stretch, I obviate this difficulty and permit the tubing to be bent cold without stretching it or in any way impairing its strength. Various devices may be employed for thus subjecting the pipe to a constant forward pressure, but a simple and practical arrangement consists as follows:

The long rear frame-extension $a^2$, which I have already referred to and described as forming a support for the mandrel and pipe, comprises a V-shaped trough $a^4$ and a T-iron $a^5$. The said trough supports the pipe and mandrel, and the T-iron, which, it will be observed, is supported in an inverted position directly above the trough, serves to keep the pipe and mandrel down in place, for it will be seen at this juncture that the length of the mandrel is such as to create a tendency on its part to bend or bow slightly as a result not only of the forward pressure upon the pipe, but also of the rearward pressure to which the mandrel is subject during the bending operation, and that as such bending or bowing would retract the forward end of the mandrel it is therefore desirable to make some provision for keeping it perfectly straight throughout its entire length. (See Fig. 16.) The rear end of the mandrel is adjustably connected with the trough, as shown in Fig. 14, and the mandrel may be adjusted longitudinally by turning the nuts $b$, which are screwed upon its threaded rear end portion. A cross-head B′ is arranged to slide upon the mandrel and is adapted to bear against the rear end of the pipe in the manner shown in Fig. 15. The cross-head may be connected up with any suitable means for impelling it forward, and by so doing the pipe will of course be subjected to a constant forward pressure—that is to say, to a constant forward pressure during the operation of bending its forward end portion. As a preferred arrangement, however, I provide the cross-head with a couple of side portions $b^2$ $b^2$, which project laterally from between the trough $a^4$ and T-iron $a^5$ and through which extend and slide a couple of rods $b^3$. These rods have their rear ends preferably threaded and provided with nuts $b^4$ and their forward ends suitably connected with a couple of chains $b^5$. The said rods are, as stated, free to slide in the cross-head, and between the latter and the nuts $b^5$ are arranged a couple of coil-springs $b^6$ $b^6$. The chains $b^5$ are preferably of a length to extend forward along the upper surface of the frame $a^2$ and have their forward end portions connected with some suitable form of windlass or winding mechanism. This winding mechanism can be arranged at any suitable point and can be of any known or approved form—for instance, the chains can be carried upward about a couple of sheaves $b^7$ and then connected with a winding device L. (See Fig. 14.) The said sheaves are preferably so arranged as to keep the chains parallel with the mandrel and are mounted in bearings, which are secured to the body-frame A, and the said winding mechanism may be driven and controlled in any suitable manner and can, as stated, consist of any known or approved form of windlass, chain hoist, or other similar device. With this arrangement I first adjust the pipe in position for bending and then tighten or wind up the chains sufficiently to place the springs $b^6$ under considerable tension. Next, the bending mechanism is started by operating the clutch mechanism K, and both the bending mechanism and the winding device L′ are then permitted to run until the pipe is bent to the desired extent. The winding device L is preferably driven so as to impel the cross-head forward with a speed exactly the same as the speed at which the pipe is drawn forward along the mandrel by the rotary former. It will readily be understood, however, that it is practically impossible to thus synchronize the operations of these two portions of the machine, and it is for this reason that I provide the coil-springs $b^6$. These springs, which are, as just stated, compressed or under tension while the pipe is being bent, serve to equalize the pressure, so to speak, and render it immaterial whether the winding device L′ is running a little too fast or a little too slow, for it is quite obvious that with this arrangement a slight lag on the part of the cross-head will not materially reduce the pressure and that a slight increase in its speed will have no other effect than to place the springs under slightly-greater tension, and as a further advantage the cross-head and winding device afford a means for stripping the pipe from the mandrel.

In Fig. 17 I have illustrated a preferred form of bending mechanism. Ordinarily the roll E and the grooved block $g'$, which are comprised in the construction shown in Fig. 3, afford a satisfactory means for supporting the pipe against lateral flexure back of the bending-point. I find, however, that the said roll has, particularly in operating upon light or thin tubing, a tendency to produce a slight caving in on the part of the pipe as a result of its limited extent of contact with the latter and that for this reason it is preferable to provide a support having a longer bearing-surface. Such form of support is shown in Fig. 17, from which it will be seen that my preferred form of support comprises a couple of rolls E′ E′ and a grooved block $E^2$. The said rolls are mounted upon the adjustable plate G and are adapted and arranged to hold or maintain the block in position against the pipe. With this arrangement the pipe or tubing is adequately supported for some distance back of the bending-point, and lateral flexure back of such point is effectively prevented without denting or caving in the pipe. The block $E^2$ during the bending operation moves forward with the pipe, and in this way the block or traveling support has the further advantage of operating with a minimum of friction. It is ob-

vious that the block may be mounted to slide in suitable guideways, and it is also obvious that various antifriction devices may be employed to back up and maintain the block in contact with the pipe.

What I claim as my invention is—

1. In a pipe-bending machine comprising suitable means for gripping and bending the pipe, a non-flexible mandrel adapted to be inserted within the pipe and having its forward end rounded and arranged to support the pipe internally at the bending-point.

2. A pipe-bending machine comprising a former, means for gripping and bending the pipe about said former, and a long, straight and non-flexible mandrel adapted to be inserted within the pipe and having its forward end rounded and arranged to support the pipe internally at the bending-point.

3. A pipe-bending machine comprising a suitable former, means for gripping and bending the pipe around said former, and a mandrel having one side only of its end rounded substantially as and for the purpose described.

4. The combination of mechanism for gripping and bending the pipe, and a mandrel having the outer side only of its forward end portion rounded, substantially as and for the purpose described.

5. A pipe-bending machine comprising a rotary shaft, a former mounted upon said shaft, a clamping device also mounted upon said shaft and adapted to grip the pipe, and a non-flexible mandrel having its forward end rounded and arranged to support the pipe internally at the bending-point.

6. A pipe-bending machine comprising a rotary former, a traveling support for clamping the pipe against said former, a clamping device for gripping and bending the pipe about said former, and a mandrel having one side only of its forward end portion rounded, substantially as and for the purpose described.

7. A pipe-bending machine comprising suitable mechanism for gripping and bending the pipe, and a stationary and non-flexible mandrel which supports the pipe internally at the bending-point.

8. The combination of a rotary former, a traveling support for clamping the pipe against the said former, means for gripping and bending the pipe about said former, and a stationary and non-flexible mandrel which supports the pipe internally at the bending-point.

9. A pipe-bending machine comprising a rotary former, an adjustable member provided with a traveling support for holding the pipe against the said former and provided also with means for holding said support against the pipe, a swinging clamping device adapted to grip and bend the pipe about the said former, and a non-flexible mandrel which supports the pipe internally at the bending-point.

10. A bending-machine comprising a rotary former, a swinging plate provided with a sliding block for clamping the pipe against the said former, a lever for shifting said plate, a clamping device for gripping and bending the pipe around said former, and a straight and non-flexible mandrel which supports the pipe internally at the bending-point.

11. A bending-machine comprising a former, means for gripping and bending the pipe about said former, a mandrel for supporting the pipe internally at the bending-point, a swinging member provided with a sliding block for holding the pipe against the said former, said sliding block being arranged to bear against the pipe back of the bending-point, and a hand-lever for shifting said swinging member.

12. A pipe-bending machine comprising a suitable former, means for gripping and bending the pipe about said former, a mandrel for supporting the pipe internally at the bending-point, a swinging member provided with a traveling support for holding the pipe against the said former, a lever pivoted adjacent to the said swinging member, and a link for connecting said lever and swinging member.

13. In a pipe-bending machine, the combination of a rotary former, and a non-flexible mandrel having the outer side only of its end portion rounded or curved on the line of a circle struck from a point near the center of said former.

14. In a pipe-bending machine, the combination of a rotary former, and a non-flexible mandrel having a rounded end which extends beyond or forward of the periphery of said former, substantially as and for the purpose of supporting the pipe internally at the bending-point.

15. In a pipe-bending machine, the combination of a rotary former, and a mandrel having the outer side only of its end rounded and arranged beyond or forward of the periphery of said former, substantially as and for the purpose described.

16. In a bending-machine, a rotary former, means for gripping and bending the pipe about said former, a mandrel for supporting the pipe internally at the bending-point, a friction-clutch for starting and stopping said rotary former, and means for automatically operating said clutch for the purpose of automatically stopping the said former.

17. A bending-machine comprising a rotary former, a clamping device mounted to swing in unison with said former and adapted to grip and bend the pipe about the same, a mandrel for supporting the pipe internally at the bending-point, a friction-clutch for starting and stopping the former and clamping device, and means for automatically operating said clutch for the purpose of automatically interrupting the motion of the said former and clamping device.

18. A bending-machine comprising a rotary former, a clamping device mounted to swing in unison with said rotary former, a mandrel

for the purpose described, a friction-clutch for controlling the motion of said former and clamping device, a hand-lever for operating said clutch, and means for automatically shifting said lever for the purpose of automatically stopping the former and clamping device.

19. A pipe-bending machine comprising a former, a clamping device for gripping and bending the pipe about the said former, a mandrel for supporting the pipe internally at the bending-point, and a power-actuated device for applying pressure to the pipe in the direction in which the pipe is moved along said mandrel by the bending mechanism, substantially as and for the purpose described.

20. In a pipe-bending machine, the combination of mechanism for gripping and bending the pipe, and mechanism for applying longitudinal pressure to the pipe in the same direction in which the pipe is moved by the said bending mechanism, substantially as and for the purpose described.

21. In a pipe-bending machine, the combination of bodily-swinging mechanism for gripping and bending the pipe, a movable abutment arranged to bear against the rear end of the pipe, and mechanism for impelling said abutment for the purpose of subjecting the pipe to a constant forward pressure during the operation of bending its forward portion, substantially as and for the purpose described.

22. A pipe-bending machine comprising bodily-swinging mechanism for gripping and bending the pipe, a mandrel, a trough for supporting the pipe and mandrel, a cross-head arranged to slide upon said mandrel and bear against the rear end of the pipe, and means for impelling the cross-head forward for the purpose of subjecting the pipe to a constant forward pressure during the operation of bending its forward portion, substantially as and for the purpose described.

23. A bending-machine comprising suitable bending mechanism, a mandrel held or secured at its rear end, a cross-head arranged to slide upon said mandrel and bear against the rear end of said pipe, means for impelling said cross-head forward, and one or more springs arranged intermediate of said impelling means and cross-head, substantially as and for the purpose described.

24. A pipe-bending machine comprising mechanism for gripping and bending the pipe, a mandrel held or secured at its rear end, a cross-head arranged to slide upon said mandrel and bear against the rear end of the pipe, rods extending through said cross-head and having their threaded ends provided with nuts, coil-springs arranged upon said rods and between said nuts and the cross-head, and chains or cables for connecting said rods with a suitable windlass or winding device, substantially as described.

25. In a bending-machine, the combination of mechanism for gripping and bending the forward portion of the pipe, and one or more springs for applying pressure to the rear end of the pipe for the purpose of subjecting the latter to a constant forward pressure during the operation of bending its forward portion.

26. A bending-machine comprising a former, means for gripping and bending the pipe about said former, and a stationary and longitudinally-adjustable mandrel having its forward end rounded to support the pipe internally at the bending-point.

27. The combination of a rotary former, and a long, straight and non-flexible mandrel having its forward end rounded to support the pipe internally at the bending-point and its rear end adjustably connected with a portion of the body-frame.

28. A bending-machine comprising mechanism for gripping and bending the pipe, a long, straight and non-flexible mandrel having its forward end rounded to support the pipe internally at the bending-point and its rear end adjustably connected with the frame, a cross-head arranged to slide upon said mandrel and bear against the rear end of the pipe, a trough for supporting the pipe and mandrel intermediate of the latter's ends, and means for impelling the said cross-head forward for the purpose of subjecting the pipe to a constant forward pressure during the operation of bending its forward portion.

29. A pipe-bending machine comprising bending mechanism, a long, straight mandrel having its forward end adapted to support the pipe internally at the bending-point, means for applying pressure to the pipe in the direction in which it is moved along the mandrel by the bending mechanism, and means for inclosing the pipe and mandrel for the purpose described.

30. The combination of bending mechanism, a mandrel, and one or more springs adapted and arranged for applying pressure to the pipe in the direction in which the same is moved along the mandrel by the said bending mechanism.

31. The combination of a rotary former, means for gripping and bending the pipe about said former, a sliding block for holding the pipe against said former, a mandrel having the outer side of its forward end rounded to support the pipe internally at the bending-point, means for holding the rear end of the mandrel, and one or more springs for applying pressure to the pipe in the direction in which the same is moved along said mandrel.

32. The combination of a former, a mandrel, a clamping device for gripping and bending the pipe about the said former and consisting of jaws held together by tapered keys, and a traveling support for holding the pipe against the said former.

33. A pipe-bending machine comprising bending mechanism, a mandrel, a V-shaped trough for supporting the pipe and mandrel, and a T-iron arranged above the pipe and

mandrel, substantially as and for the purpose described.

34. The combination of a rotary former, means for gripping and bending the pipe about said former, a sliding or traveling block adapted and arranged to bear against the pipe back of said former, and antifriction-rolls for backing and holding the block against the pipe, the said rolls being mounted upon a horizontally-swinging plate or casting.

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