

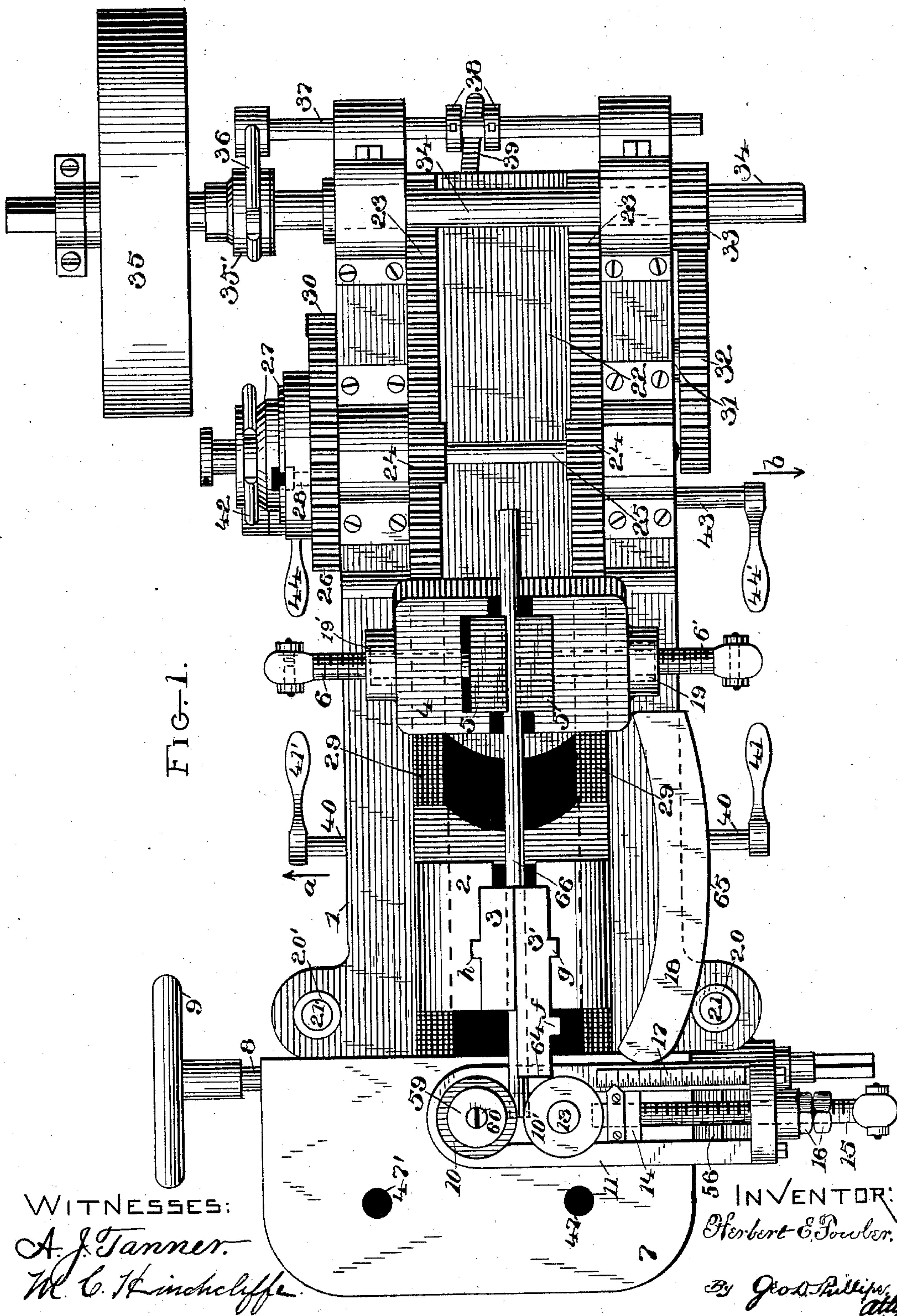
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7 Sheets—Sheet 1.

H. E. FOWLER.
METAL BENDING MACHINE.

No. 473,455.

Patented Apr. 26, 1892.



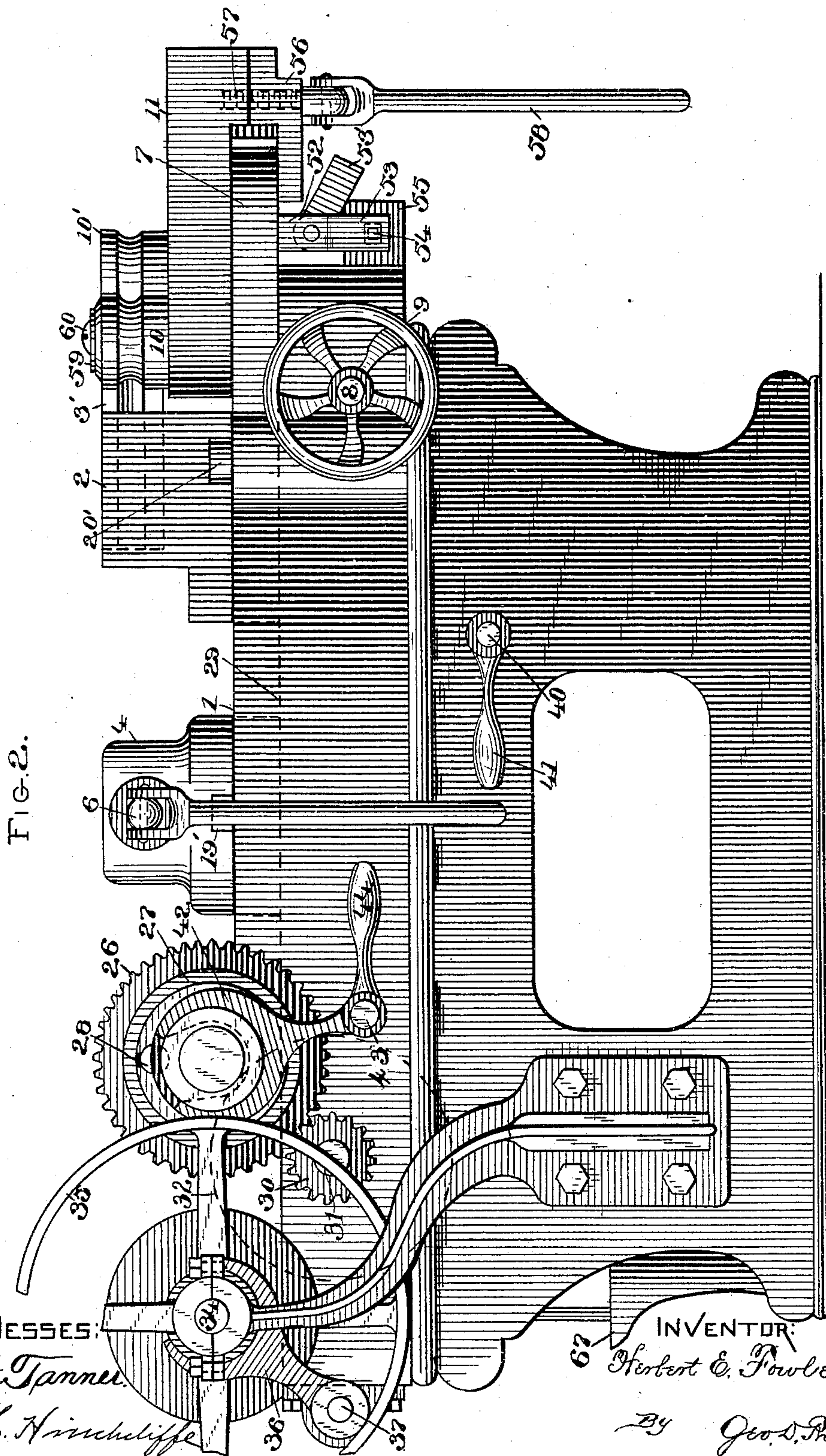
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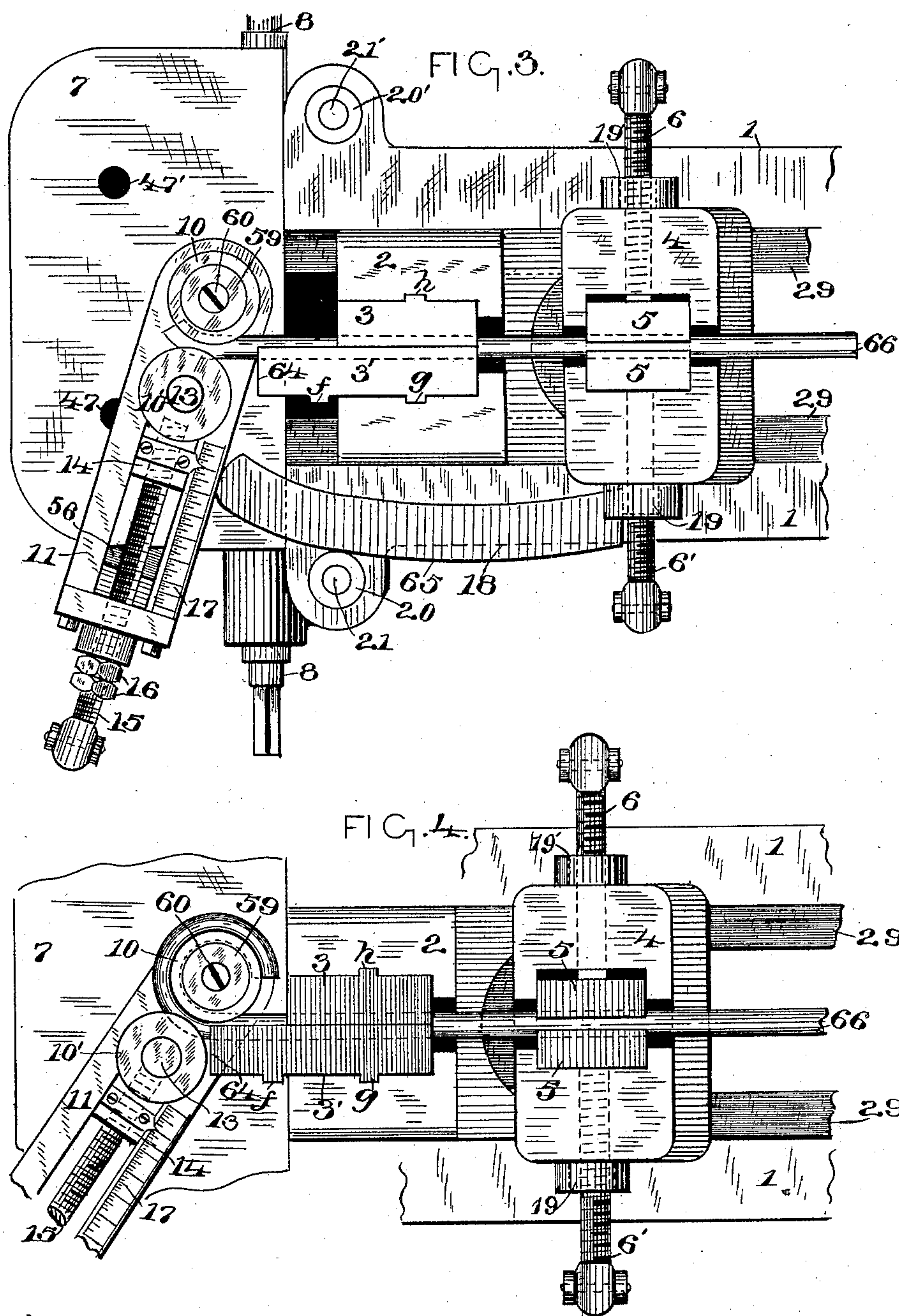
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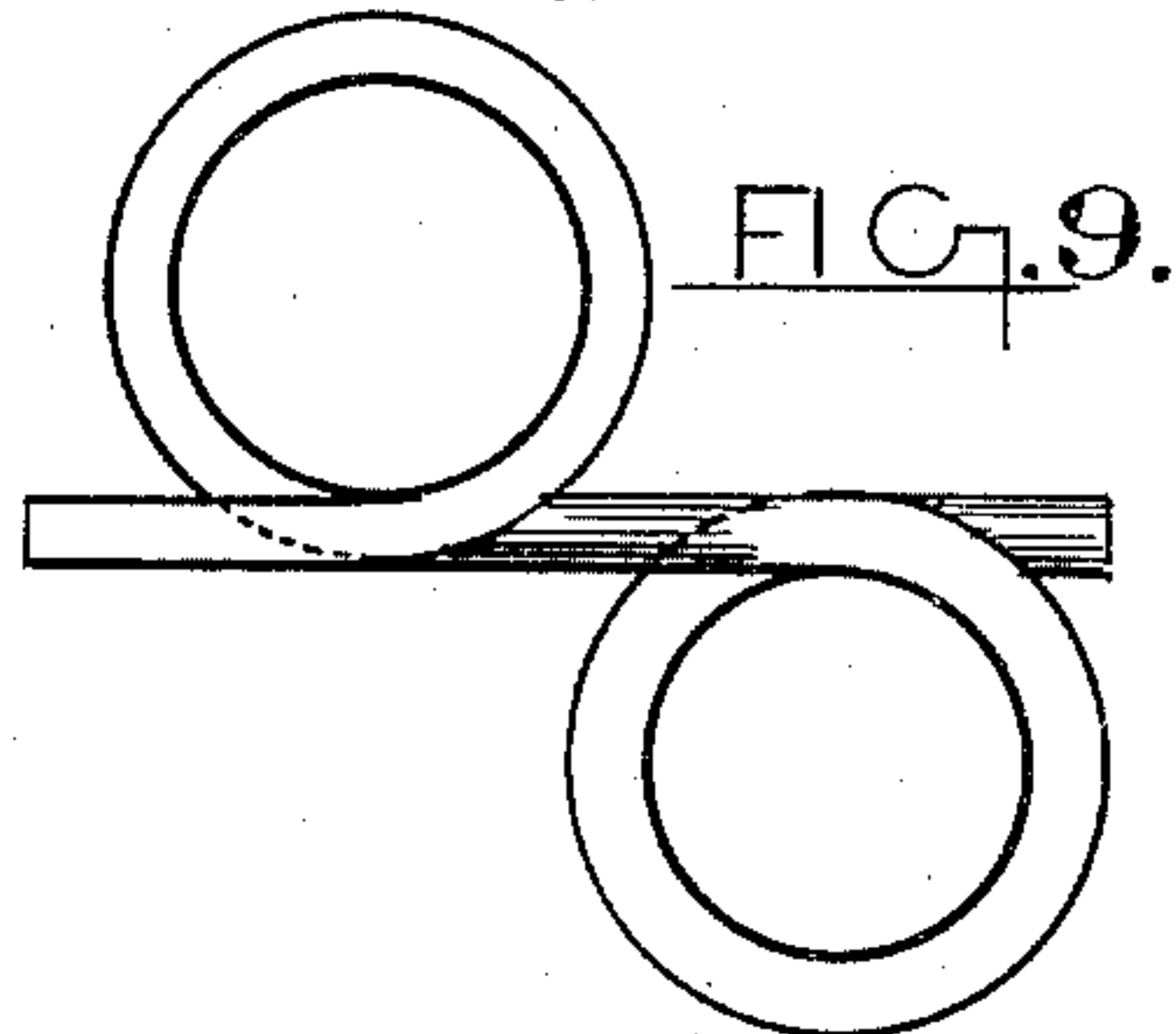
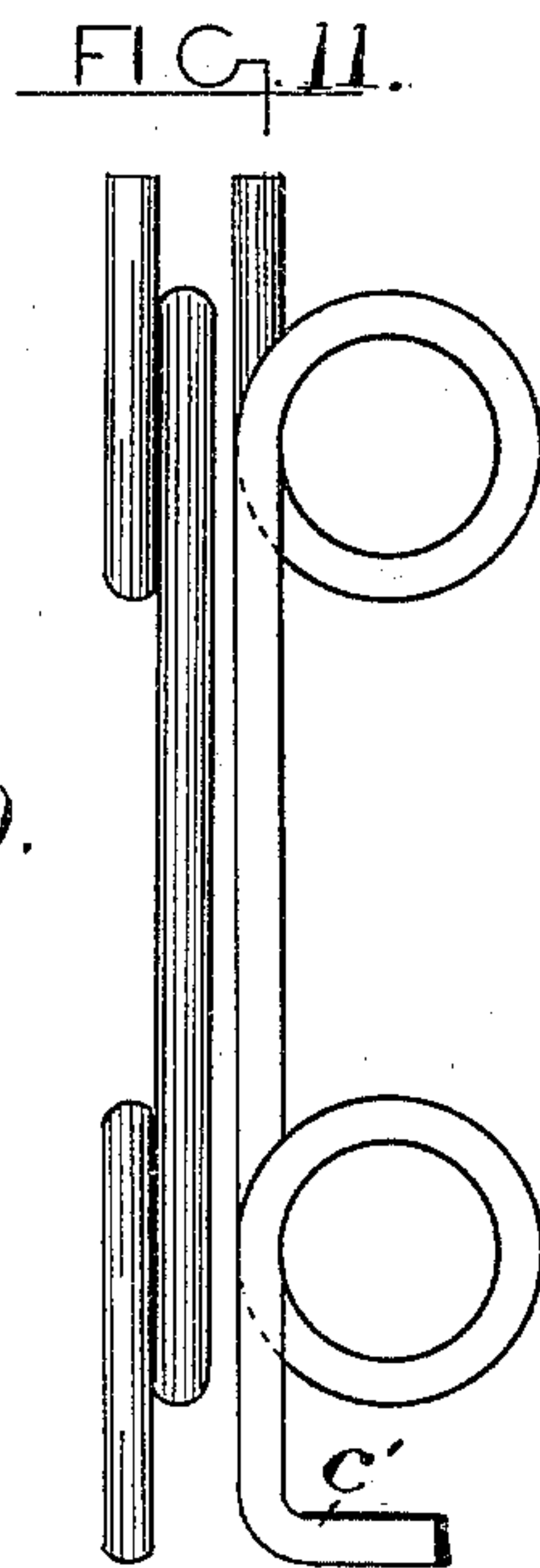
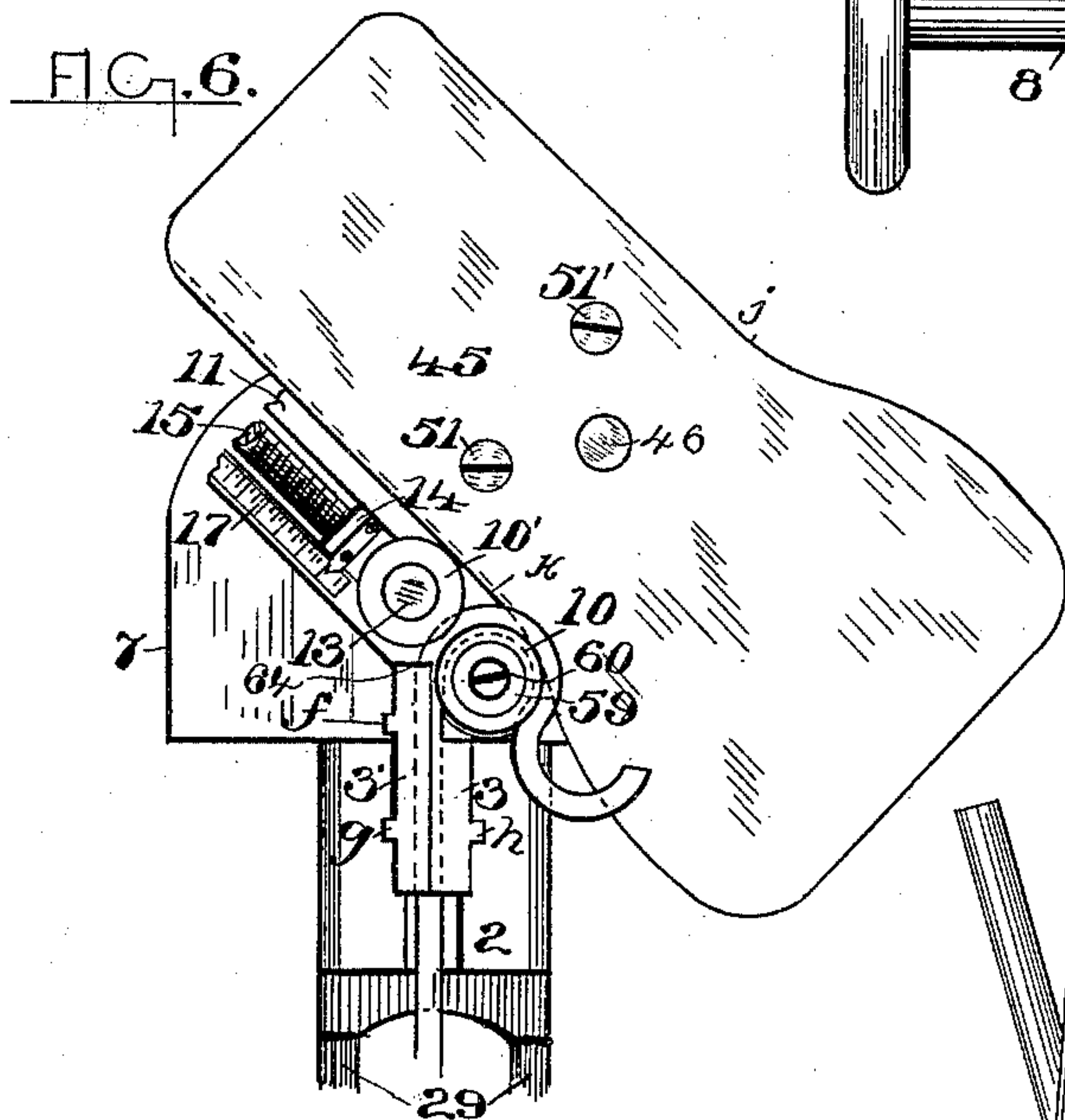
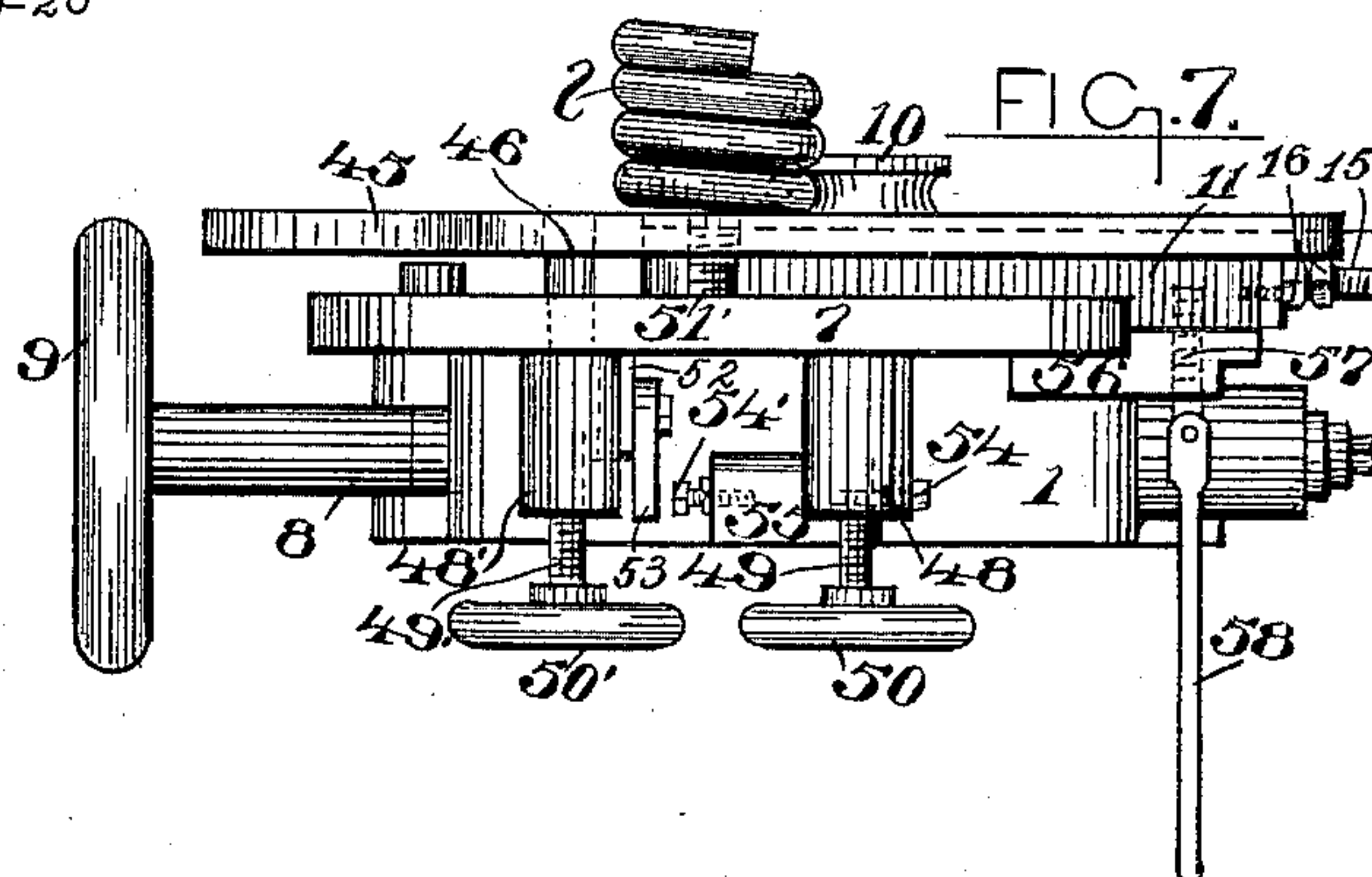
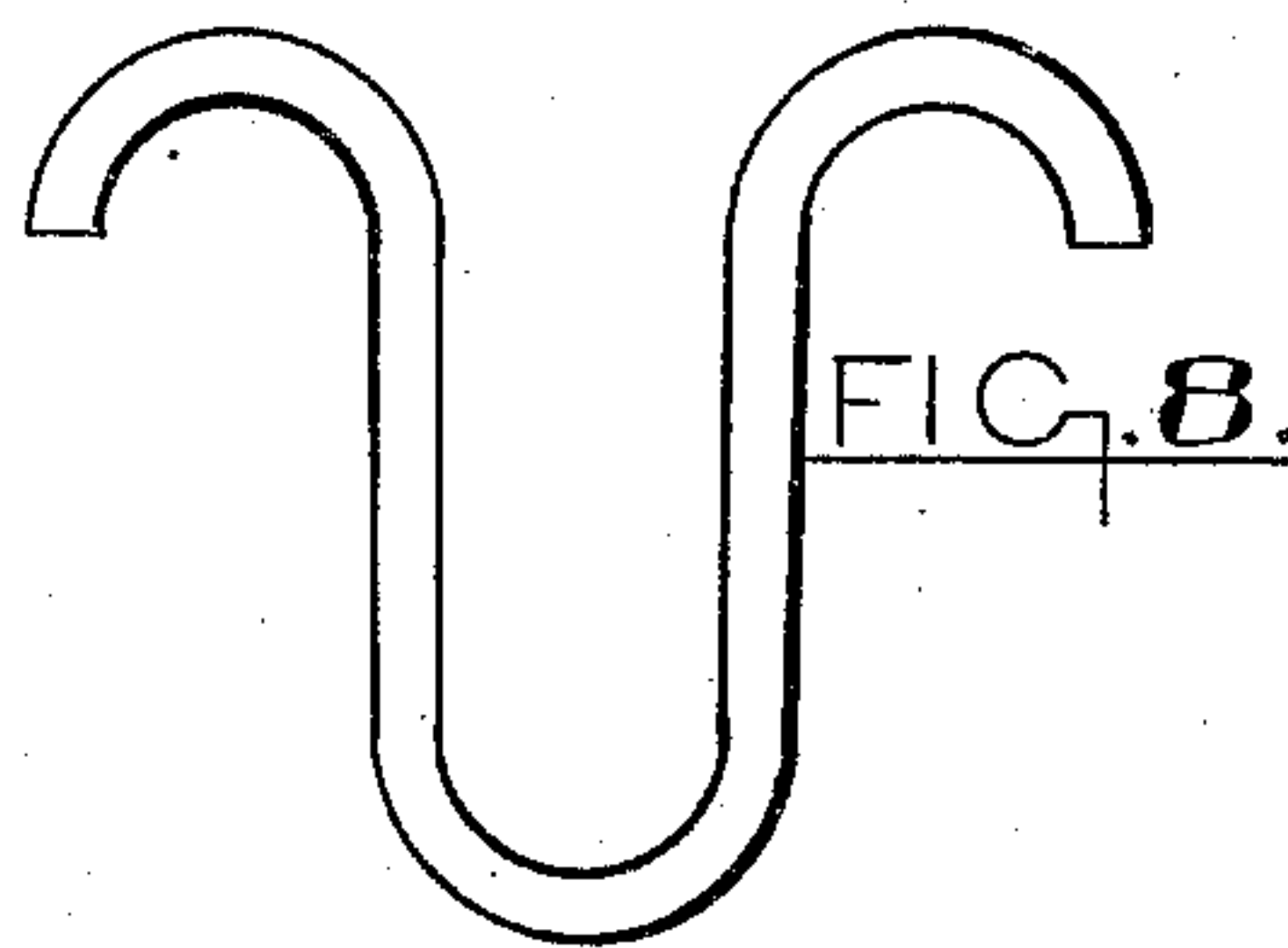
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7 Sheets—Sheet 4.

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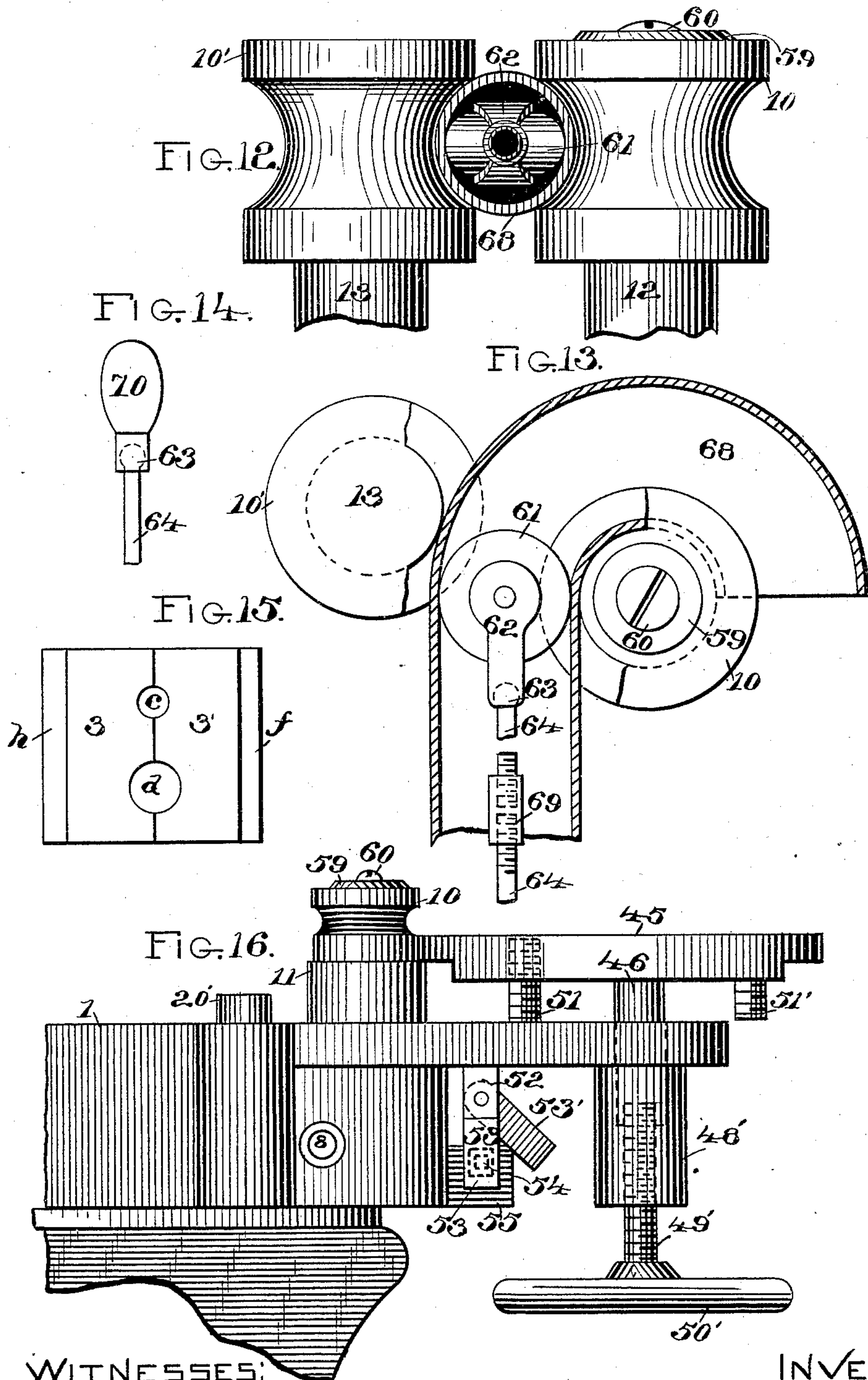
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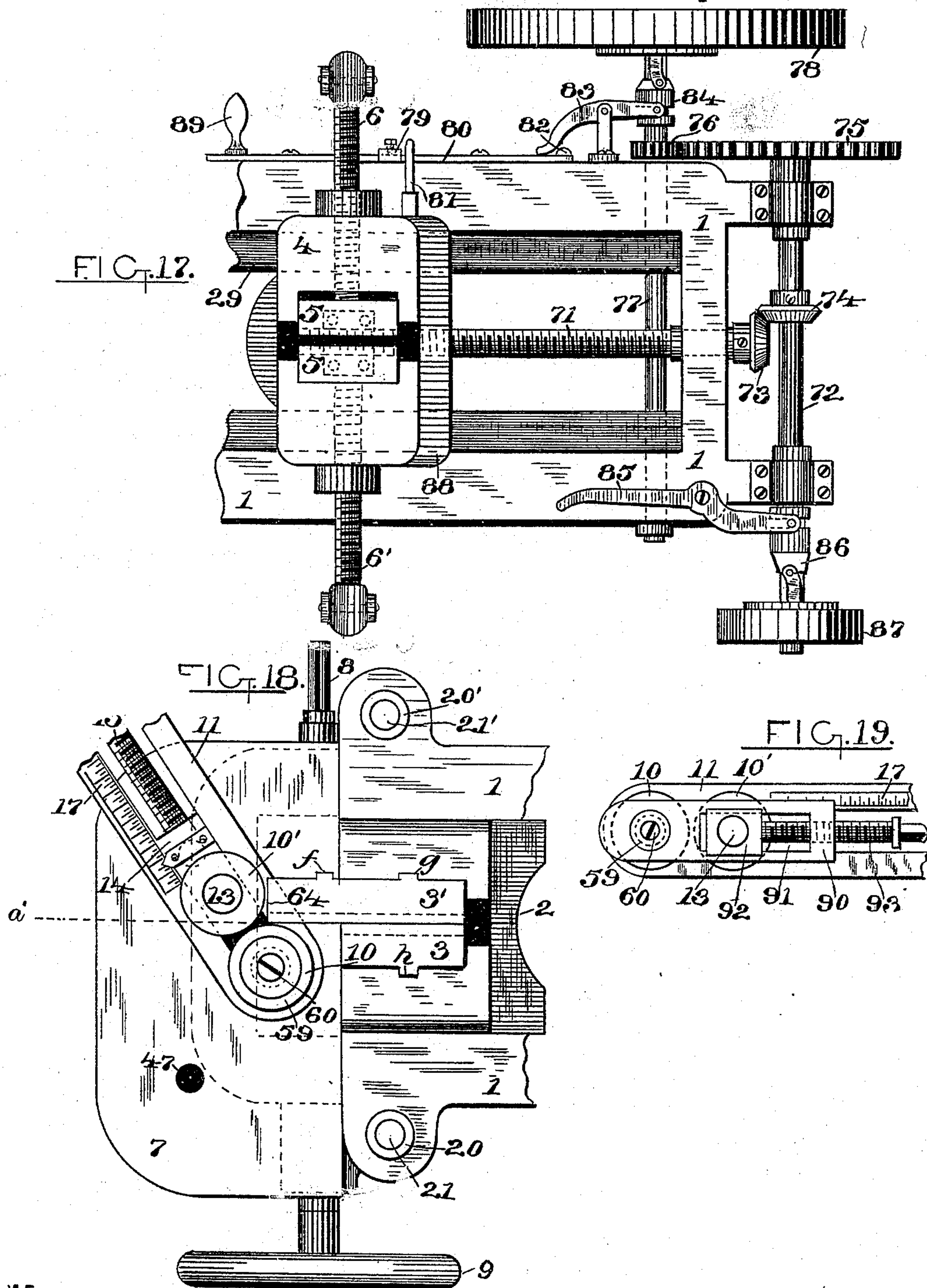
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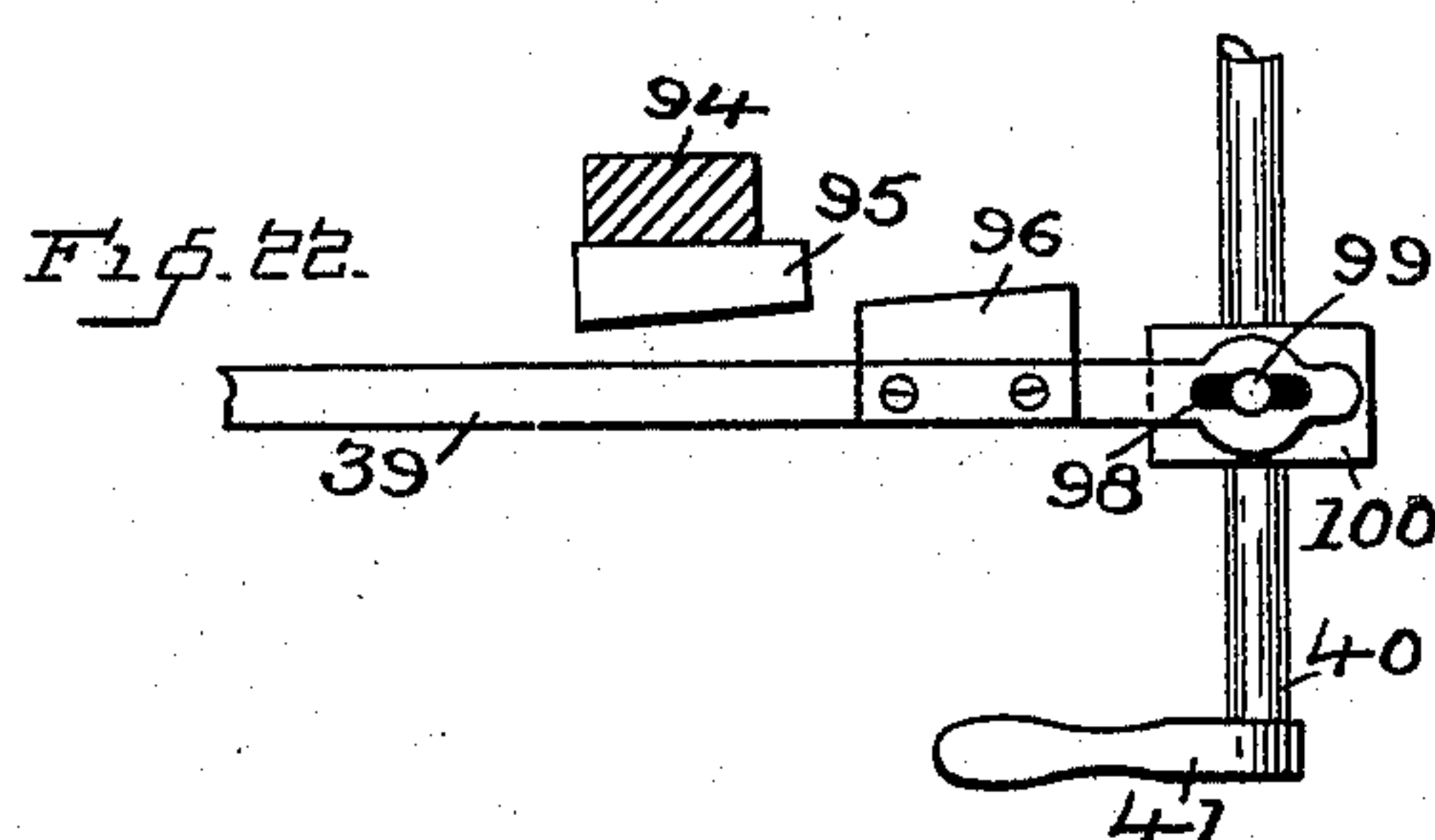
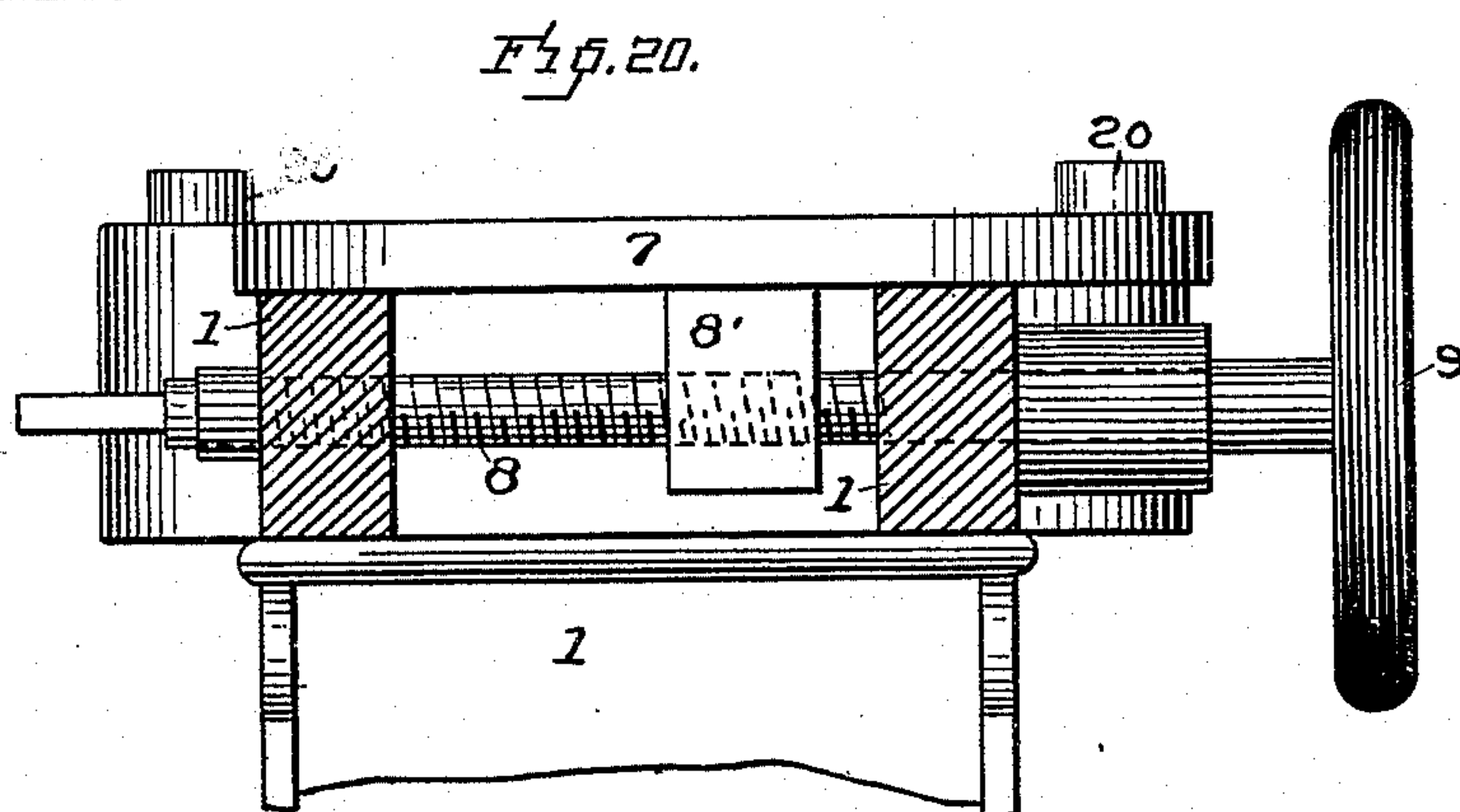
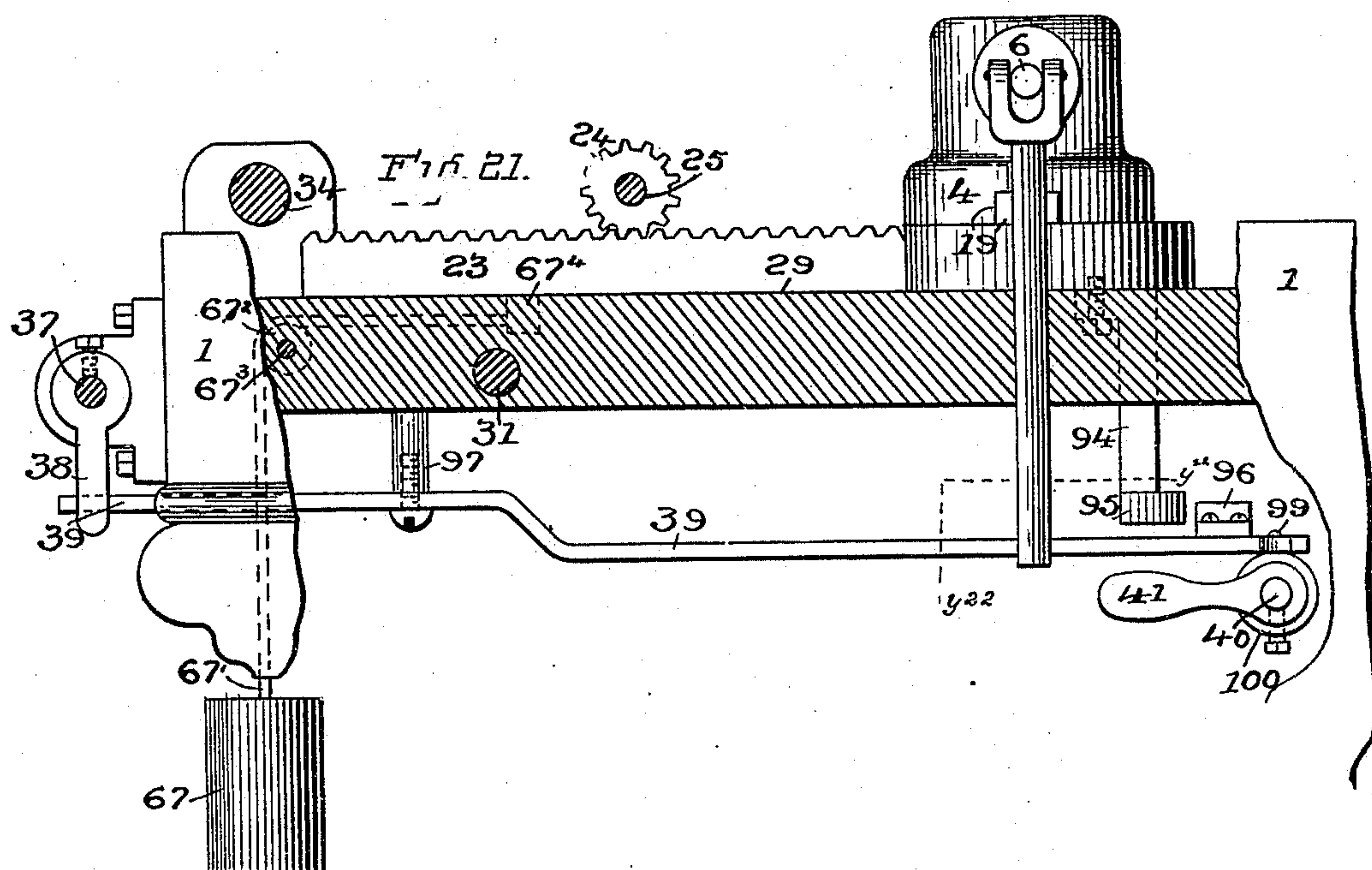
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Inventor.
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INVENTOR:
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UNITED STATES PATENT OFFICE.

HERBERT E. FOWLER, OF NEW HAVEN, CONNECTICUT.

METAL-BENDING MACHINE.

SPECIFICATION forming part of Letters Patent No. 473,455, dated April 26, 1892.

Application filed June 11, 1891. Serial No. 395,967. (No model.)

To all whom it may concern:

Be it known that I, HERBERT E. FOWLER, a citizen of the United States, and a resident of New Haven, in the county of New Haven and State of Connecticut, have invented certain new and useful Improvements in Metal-Bending Machines, of which the following is a specification.

My invention relates to machines for bending pipes and bars of metal of all descriptions, wherein the metal to be bent is fed between suitable bending-rolls, which rolls are situated forward of the feeding mechanism, so that said rolls will simply bend the metal to the required shape and not draw the same forward in advance of the feeding mechanism.

To this end my invention consists, among other improvements, first, in an adjustable guiding die or dies for the pipe or bar to sustain the metal at the bending-point of the rolls, said guiding die or dies arranged to be brought directly into the bending-field—i. e., to the center of the bending-roll, at which point the metal is bent or deflected—thus sustaining or supporting the unbent portion of the metal against the bending strain, so that such bending action shall take place only at the center of said rolls and at the extreme end of the guiding-die and not, as heretofore, back of said center; further, to so construct the metal-support or guiding-dies that the metal to be bent will virtually pass through a solid die shaped to the surface of the metal, and thereby fully supporting its exterior surface at a point outside of the bending-field of the rolls. Said guides or dies are arranged to be used either right or left hand.

Second, my invention also consists in constructing the gripping-jaws and their holder so that said jaws may be moved independently and arranged to engage with the straight portion of the pipe or bar and advance the same to the bending-rolls by shorter or longer stages, as may be required; third, to so construct the machine that it may be used or operated from either side of the same; also, to provide a transversely-movable table supported from the bed of the machine, the roll-supporting arm pivoted upon said table and arranged to swing on its pivoted support and to be operated from either side of the machine, whereby return-bends or double coils are formed; fourth, a combined surface and guide plate pivotally supported above the surface of the

table and arranged to turn in unison with the bending-roll arm, so that the coiled or bent portion of the pipe or other metal may be kept true and level with other coils being formed from the same piece of metal; also, providing such plate with a vertical adjustment, whereby the proper pitch is given while forming two or more turns or coils, all of which improvements will be more fully set forth in the following specification, and particularly pointed out in the claims.

To more fully understand my invention and its application to use, reference is had to the accompanying drawings and to the figures and letters of reference thereon, which form part of this specification.

Figure 1 represents a plan view of the machine. Fig. 2 is a side elevation, a portion of the driving-pulley and return-weight being broken away, the adjusting-screw of the roll-bending arm also removed. Fig. 3 is a plan view of the table, bending-rolls, and the arm on which said rolls are supported, the pipe or metal guides and their holder, gripping-jaws and holder for same, and broken section of the bed of the machine. Fig. 4 is a plan view showing a broken section of the table, roll-supporting arm, bed of the machine, and full view of the gripping-jaws, metal-supporting dies, and their holders. Fig. 5 is a reduced plan view of a broken section of the bed and the roll-supporting arm; also, a plan view of the coil guide-plate supported on the table; also, views of the dies or metal-supporting guides and their holder. Fig. 6 is a view similar to Fig. 5, showing the coil guide-plate and roll-supporting arm set at an angle with the table. Fig. 7 is an end elevation of the bed of the machine, showing the table mounted thereon, broken section of the end of the shaft which operates the table, and broken section of the roll-adjusting screw. Figs. 8, 9, 10, and 11 represent the various shapes of the pipe or bar after passing through the bending-rolls. Fig. 12 is a side elevation of the bending-rolls and a section of their supporting-studs, end elevation of a pipe between the curved surface of said rolls, and a metal-supporting roll placed within the pipe to support said pipe at the center of the bending-rolls. Fig. 13 is a plan view of Fig. 12, showing a sectional view of the pipe and plan of the supporting-roll and its frame. Fig. 14 is a modified form of the pipe-supporting roll.

Fig. 15 is a detail view. Fig. 16 is a side elevation and broken sectional view of the bed and a side elevation of the table, one of the bending-rolls and its supporting-arm, coil guide-plate, and adjusting-screw for the same. Fig. 17 is a plan showing a broken section of the bed, gripping-jaw holder mounted thereon, and a screw-feed for operating said holder longitudinally along the bed. Fig. 18 is a plan view of the table, broken section of the bed and roll-supporting arm, dies, and their holder. Fig. 19 is a broken detached view of the roll-supporting arm, the rolls thereon, and a yoke binding said rolls together, supporting them against the strain incidental to the bending of large pieces or bars of metal. Fig. 20 is a broken end elevation of the bed of the machine, transverse sectional view of its forward end for supporting the table, table-adjusting screw journaled in said forward end; also, a lug projecting from beneath the table to engage with such screw. Fig. 21 is a broken side elevation of the bed with the gripping-jaw holder mounted thereon, showing more clearly the manner of checking the forward movement of said holder; also, manner of connecting the return-weight to the rack-plate of the gripping-jaw holder. Fig. 22 is a broken detail view of the shipper-rod and its bar, shipping-toe thereon, and section of shipping-arm of the jaw-holder, and also the shipper-bar through line Y²² of Fig. 1. Fig. 23 is a plan view of one of the feeding-rolls and its frame.

Its construction is as follows: 1 represents the bed of the machine; 2, the die-holder; 3 3', the dies therein; 4, the gripping-jaw holder; 5, gripping-jaws therein; 6 6', clamping-screws for the gripping-jaws; 7, table situated on the forward end of the bed of the machine; 8, threaded shaft journaled in the bed of the machine, its threaded portion engaging a lug on the under side of the table 7, whereby said table is adjusted laterally on the machine-bed; 9, hand-wheel on the shaft 8 for operating the same.

8' is a lug projecting downward beneath the table 7, having a threaded hole through the same to engage the threaded shaft 8, so that by such engagement the table is moved laterally across the bed; 10 10', bending-rolls; 11, roll-supporting arm; 12 and 13, upright studs, on which the bending-rolls are mounted and arranged to turn freely; 14, sliding block-supporting stud 13, said block arranged to be longitudinally adjusted in the arm 11 by means of screw 15; 16, jam-nuts for tightening the screw 15 in any position required; 17, scale on the roll-supporting arm 11 to adjust roll 10' to the diameter of the circle of the coil or bend of the metal; 18, pusher, one end of which engages the inner side of the roll-supporting arm 11 while its opposite end engages with the lug 19, which lug projects laterally from the gripping-jaw holder 4, such pusher being arranged to swing the roll-supporting arm 11 around on its pivoted sup-

port and move said arm in proper time with the forward movement of the gripping-jaw holder. Said pusher is detachable and may be used on either side of the machine.

20 20' are rolls mounted on studs 21 21', which studs project from the surface of bed 1, the outer edge of the pusher 18 engaging said rolls, and by means of such engagement the alignment of said pusher is maintained at all points of its travel; 22, plate attached to the gripping-jaw holder 4. (See Fig. 1. Said plate not shown in the other views.)

23 are racks attached to plate 22, into which racks the pinions 24 engage, said pinions being mounted on the shaft 25; 26, gear, also mounted on said shaft; 27, clutch mounted on shaft 25, said clutch operating locking-bolt 28, which bolt engages with holes (not shown) provided in the face of gear 26, so that by means of this clutch connection, the pinions 24, and racks 23 motion is given to the gripping-jaw holder 4; 29, ways of the machine-bed which support the die-holder 2, gripping-jaw holder 4, and its rack-plate 22; 30, pinion engaging with gear 26 and mounted on the shaft 31; 32, gear mounted on the opposite end of shaft 31, said gear engaging pinion 33, mounted on the driving-shaft 34; 35, driving-pulley mounted on shaft 34; 35', clutch on said shaft; 36, clutch-fork mounted on the shipper-shaft 37; 38, shipper-fingers; 39, shipper-bar engaging said fingers and controlled by rod 40, having handles 41 41', said rod passing transversely through the bed of the machine; 42, fork engaging the gear-clutch 27, said fork mounted on shaft 43, which shaft passes transversely through the machine-bed; 44 44', operating handles on shaft 43; 45, guide or coil supporting-plate arranged above and parallel with the table 7, said plate mounted on stud 46, which stud is stepped in the holes 47 47', which holes extend through said table and into the bosses 48 48', forming part of said table and projecting downward from the under side of the same; 49 49', adjusting-screws having hand-wheels 50 50', said screws engaging the stud 46 of the coil-supporting plate 45, giving to such plate the necessary vertical adjustment; 51 51', adjusting-screws situated in and projecting downward through the coil-supporting plate 45, said screws resting on table 7 alternately to support plate 45 at or near the bending-rolls; 52, downwardly-projecting lugs on the under side of table 7, said lugs pivotally supporting stop-pieces 53 53', which stop-pieces alternately engage with adjustable stop-screws 54 54' of the projection 55 of the bed 1; 56, clamp attached to the under side of roll-supporting arm 11, said clamp projecting under table 7, so that by means of the screw 57 and handle 58 said roll-arm is rigidly secured to table 7 in any position required; 59, plate on roll 10; 60, screw, which is tapped into the supporting-stud 12 of said roll, so that by means of said plate 59 and screw 60 the roll is prevented from lift-

ing from said stud during the bending operation, while such plate and screw will not interfere with the rotative action of the bending-roll; 61, roll pivotally supported in forked frame 62 for sustaining the internal diameter of a very thin pipe at the bending-point; 63, ball-joint connection between rod 64 and frame 62, so that by means of such connection said roll may turn or swivel in any direction required.

65 is the curved edge of the pusher 18, which engages with either of the rolls 20 20' on the bed.

66 is the pipe or bar to be bent.

67 is the return-weight for the holder-rack plate 22. The cord 67', attached to such weight, passes over pulley 67², mounted upon the shaft 67³, which shaft passes transversely through the bed 1, thence to the lug 67⁴, projecting downward from plate 22, to which lug such cord is firmly secured.

The operation of the machine is as follows: The position of all the parts at the commencement of the bending process is as shown in the plan view, Fig. 1. The roll-supporting arm is brought around at right angles to the bed; as shown. The die-holder 2 is moved forward, so that the projecting end 64 of the leading-die 3' is brought into close proximity with roll 10', said roll having been previously set to scale on arm 11 for determining the diameter of the coil to be formed. The pusher 18 is resting upon the bed of the machine, its forward end against the arm 11 and its outer edge 65 against roll 20, while the gripping-jaw holder 4 is at the extreme end of its backward travel. The bar or pipe, as the case may be, is firmly secured within gripping-jaws 5, the forward end of such rod passing through the dies 3 3', and such end resting against the grooved surface of rolls 10 10'. Motion is communicated to gear 26 on shaft 25 through the medium of rod 40, moved in the direction of arrow *a*, and the engagement of said rod with the shipping mechanism connected with the driving-pulley 35, as before mentioned, will set in motion the rotating mechanism connected therewith. Clutch-rod 43, moved in the direction of arrow *b*, will bring bolt 28 into engagement with one of the holes (not shown) in the face of gear 26, when shaft 25 will rotate and its pinions 24 engage with the racks 23 and move the gripping-jaw holder 4, carrying the pipe or bar 66, forward toward the bending-rolls. Said rolls will instantly engage the bar, while the roll-supporting arm 11, under the influence of this forward movement, will be carried around on its pivoted support until the holder 4 has reached both the pusher 18 and the die-holder 2, as shown in Fig. 3, when said pusher and die-holder will be carried forward with the jaw-holder. As the die and jaw holders are on the same center line, their rates of speed will be equal, while with the pusher engaging the roll-arm 11 away from said center line of motion its rate of speed will be

correspondingly less, such speed being proportionate to the distance said pusher engages the roll-arm from its pivoted support. This slow movement of the roll-arm is essential, as the rolls in their bending action should move slower than the rod or pipe is fed, so as not to draw or pull the rod, but simply to bend or deflect it, and in consequence act upon every atom or particle of the metal. When the forward movement is completed, the position of the arm 11, die-holder 2, and gripping-jaw holder 4 will be in the position shown in Fig. 4, when the arm 11 will be clamped firmly to the table 7 by means of the screws 57. (See, also, Fig. 7.)

It will be observed on referring to Fig. 4 that the leading-die 3' has been advanced by the movement above described, so that its end 64 extends just beyond the center of roll 10, thus supporting the bar 66 close to the point of deflection of said bar. This advanced position of the die 3' will prevent the bar 66 from buckling or springing back of the bending-rolls, and will effectually prevent the bar being deflected at any point except at the extreme end of the die 3'.

When the different parts of the machine are in the position as seen at Fig. 4, and the roll-arm 11 firmly clamped in the position shown, the holder 4 must be returned and the gripping-jaws re-engaged with the bar 66 to again feed it forward to the rolls and continue the bend. This is effected by releasing either of the screws 6 6' when the weight 67, (see also Fig. 2,) which weight is attached to the under side of the plate 22, will carry the holder 4 back to its normal position. Previous to this, however, the locking-bolt 28 must be disengaged from the gear 26. The jaws 5 are again closed on the rod 66, the locking-bolt re-engaged with the gear 26, and the bar or pipe fed to the rolls until the required bend is made. When the holder 4 has reached its extreme forward position, as shown in Fig. 4, the arm 94, (see Fig. 21,) attached to said holder and projecting downward therefrom, carries the toe 95, whose taper face engages the taper face of the toe 96, (see, also, Fig. 22,) located on the shipper-bar 39. Said bar is pivoted on the stud 97, (see Fig. 21,) projecting downward from the bed. The slot 98 (see Fig. 22) engages with the pin 99, projecting from the collar 100, attached to rod 40. The engagement of toes 95 and 96 will throw the clutch 35' out of engagement with the driving-pulley 35. This will check the forward movement of the holder 4, while the pulley 35 continues to revolve.

It is often necessary to take short bites or grips on the pipe or bar, especially when there is not sufficient length of said pipe or bar projecting rearward of the dies 3 3' to necessitate the holder 4 being fully returned to its normal position, (shown in Fig. 1;) also, when very thin pipe is being coiled, in which case it is advantageous, in order to prevent buckling of the pipe between the die and jaw hold-

ers, to advance the pipe to the bending-rolls in very short stages. To effect this, either of the screws 6 6', as the case may be, is slacked off just sufficient to enable the holder-weight 5 67 to overcome the remaining frictional contact of the gripping-jaws upon the bar or pipe. When the holder 4 has retreated a suitable distance, one of the clamping-screws is tightened, the locking-bolt re-engaged, and the 10 holder 4 advanced as before. This operation may be repeated as often as desired. By means of this independent movement of the gripping-jaw holder said holder may be caused to advance or retreat any distance required 15 within the limit of its travel. The roll 20 on the bed of the machine, engaging with the curved edge of the pusher 18 while said pusher is being moved forward by the jaw-holder, will always keep the forward end of 20 said pusher engaged with the roll-supporting arm 11 at the same point, so that the movement of said arm may be uniform from start to finish.

One very important feature possessed by 25 this machine is its ability to bend opposite coils—*i. e.*, coils formed in opposite directions, as shown in Figs. 9 and 10; also, return-bends, as shown in Fig. 8; also, turns or coils made on the same plane, as shown by the plan and side 30 elevation of such a bend in Fig. 11.

To bend a piece of metal in the direction opposite to that shown in Figs. 3 and 4, the table 7 is carried over so that the center of roll 10 or pivoted support of the arm 11 shall 35 be on the opposite side of the center line a' of the machine or center line of the pipe to be bent, as shown in Fig. 18. The dies 3 3' are also reversed in holder 2, so that they will stand in the same relation to the bending- 40 rolls when the arm 11 is swung around to the opposite side of the table, as shown. The pusher is transferred to the opposite side of the machine and will then engage roll 20' and projection 19' of the jaw-holder 4, one side of 45 the machine being an exact duplicate of the other. The process of bending coils in the opposite direction is the same as formerly described.

The faculty of being able to bend metal in 50 either direction gives to this machine a wide scope. Return-bends, as shown in Fig. 8, or the short turn c' , as shown in Fig. 11, would be impossible to effect (except by hand) without this reversible feature of the table and 55 roll-arm 11.

When the proper position of the roll 10 is once established on either side of the center line a' of the machine for either right or left bends, as the case may be, one or the other of 60 the screws 54 in the projection 55 is set to limit the travel of the table 7 and one of the stop-pieces 53 will, as before mentioned, engage with one or the other of said screws, while the other stop-piece (not in use) will be swung 65 over on the projection 55, as seen in Fig. 16. This arrangement will enable the table to be brought to the same position and always

maintain the proper relation between the bending-rolls and the piece of metal to be bent. 70

As constructed the dies 3 3' are given a wide range and are both economical and convenient. As shown in Fig. 15, the two holes c and d are provided therein to accommodate 75 different sizes of metal. The lugs $f g h$ (see other plan views) project laterally from the sides of the dies, die 3 having one and die 3' two of such lugs. A corresponding groove is 80 formed in the die-holder 2 to receive said lugs. The relation of the lugs $f g h$ to each other and also with reference to the ends of the dies 3 3' enables said dies to be turned end for 85 end in the die-holder, so as to bring the lower size d (see, also, Fig. 15) into position; or said dies may be reversed, as shown in Fig. 18. Changing from either size d or c may be ef- 90 fected in either position shown in Figs. 3 or 18. This feature is of great advantage, as it obviates the necessity of constructing a large number of dies.

The coil guide-plate 45 is supported on its 95 adjusting-screw by means of the stud 46, as before mentioned. In using the plate for the purpose of keeping the coil already formed level with another coil or bend to be made 100 the upper surface of said plate is brought on a line with the lower portion of the curve of the bending-rolls, as shown in Fig. 16. Then when the bend i (see Fig. 5) is formed said table will keep such bend true with the return- 105 bend, as shown in Fig. 6. The stud 46 of the plate 45 being loosely stepped in the table 7, it will turn freely on such pivoted support and be carried around with the bending- 110 roll arm 11, and will, owing to its curved edges $j k$, maintain the same relation with said arm in whatever position or angle it may occupy. By means of this guide-plate and its 115 rotating feature double coils or return-bends of any length can be made. When the roll-arm 11 is carried over into the position shown in Fig. 18, the plate 45 will be reversed, and the 120 stud 46 placed in the hole 47. (See, also, Fig. 3.) This will bring the curved edge j of plate 45 against the rolls, the curves j and k being alike and the stud 46 occupying such a posi- 125 tion with respect to such curved edges that the plate is adapted to be used in any position that may be assumed by the bending-roll arm 11.

In forming the coil 1 (shown in Fig. 7) the 130 plate 45 is carried up far enough to give the proper pitch to the coil, when such coil will be formed, as shown. When the guide-plate 45 is not required for the purpose above described, it can be readily detached from the machine.

In forming short curves in very thin pipe, the sides of such pipe not being strong 135 enough to withstand the pressure of the bending-rolls, such sides are apt to be flattened under the bending-pressure. To overcome this tendency, the roll 61, (see Figs. 12 and 13,) which roll is pivotally mounted in

the frame 62, as before mentioned, is introduced inside of the pipe 68 and brought to the central bending-line of the bending-rolls 10 10', the diameter of roll 61 being equal to the inner diameter of pipe 68. The ball-joint connection of rod 64 with roll-frame 62 will allow freedom of movement to roll 61, so that it may adjust itself to the center line of the pipe. For pipes of different lengths the coupling 69 may be used and extensions of rod 64 connected therewith so that said roll may be introduced into any length of pipe, so as to bring roll 61 to the proper position with relation to the bending-rolls.

Fig. 14 represents a modification of roll 61. The oval plate 70, which is connected to rod 64 in the same manner as above described, is so constructed that its widest portion will be placed on the bending-line.

In bending very heavy metal—such as tramway-rails or heavy angle-irons—the construction shown in Fig. 17 would be employed, as the rack-feed shown in the other views would not possess sufficient strength to force the holder 4 forward against the increased pressure that would be required for such heavy work. In this construction the large feed-screw 71 is employed, one portion being journaled in the bed of the machine, while the threaded portion engages with the jaw-holder 4. Said screw is also connected to shaft 72 by the bevel-gears 73 and 74. The large gear 75 is mounted on the end of shaft 72, which gear engages with the pinion 76, mounted on the driving-shaft 77, which shaft also supports the driving-pulley 78. The forward movement of holder 4 is effected by means of motion imparted through the driving-pulley 78. This movement is necessarily slow, owing to the pinion on shaft 77 engaging with the large gear 75. When the limit of the forward movement is reached, which may be determined by the location of the stop 79 on the sliding plate 80, the pin 81, which pin projects from the holder 4, will engage said stop and move plate 80 until the projection 82 thereon engages lever 83 of clutch 84, releasing said clutch from the driving-pulley 78. Then by means of lever 85 and clutch 86 or in any other suitable manner said clutch is caused to engage with the small rapidly-rotating pulley 87, mounted on shaft 72. This will cause the holder 4 to retreat at a faster rate of speed than it was advanced. In operating this construction the screws 6 or 6', as the case may be, will be slackened, releasing the hold of gripping-jaws 5 upon the piece of metal and the holder carried back by means of screw 71 any distance required for either a long or short bite. When holder 4 makes a full return movement, the lever 85 will engage with the corner 88 of the holder 4 and bring such holder to a standstill. By means of handle 89 on plate 80 the forward movement of the holder 4 may be checked at any desired point.

The manner of shipping from one motion to another for the purpose as above described

may be varied to suit any particular construction desired. Any well-known means may be employed to operate the driving-screw 71.

In bending very large pieces of metal I prefer to support the bending-rolls in such a manner that they will not spread apart during the bending operation. This I effect by means of the yoke 90, (see Fig. 19,) having therein the opening 91, and place therein the sliding block 92, which block is controlled by screw 93. In this construction the studs on which the bending-rolls 10 10' are mounted will be made longer. Stud 13 will project through a hole for the same in sliding block 92. The stud for roll 10 will also project through yoke 90, and such yoke held thereto by plate or washer 59 and screw 60. The block 92 is adjusted to the proper position required in the yoke, and the outward pressure on the bending-rolls sustained by screw 93.

The machine as above described combines in its construction all the advantages of two single machines. It can be operated from either side, and such double use is necessary whenever the roll-arm is thrown around for the purpose of making double coils or return-bends, as before stated. The bending-rolls and the supporting-die can be brought into close proximity with each other, leaving no intervening space between such rolls and die, thus fully supporting and sustaining the metal at the point of deflection. These and other advantages above enumerated render this machine particularly valuable in the art of bending metals of all descriptions and in any direction.

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

1. The combination, in a metal-bending machine of the character described, of the bending-rolls, a swinging roll-supporting arm, one of said rolls located at the pivotal point of said arm, the other roll arranged to be adjusted on said arm, as shown, with a table, said roll-supporting arm pivoted thereto and arranged to be turned on its pivoted support and be operated from either side of said table, said table having a lateral adjustment on its support, so that by means of such lateral adjustment the first or pivotal roll is carried across the central or feeding line of the pipe or bar and operated from either side of said line to effect double coils or return-bends, combined with gripping-jaws for the pipe or bar and means for advancing the same, as set forth.

2. The combination, in a metal-bending machine of the character described, of the bending-rolls arranged as shown and described, a swinging arm supporting said rolls, one of which is mounted on the pivot of said arm, the other arranged to be adjusted on said arm, as shown, with a laterally-adjustable table, a support for the same, said roll-arm pivoted to said table and arranged to swing on its pivoted support and be operated from either side

of said table, and means for securing it in each position, and means, substantially as shown, whereby said table is adjusted laterally, and the bending-roll located at the pivotal point of the roll-arm is operated from either side of the central feeding-line of the pipe or bar or caused to engage with either side of the metal to be bent, whereby double or return bends and other coils can be made, as set forth.

3. The combination, in a metal-bending machine of the character described, of the bending-rolls, bending-roll arm constructed and arranged substantially as shown, a laterally-adjustable table, and roll-supporting arm pivoted thereto and arranged to operate thereon, as described, combined with suitable gripping-jaws arranged to engage the straight part of the pipe or bar to be bent, and means, substantially as shown, whereby said jaw-holder is advanced with the pipe or bar to the bending-rolls, as shown.

4. The combination, in a metal-bending machine, of the bending-rolls, bending-roll arm, said rolls arranged thereon, as shown, laterally-adjustable table, roll-supporting arm pivotally supported thereto, gripping-jaws to engage the straight portion of the pipe, and a holder for said jaws, said holder arranged to be moved on the bed or other suitable support and advance the pipe or bar by longer or shorter stages to the bending-rolls, as set forth.

5. The combination, in a metal-bending machine of the character described, of the bending-rolls, swinging roll-supporting arm arranged to operate substantially as shown, independently-operating gripping-jaws adapted to engage the straight portion of the pipe, a holder for said jaws, a support for said holder, and means, substantially as shown, whereby said holder is caused to move on its support and advance the pipe to the bending-rolls, and means for imparting a retrograde movement to such holder, such means entirely independent of the means for advancing the same, so that through the instrumentality of the independent mechanism for causing said holder to advance or retreat the pipe may be fed to the rolls in longer or shorter stages, as may be desired, whereby the bending of short pieces or very thin pieces of pipe is effected, combined with a movable guiding-die placed between said gripping-jaws and the bending-rolls.

6. The combination, in a metal-bending machine, with suitable bending-rolls, of a movable supporting guide or die to engage the straight portion of the pipe or bar to be bent, said supporting guide or die arranged to be advanced into the bending-field of the bending-rolls, and thus support the pipe or bar in close proximity to the point of deflection or bending-point of said pipe or bar, combined with gripping-jaws or other suitable device, substantially as shown, and means, substantially as shown, to advance the same with said

pipe or bar, the supporting guide or die placed between the gripping-jaws and the bending-rolls, as described.

7. The combination, in a metal-bending machine, with the bending-rolls, of a supporting guide or die to support the straight portion of the metal, a holder for such support or die, and a support for said holder, said holder arranged to move on its support and advance the supporting guide or die in close proximity to the bending-field, and thereby support the metal to be bent at the bending-point of such metal, combined with gripping-jaws and means, substantially as shown, for advancing the same, as shown and described.

8. The combination, in a metal-bending machine, of the bending-rolls, supports for the same, said rolls arranged to rotate on said supports, guiding-dies for the straight portion of the pipe or bar to be bent, and a holder for said guiding-dies, said dies adapted to engage the pipe or bar on both sides of the same, one side of said die projecting beyond the other or its companion die, so that said projecting end may be advanced to the bending line of the bending-rolls and support the pipe or bar at said point, combined with gripping-jaws and means for advancing the same, as set forth.

9. The combination, in a metal-bending machine, of the bending-rolls, roll-supporting arm 11, and means, substantially as shown, to adjust one of said rolls on said arm and table 7, said roll-supporting arm being pivotally supported thereon and said table arranged to have a lateral movement on the bed at right angles to the feeding-line of the pipe or bar, so that the roll at the pivotal point of the roll-supporting arm may be operated from either side of said line, combined with gripping-jaws and means for advancing the same, substantially as shown.

10. The combination, in a metal-bending machine of the character described, of the bending-rolls, swinging roll-supporting arm, transversely-movable table, said arm pivoted thereto and arranged to operate thereon, as shown and described, gripping-jaws adapted to engage the straight portion of the pipe and advance the same to the bending-rolls in longer or shorter stages, guiding die or dies, and a support for the same placed between the gripping-jaws and the bending-rolls, said gripping-jaw and guiding-die holders arranged to move independently of each other or both together, as may be desired.

11. The combination, in a metal-bending machine, with the bending-rolls supported and operated as shown and described, of the guiding-dies 3 3' and holder 2, said dies arranged, substantially as shown, to be reversed in their holder, so that the projecting die may be advanced into the bending-field of the bending-rolls from either side of the central or feeding line of the pipe or bar, combined with gripping-jaws and means for advancing the same, as set forth.

12. The combination, in a metal-bending ma-

chine of the character described, of the bending rolls, swinging roll-supporting arm, laterally-adjustable table, roll-supporting arm pivoted thereto and arranged to operate thereon, in the manner and for the purpose shown and described, and means for securing the arm in any position required with gripping-jaws, and means to advance the same, said jaws adapted to engage the straight portion of the pipe or bar, guiding die or dies placed between the bending-rolls and the gripping-jaws, a holder for the same, the gripping-jaw holder arranged to be advanced a predetermined distance on its support, and a pusher arranged substantially as shown, said gripping-jaw holder engaging the pusher and by means of such engagement being enabled to turn the roll-supporting arm on its pivoted support, said jaw-holder also engaging the guiding-die holder to advance the die into the bending-field of the rolls, so as to support the pipe or bar at the bending point, as set forth.

13. The combination, in a metal-bending machine, of the bending-rolls, supporting-arm for the same, laterally-adjustable table, the arm being pivotally supported thereon, the gripping-jaws for the straight portion of the pipe or bar, a holder for said jaws, and means for operating the same, guiding die or dies, holder for the same, said holder placed between the bending-rolls and the gripping-jaws, the pusher, and guide-roll for the same, all combined and arranged to operate in the manner substantially as shown and described.

14. In a metal-bending machine of the character described, the combination of the bending-rolls, the swinging roll-supporting arm, the table, said arm pivotally supported thereon, and a coil-supporting guide-plate arranged above the table and parallel therewith, said guide-plate pivotally supported on said table and having a vertical adjustment on said support, said guide-plate arranged to turn on its pivoted support in unison with the roll-supporting arm, and thereby support the bent portion of the pipe or bar in any position assumed by the roll-supporting arm, combined with gripping-jaws and means for advancing the same, substantially as shown and set forth.

15. In a metal-bending machine, the combination of the bending-rolls, roll-supporting arm, the table, said arm pivotally supported thereon and arranged to operate thereon, substantially as shown, and the coil guide-plate pivotally supported on said table and having a vertical adjustment thereon, the edges of said guide-plate so formed with respect to its pivoted support and the pivoted roll-supporting arm that said arm when turned on its support will carry the coil guide-plate with it, so that the proper relation between said plate and arm will remain substantially the same, combined with the gripping-jaws and means for advancing the same, as set forth.

16. The combination, in a metal-bending machine of the character described, of the coil

guide-plate 45, having the edges *j k*, each of the same curved shape or formation, stud 46, projecting downward from said plate, adjustable supporting-screws 51 51', projecting downward through said plate, with the table 7, having holes 47 47' through the same, adjusting-screws 49, engaging such holes from beneath the table, and stud 46 of the guide-plate, inserted in said holes on the upper surface of the said table and adapted to rest, as the case may be, on either of said adjusting-screws 49 to effect a vertical adjustment of said guide-plate, combined with the bending-rolls and roll-supporting arm, the curved edges *j k* of said guide-plate so formed with respect to the position of its pivoted stud 46 and the movement of the roll-supporting arm that when said arm is turned on its support it will carry the guide-plate with it, and thus support the bent portion of the pipe in any position said roll-arm may be placed, said guide-plate also adapted to be reversed, as shown, and used on either side of the table and roll-supporting arm, combined with gripping-jaws and means for advancing the same, as set forth.

17. In a metal-bending machine of the character described, the combination of the bending-rolls 10 10', roll-supporting arm 11, gripping-jaws for the straight portion of the pipe, and means, substantially as shown, for advancing the said jaws, and thus feeding the pipe to the bending-rolls, with the internal supporting-roll 61, adapted to be placed within the pipe and between the bending-rolls to support the pipe at the bending-point, the supporting-roll pivotally mounted to the frame 62, so that said roll may turn, and thereby reduce the frictional contact with the interior of the pipe, the roll-supporting frame also swiveled to the rod 64, as shown, to give freedom of action to said frame, so that the supporting-roll may readily locate itself to the curved surface of the bending-rolls, as set forth.

18. The combination, in a metal-bending machine, of the bending-rolls, swinging roll-supporting arm, roll-supporting studs mounted thereon, one of said studs fixedly located at the pivoted point of the arm, the other adapted to be adjusted thereon, and means, substantially as shown, to effect such adjustment, combined with a clamp or yoke, an adjustable block thereon, and a screw actuating such block, one end of the yoke engaging the upper end of the fixed roll-stud, while the movable block engages the upper end of the movable roll-stud, so as to preserve the vertical alignment of such studs while bending heavy pipe or metal, as set forth.

Signed at New Haven, in the county of New Haven and State of Connecticut, this 2d day of June, A. D. 1891.

HERBERT E. FOWLER.

Witnesses:

F. A. CARGILL,
WM. H. ELY.