No. 841,838. PATENTED JAN. 22, 1907.

J. R. WILLIAMS.

METAL PLATE BENDING OR FORMING MACHINE.

APPLICATION FILED OCT. 10, 1906.

6 SHEETS—SHEET 1.

Fig. 1

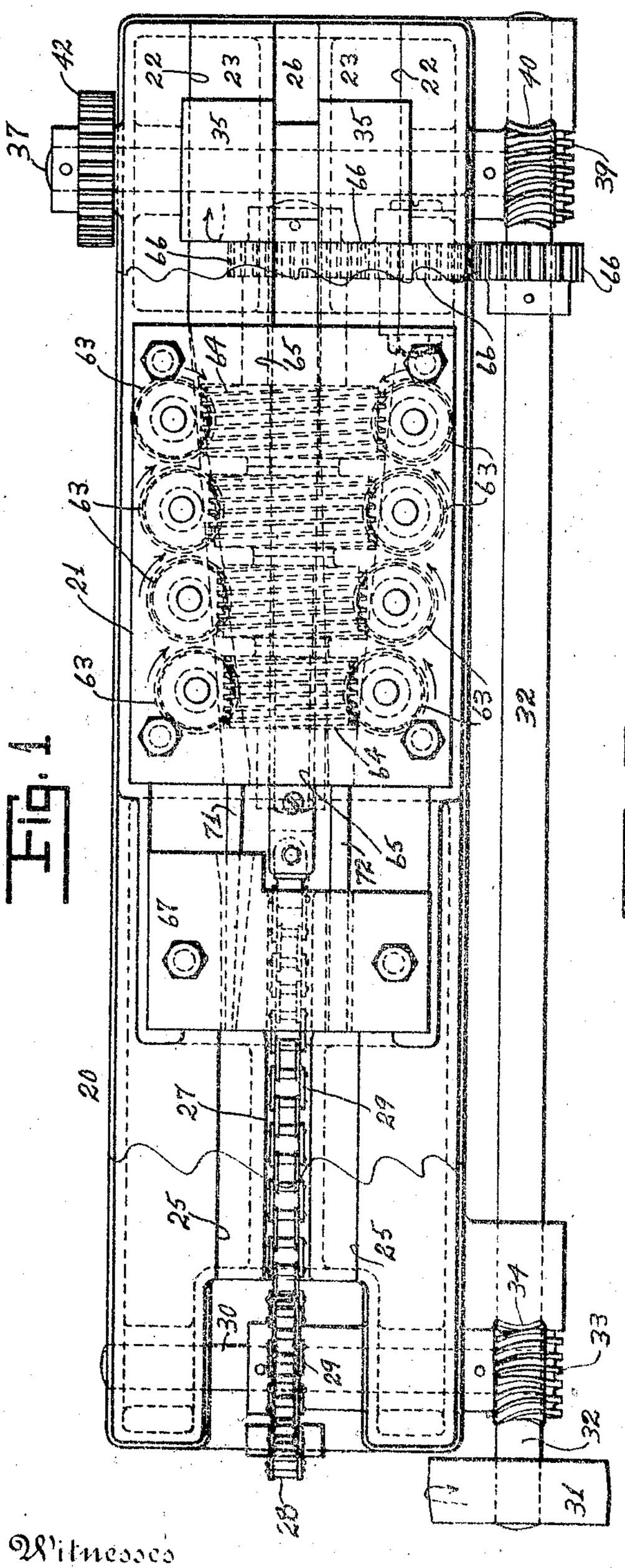
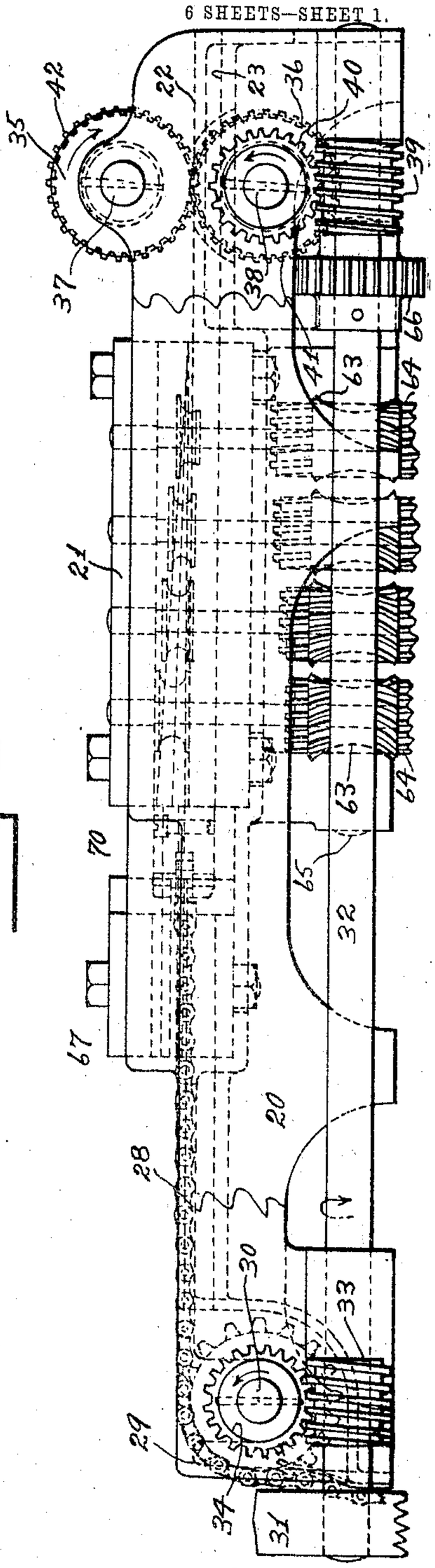


Fig. 2



Witnesses
E. C. James.
L. R. Compton

Inventor
John R. Williams
By his Attorney Chas. C. Gill

No. 841,838. PATENTED JAN. 22, 1907.

J. R. WILLIAMS.

METAL PLATE BENDING OR FORMING MACHINE.

APPLICATION FILED OCT. 10, 1906.

6 SHEETS—SHEET 2.

Fig. 3

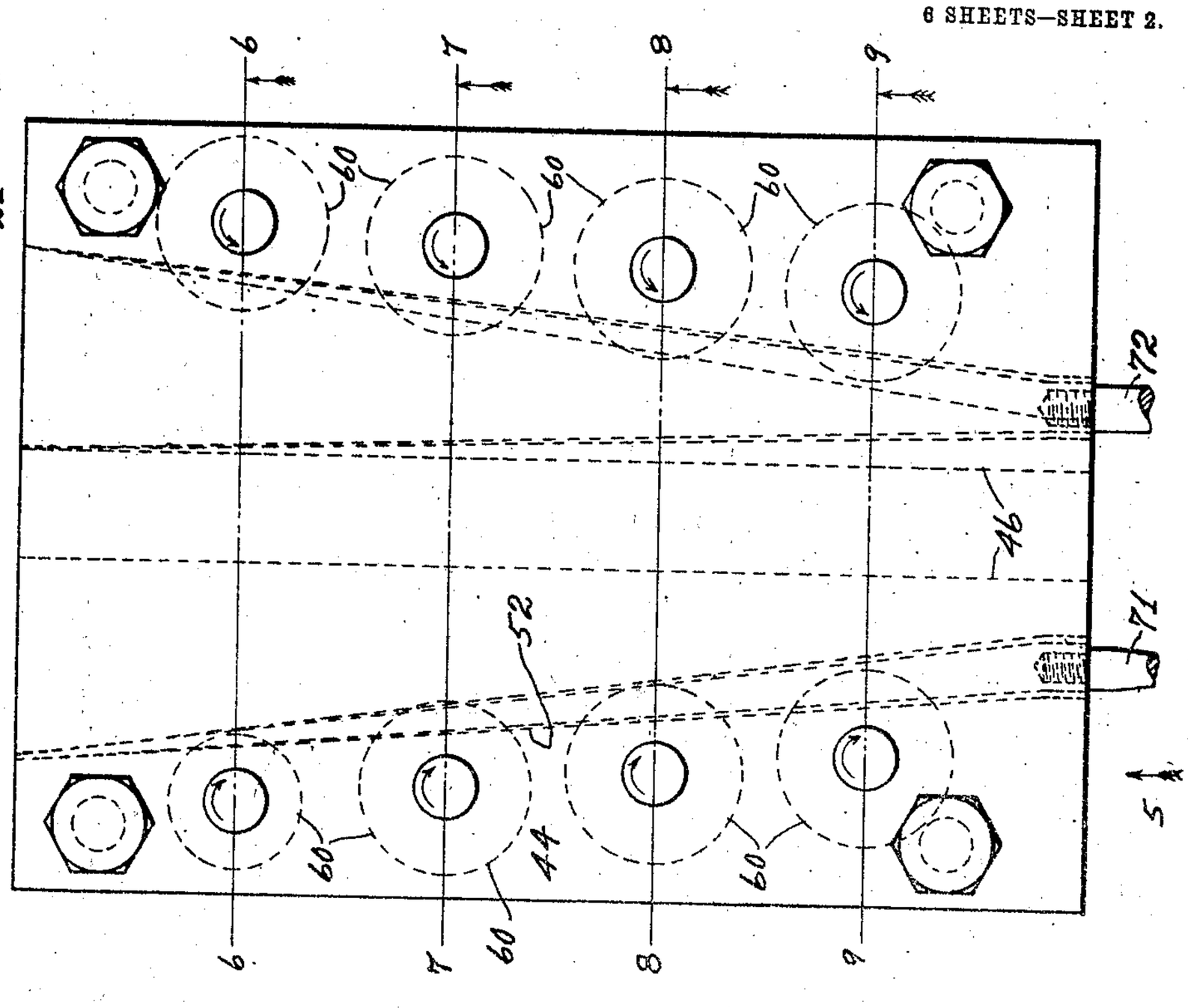


Fig. 4

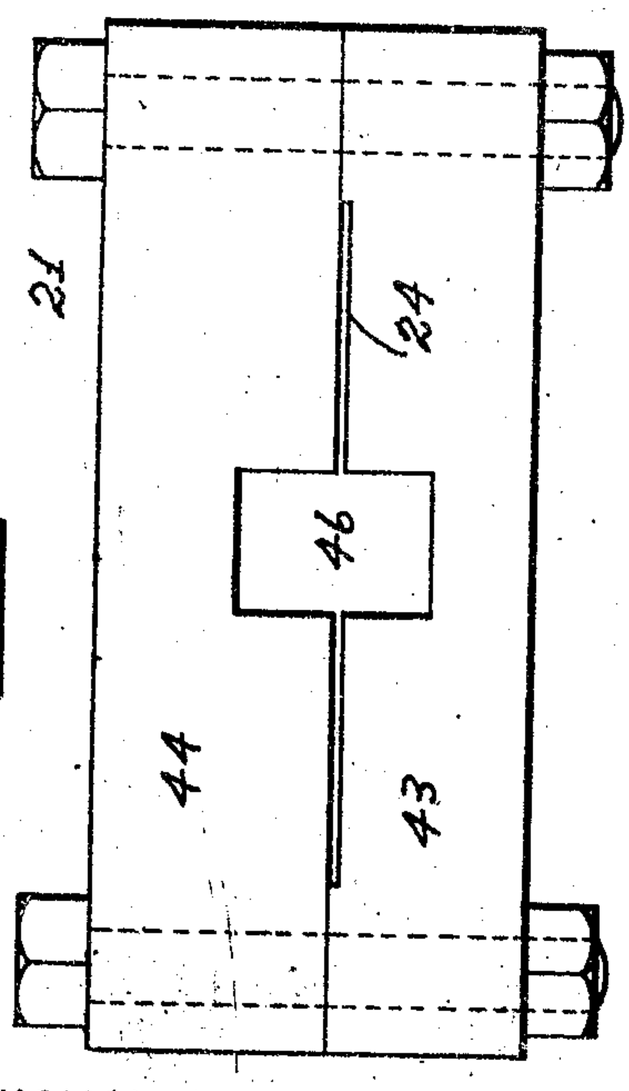
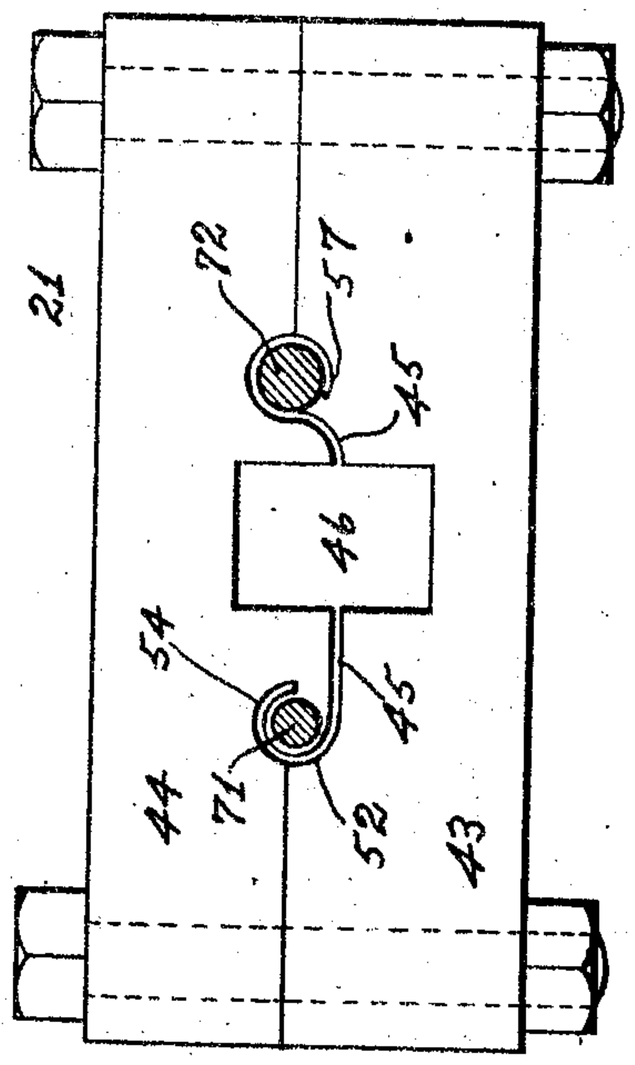


Fig. 5



Witnesses
E. C. James.
L. A. Comptoner

Inventor
John R. Williams
By his Attorney
Chas. C. Gill

No. 841,838. PATENTED JAN. 22, 1907.

J. R. WILLIAMS.

METAL PLATE BENDING OR FORMING MACHINE.

APPLICATION FILED OCT. 10, 1906.

6 SHEETS—SHEET 3.

Fig. 6

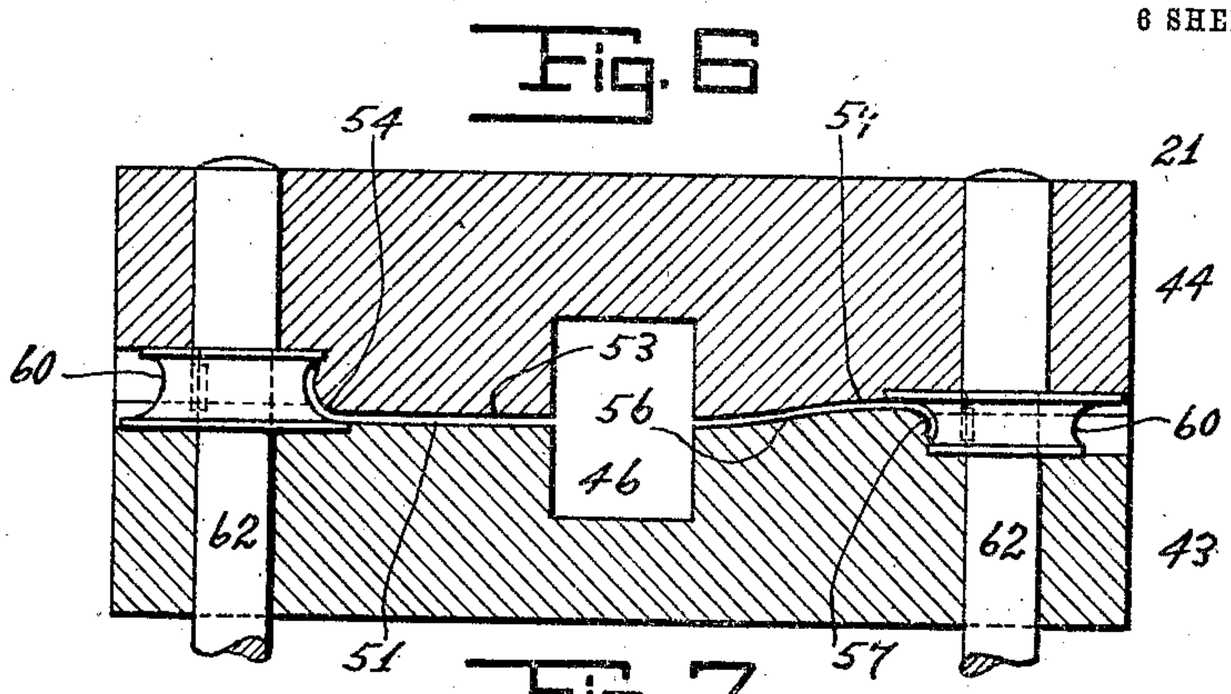


Fig. 7

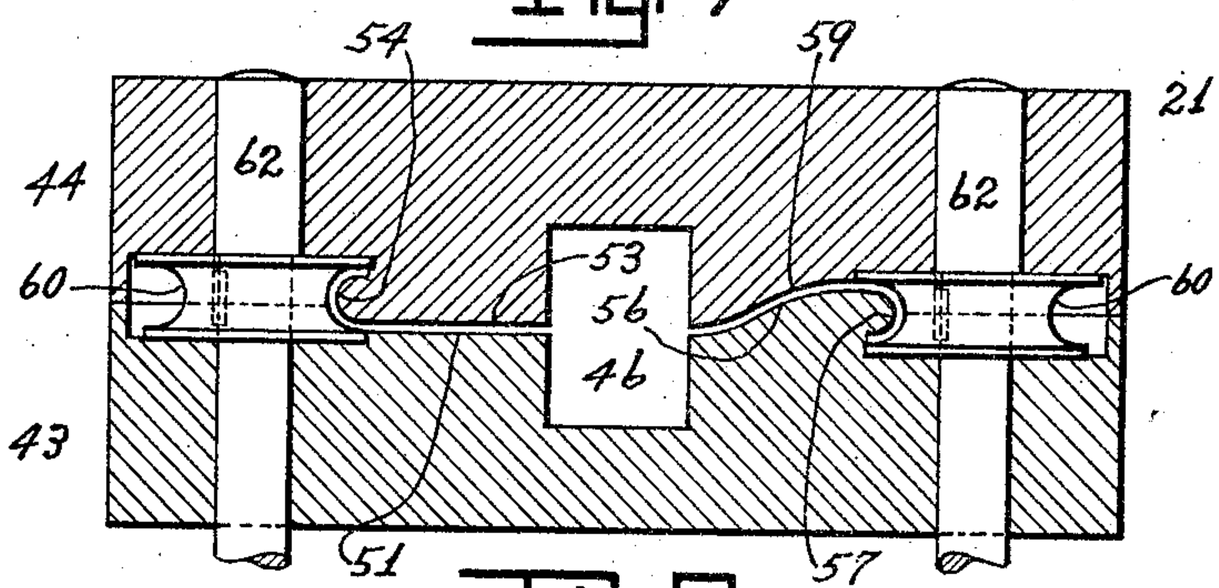


Fig. 8

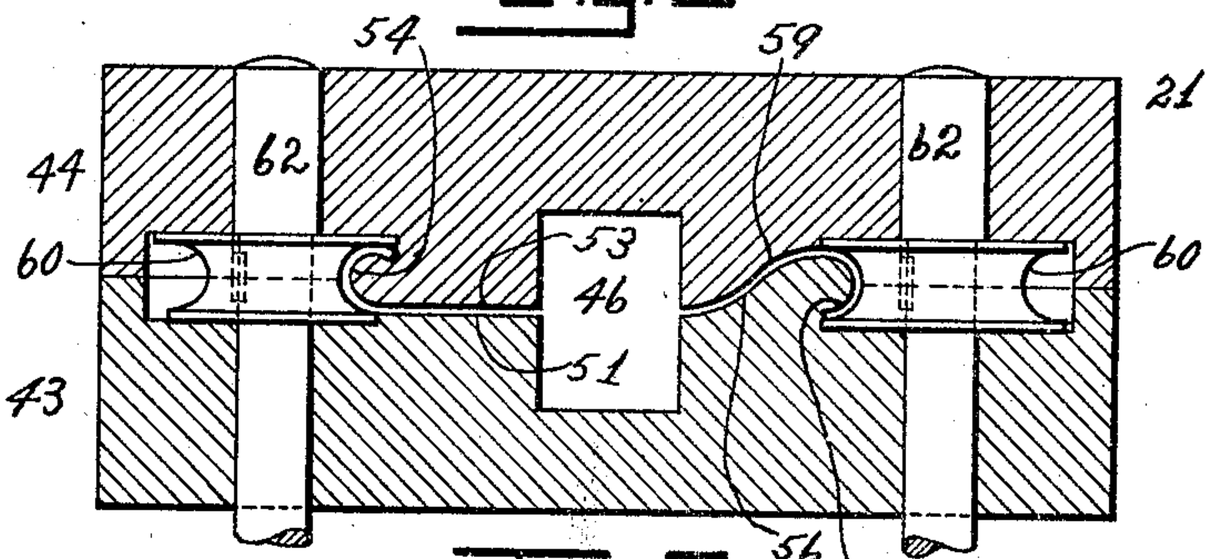
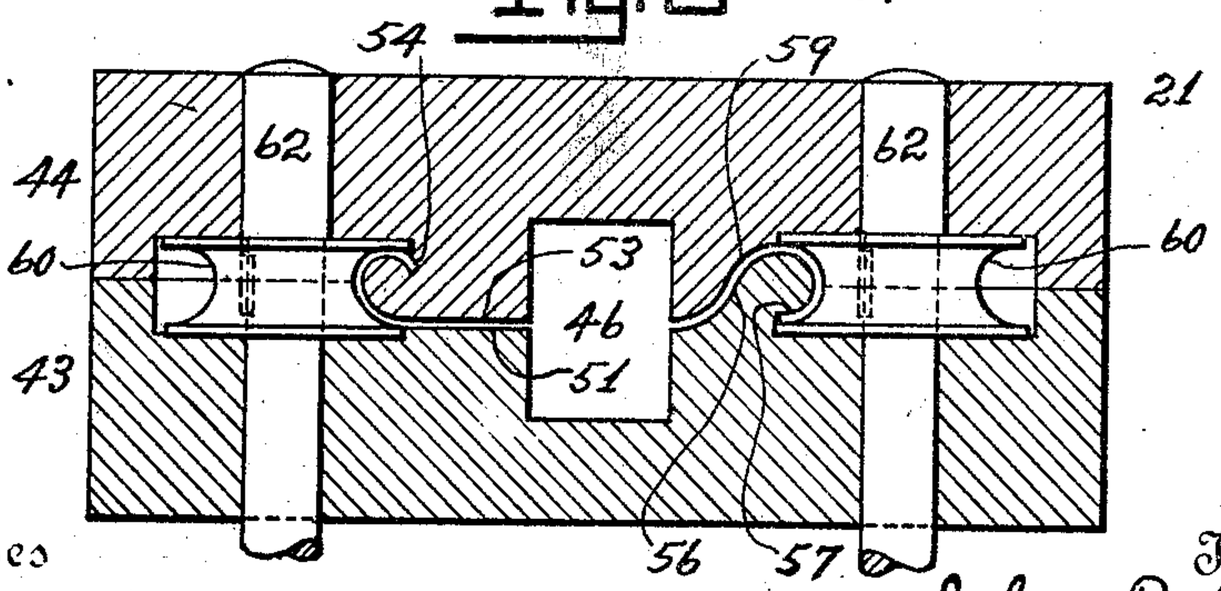


Fig. 9



Witnesses
G. F. James
L. R. Compton

Inventor
John R. Williams,
By his Attorney
Chas. C. Gill

No. 841,838. PATENTED JAN. 22, 1907.

J. R. WILLIAMS.

METAL PLATE BENDING OR FORMING MACHINE.

APPLICATION FILED OCT. 10, 1906.

6 SHEETS—SHEET 4

Fig. 11

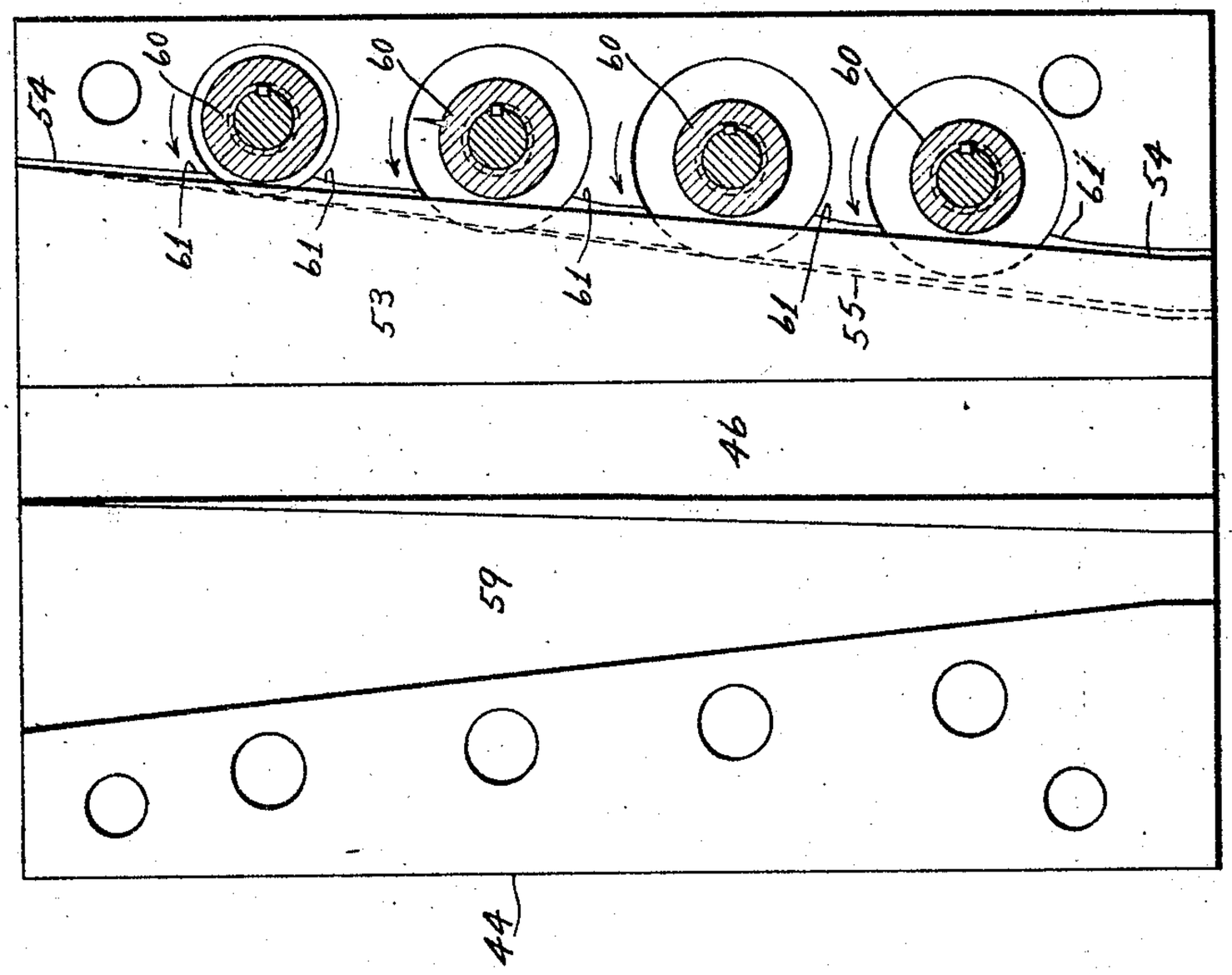
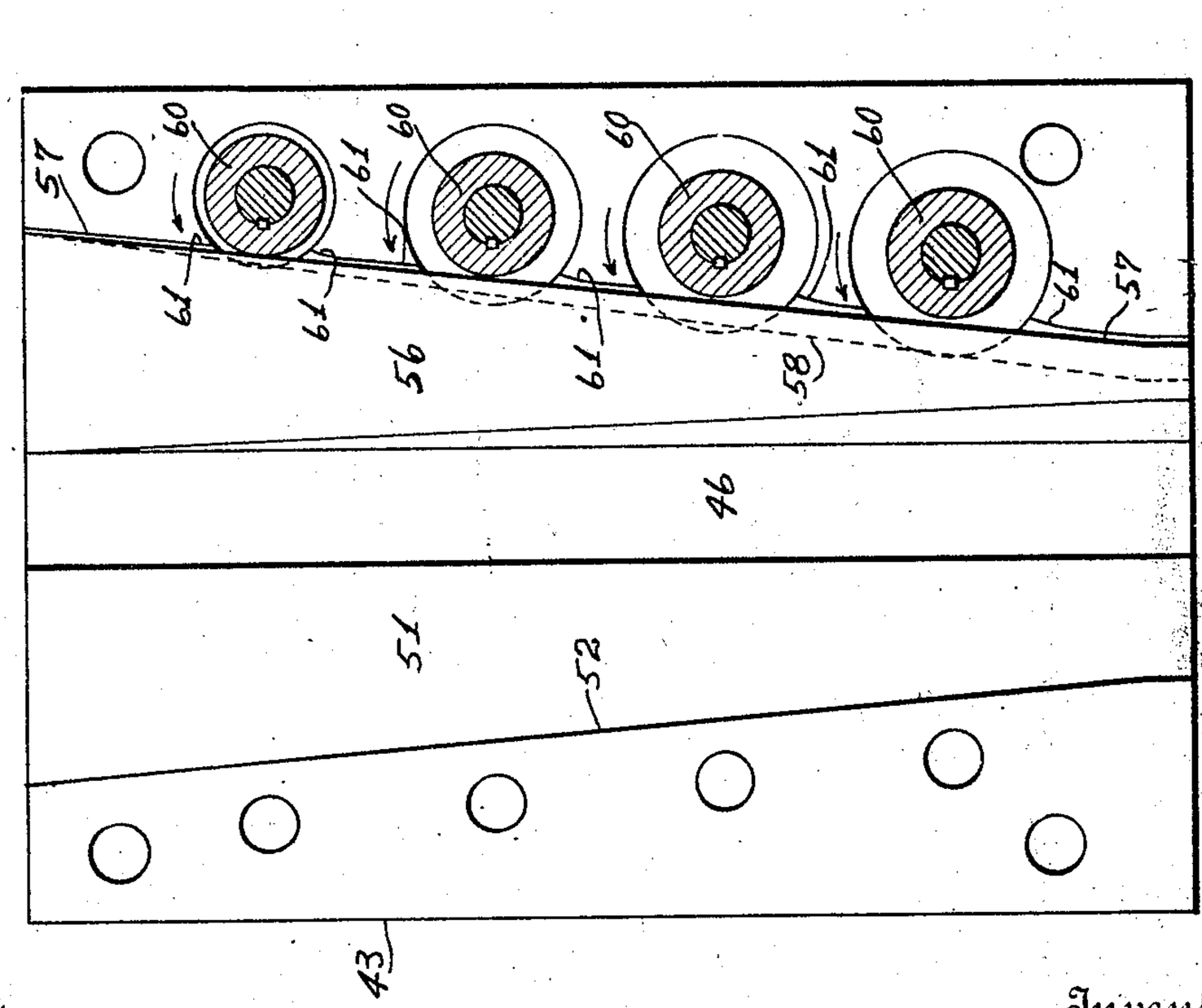


Fig. 10



Witnesses
G. A. James.
L. R. Compton

Inventor
John R. Williams,
By his Attorney Chas. C. Gill

No. 841,838. PATENTED JAN. 22, 1907.

J. R. WILLIAMS.

METAL PLATE BENDING OR FORMING MACHINE.

APPLICATION FILED OCT. 10, 1906.

6 SHEETS—SHEET 5.

Fig. 12

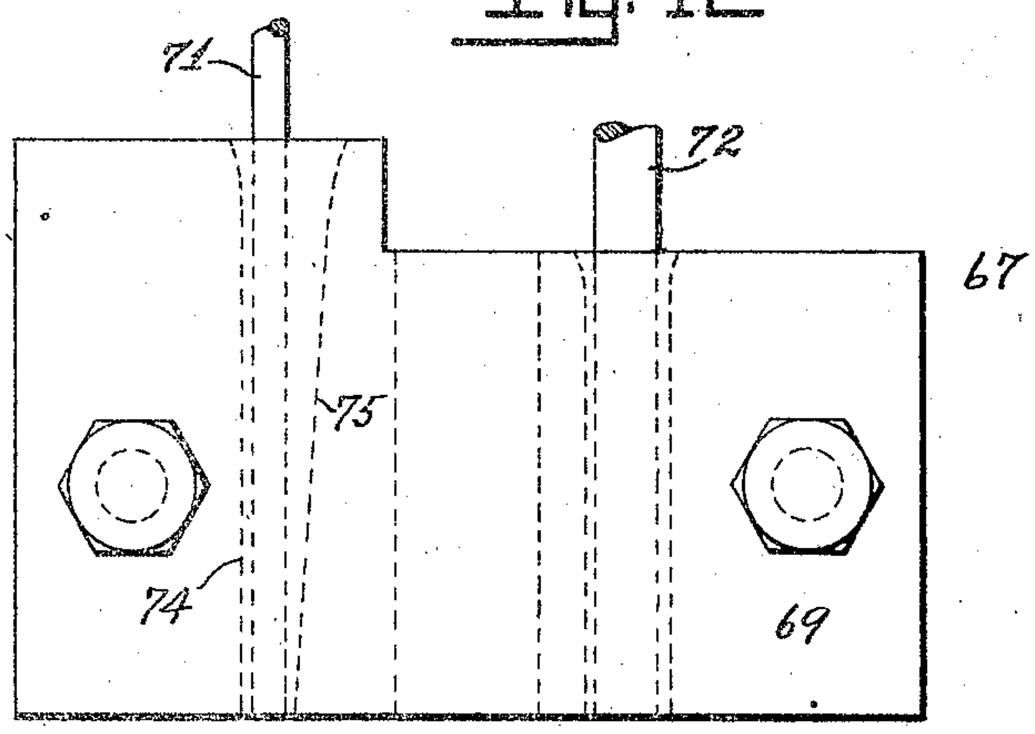


Fig. 13

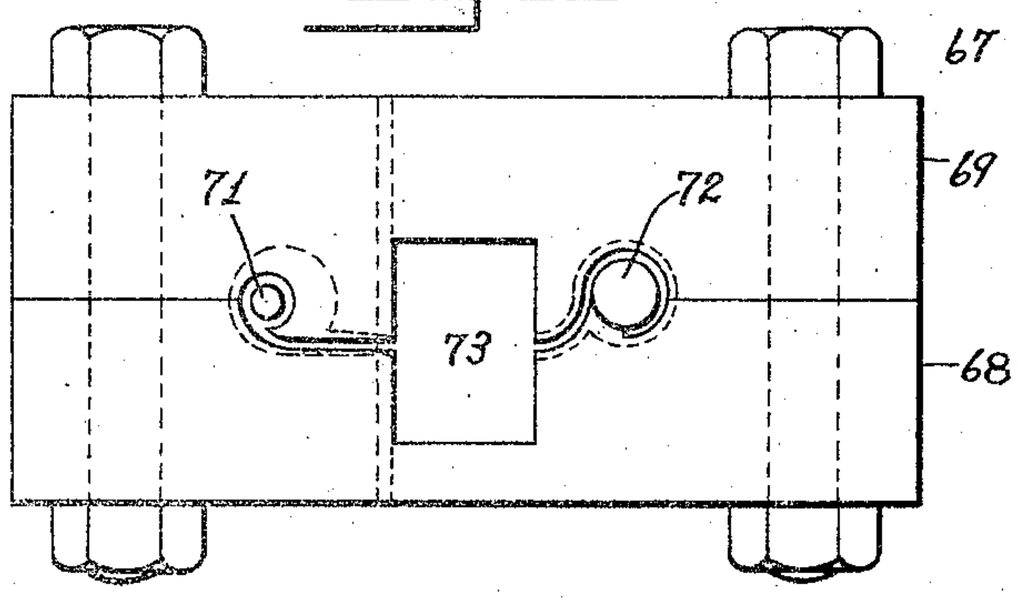


Fig. 14

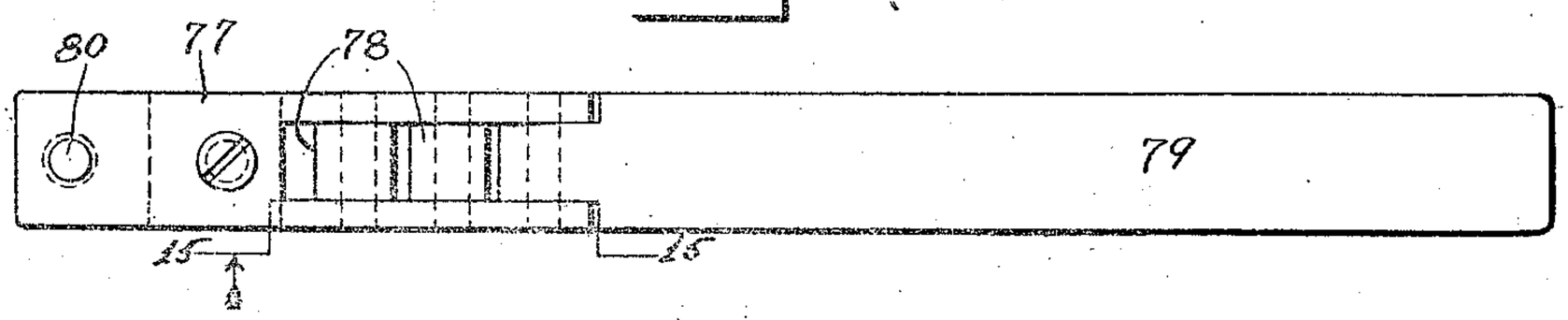
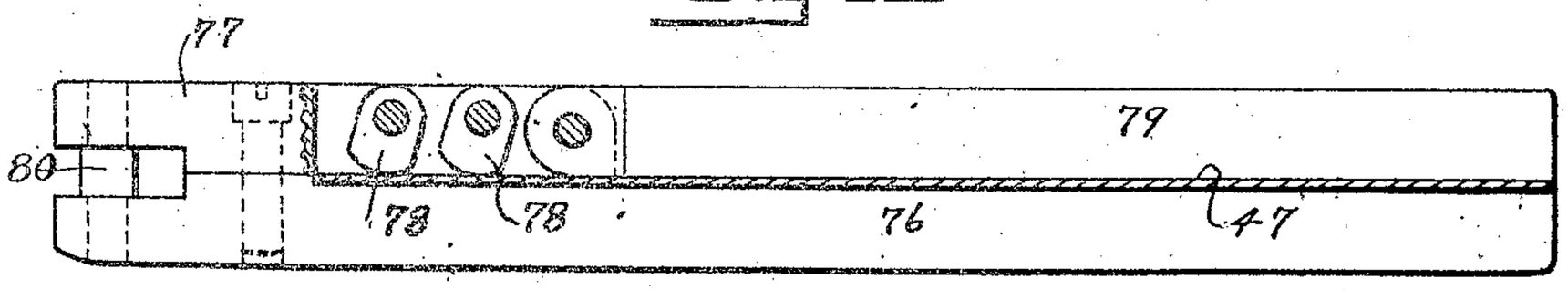


Fig. 15



Witnesses
G. F. James.
L. R. Compton

Inventor
John R. Williams,
By his Attorney Chas. C. Gill

No. 841,838. PATENTED JAN. 22, 1907.

J. R. WILLIAMS.

METAL PLATE BENDING OR FORMING MACHINE.

APPLICATION FILED OCT. 10, 1906.

6 SHEETS—SHEET 6.

Fig. 16

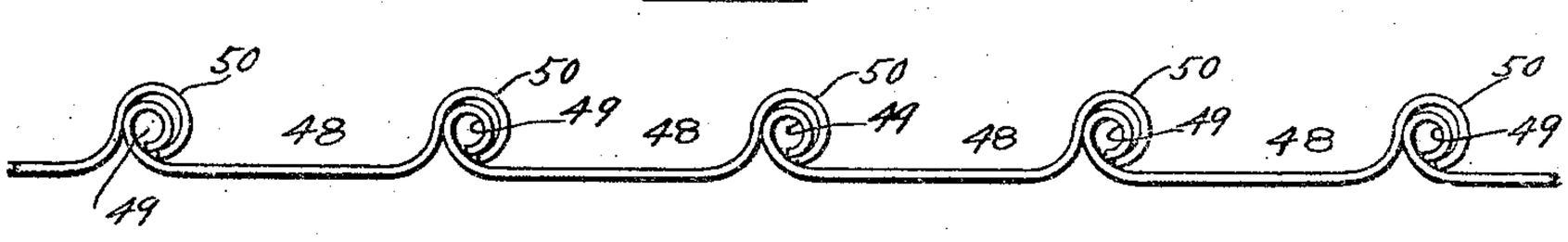


Fig. 17

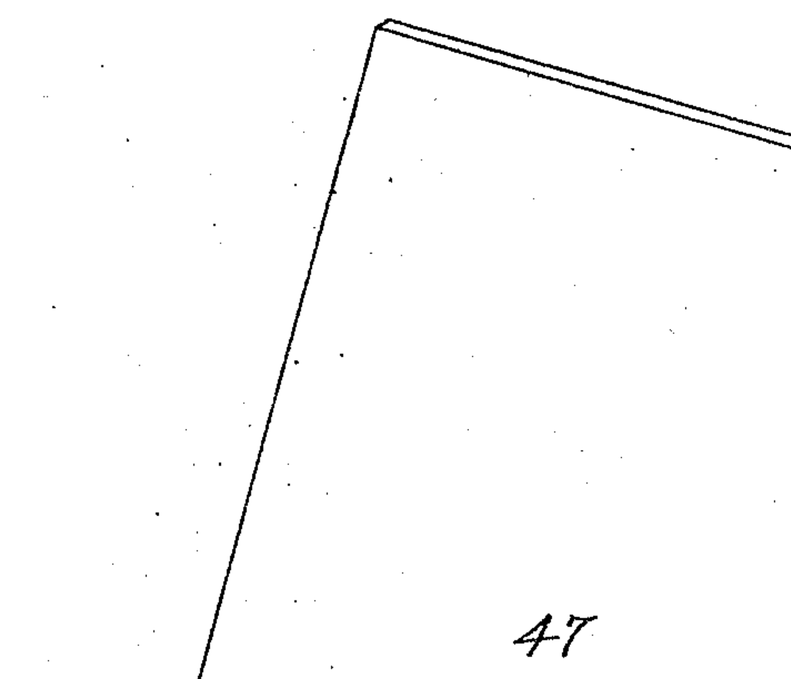
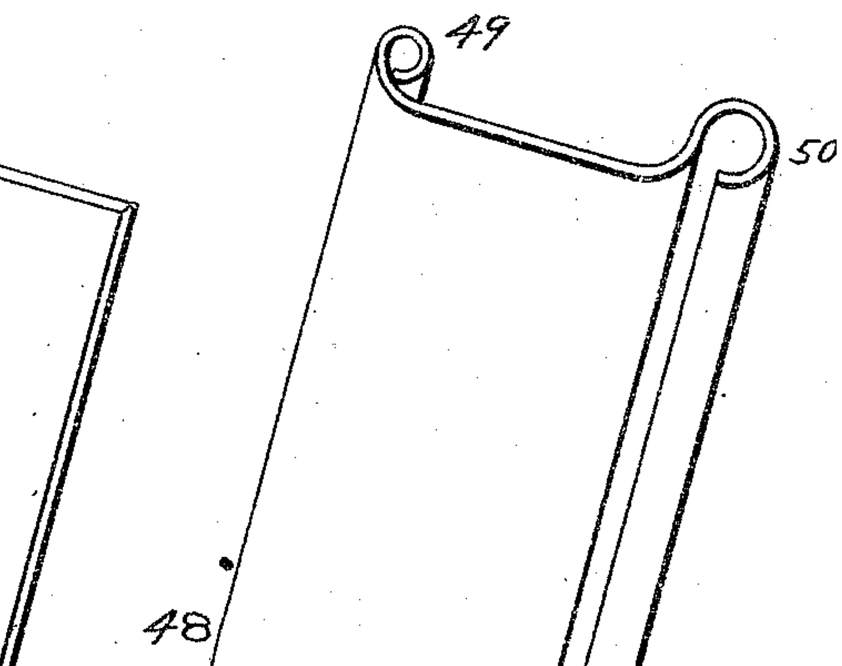


Fig. 18



Witnesses
G. F. James
L. R. Compton

Inventor
John R. Williams
By his Attorney Chas. C. Gill

UNITED STATES PATENT OFFICE.

JOHN R. WILLIAMS, OF EAST ORANGE, NEW JERSEY

METAL-PLATE BENDING OR FORMING MACHINE.

No. 841,838. Specification of Letters Patent. Patented Jan. 22, 1907.

Application filed October 10, 1906. Serial No. 338,213.

To all whom it may concern:

Be it known that I, JOHN R. WILLIAMS, a citizen of the United States, and a resident of East Orange, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Metal-Plate Bending or Forming Machines, of which the following is a specification.

The invention relates to improvements in metal-plate bending or forming machines; and it consists in the novel features, arrangements, and combinations of parts hereinafter described, and particularly pointed out in the claims.

The object of the invention is to produce an apparatus or machine by means of which metal plates may have their edges coiled or fashioned into the necessary shapes for the purpose for which the plates may be intended to be employed.

I present my invention herein as embodied in a machine for forming metal sheet-piling, the edge portions of the sections or units of which are coiled or fashioned into loops, the loop on one edge being of smaller diameter than the loop on the other edge, so that in the assembling of the sections of the piling as driven the smaller loops of the respective sections may be inclosed within the larger loops of the respective adjacent sections and enter into locking engagement therewith.

The machine of my invention embodies means by which the metal plate may be gripped and drawn or pulled through forming and finishing devices which during the travel of the plate will coil or fashion the edge portions of same into the shapes desired.

There are several novel features aside from novel details embodied in the machine of my invention, and one is the provision of a primary bending or forming die and a finishing die or block separated by a space from the primary die and through which dies the metal plate is moved, the space between the dies permitting the metal after having been wholly or partly fashioned to spring into such shape as its constitution or tension may demand prior to passing through the finishing die or block, by which the plate is given its finished form and all tendency to buckle or distort itself removed therefrom.

Another novel feature of my invention resides in the provision of means within the primary forming or bending die for facilitating the passage of the metal plate therethrough, so that the metal plate may not unduly bind within or wear against the walls of said die and be drawn or moved through the same with the minimum power.

A further novel feature of my invention resides in the construction of the grip device and bending or forming die by which a plate of metal of full width throughout may be gripped by said device and pulled through said die and against the tapering or converging walls of same in lieu of at first providing the plate with a tapered or tang-advancing end portion to be primarily projected freely through the forming-die for the purpose of being engaged by the grip device, said end representing waste metal and a loss, since it must thereafter be removed from the plate.

In accordance with my invention I provide a grip device which may be moved through the bending or forming die to take hold of the metal plate at a point beyond the entrance to the same and then draw or pull the plate through said die, thus making it possible to handle a plate of full width throughout, and I also provide means for filling the space in said die through which the grip passes, so that the metal plate when pulled through the die and having its edge portions fashioned may not buckle into said space.

The invention will be fully understood from the detailed description hereinafter presented, reference being had to the accompanying drawings, in which—

Figure 1 is a top view, partly broken away, of a machine constructed in accordance with and embodying my invention. Fig. 2 is a side elevation of same. Fig. 3 is an enlarged top view of the primary bending or forming die or tool. Fig. 4 is an end view of the entrance end of same looking in the direction of the arrow 4 of Fig. 3. Fig. 5 is an end view of the exit end of same looking in the direction of the arrow 5 of Fig. 3. Fig. 6 is a vertical transverse section of same on the dotted line 6 6 of Fig. 3. Fig. 7 is a like section of same on the dotted line 7 7 of Fig. 3. Fig. 8 is a like section of same on the dotted line 8 8 of Fig. 3. Fig. 9 is a like section of same on the line 9 9 of Fig. 3. Fig. 10 is an enlarged detached top view, partly in section, of the lower section of the primary bending or forming die or tool. Fig. 11 is a detached view, partly in section, of the inner face of the upper section of the primary bending or forming die or tool. Fig. 12 is a detached top view of the finishing

block or die. Fig. 13 is a view of the exit end of same. Fig. 14 is a detached top view of the grip and means for filling the space within the primary bending die or tool through which the grip travels. Fig. 15 is a side elevation, partly broken away, of same, a plate of metal in section being represented as held by said grip. Fig. 16 is a top edge view of a series of assembled sections of the character produced on the specific form of the machine shown in Fig. 1. Fig. 17 is a detached perspective view of one of the plates to be fashioned into a section of the nature shown in Fig. 16, and Fig. 18 is a detached perspective view of one of the piling-sections.

In the drawings, 20 designates a suitable bed, table, or frame upon which is securely fastened the primary bending or forming die or tool 21 and which at its front or receiving end is formed with a longitudinal recess to receive the metal plate to be treated and whose side walls 22, Fig. 1, constitute guides for the plate. The floor 23 of the said recess is in line with the lower edge of the entrance-opening 24, Fig. 4, to said die 21. The delivery end of the table 20 is also formed with a longitudinal recess defined by the walls 25, Fig. 1, and of a width corresponding to the width of the metal plate after being fashioned into the required form.

The front or receiving end of the table 20 is provided with a longitudinal groove 26 to receive the grip device and its coöperating features, and the rear or delivery end of the table 20 is provided with a longitudinal groove 27 to receive the grip devices and the chain or flexible connection 28 by which said devices are moved to pull the metal plate through the die 21, said flexible connection being secured at its inner end to the grip device and at its outer end engaged by a sprocket-wheel 29, secured upon a shaft 30, operable by means of a belt-wheel 31, driving-shaft 32, worm 33, and pinion-wheel 34, the latter being secured upon the outer end of said shaft 30. The gearing just described for imparting power to the shaft 30 is of usual construction, except that in the present instance the shaft 32 is extended to the front or receiving end of the machine for purposes presently to be described. The rotation of the sprocket-wheel 29 in an outwardly direction, or toward the left looking at Fig. 1, causes the chain 28 to draw the grip device and the plate engaged by the same through the dies.

At the right-hand or receiving end of the machine, referring to Figs. 1 and 2, I provide at opposite sides of the groove 26 in the bed-plate upper and lower feed-rollers 35 36, secured upon shafts 37 38, respectively, the lower one of which is driven from the main shaft 32 through the worm 39 thereon and pinion-wheel 40, secured upon the end of said shaft 38. The shaft 38 transmits its motion through the gear-wheel 41, secured upon one end thereof, to the upper shaft 37 through the gear-wheel 42, secured thereon. The feed-rollers 35 36 rotate toward each other, and the space between them is about on a line with the floor-surface 23 for receiving the plates to be treated and with the entrance 24 for said plates to the forming or bending die 21. The function performed by the rollers 35 36 is that of gripping the plates fed upon the floor 23 and coöperating with the grip device operated by the chain 28 in moving said plates into and through the forming-die 21, the action of said rollers 35 36 being that of pushing the plates into and through the die 21, while the grip device operates to pull said plates through said die. It is not necessary at all times to employ both the rollers 35 36 and the grip device, since on many occasions the grip device will be found to be entirely adequate for drawing the plates through the machine.

The bending or forming die 21 comprises a bottom plate 43, Figs. 4 to 10, inclusive, and a top plate 44, Fig. 3 and Figs. 6 to 9, inclusive, and Fig. 11, which plates match each other to form the die 21, through which the metal plate (shown in Fig. 17) is drawn for shaping the same, said plate initially being flat and having parallel side edges and entering the die at the entrance 24, Fig. 4, thereto and leaving the same through the exit 45, Fig. 5.

The bottom and top plates 43 44 of the die 21 are recessed longitudinally to form a groove 46 for the grip and its parts, said groove 46 being in line with the grooves 26 27 in the table or bed 20.

The interior bending or matrix portions of the lower and upper plates 43 44 are adapted in the present illustration to transform a plain flat plate 47, Fig. 17, into the piling-section 48, Fig. 18, on the passage of said plate through the die 21, the edge portions of said plate being gradually coiled to form the loop-locking members 49 50 of approximately the outline shown in Fig. 18. The plate leaves the die 21 with a locking member 50 of exactly the final diameter desired, whereas the locking member 49 is preferably subjected after the plate leaves the die 21 to further reduction in diameter, so that it may form a closed tube, as shown in Fig. 18, by means of a finishing-die 67, hereinafter described. The members 49 50 preferably both project from the same side of the plate, and the member 49 is less in diameter than the member 50, so that in driving the sections 48 the member 49 of one section may be driven within the member 50 of the next adjacent section, as shown in Fig. 16. In the present instance, therefore, the bottom and top plates 43 44, respectively, are formed as to their interior in the manner illustrated more particularly in Figs. 6 to 11, inclusive.

The bottom plate 43 at one side of the groove 46 has a plain flat surface 51, at the outer or left-hand edge of which is a wall 52, which extends on an inwardly-inclined line toward the exit end of the die. The upper plate 44 of the die is formed with a flat surface 53, Fig. 11, corresponding with the flat surface 51 of the bottom plate 43, and the said surfaces 51 53 match each other and form parallel walls between which those portions of the plate 47 intended to remain flat will pass. The surface 51 in the bottom plate 43 is in the form of a recess or longitudinal groove, and the portion 53 of the top plate 44 sets within said groove, as shown in Figs. 7, 8, and 9. At the outer portion of the part 53 of the top plate 44 the metal is grooved out, as denoted at 54, this groove starting from the entrance end of the die and inclining inwardly and being undercut inwardly, as denoted by the dotted lines 55, Fig. 11, said groove 54 extending around the edge of the portion 53 to produce a gradually-enlarging cylindrical outline, as denoted by the successive illustrations in Figs. 6, 7, 8, 9, and Fig. 5. The groove 54 at its outer side or entrance edge is inclined inwardly correspondingly with the wall 52 of the bottom plate 43, and said groove by its gradually-increasing depth as it approaches the exit end of the die forms, in effect, a mandrel encompassed by the groove and around which the edge of the metal plate is curled. Those portions of the bottom plate represented by the surface 51 and wall 52 and of the top plate by the part 53 and groove 54 coöperate in the formation of the smaller locking member 49 of the piling-section 48, as may be clearly understood by an inspection of Figs. 6 to 9, inclusive, and Fig. 5. The straight left-hand edge portion of the plate 47 is deflected by the inwardly-inclined wall 52 upwardly into the groove 54 of the top plate 44, and as said plate 47 gradually advances through the die its said edge portion is compelled to follow the groove 54 and finally take a cylindrical form around the mandrel created by the increasing depth of said groove. I therefore during the progress of the metal plate along the inwardly-inclined wall 52 of the bottom plate 43 and inwardly-inclined groove 54 of the top plate 44 operate upon the left-hand edge portion of the metal plate 47 to coil said portion upwardly and inwardly to create the locking member 49.

The bottom plate 43 at its right-hand side looking at Fig. 10 is formed with a shaping-surface 56, which is broad and substantially flat at the entrance end of the die, and thence takes the form of a compound curve and inclines inwardly at one edge toward the exit end of the die, a groove 57 being formed along the outer edge of said shaping member 56 and which groove gradually increases in depth, as denoted by the dotted lines 58 in Fig. 10 and as shown by full lines in the successive illustrations presented in Figs. 6 to 9, inclusive. The form of the upper surface of the shaping member 56 is also clearly illustrated in Figs. 6 to 9, inclusive. That portion of the top plate 44 which matches the shaping member 56 of the bottom plate 43 is numbered 59, Fig. 11, and presents a curved surface conforming with the upper surface of said member 56, as shown in Figs. 6 to 9, inclusive, there being a space left between the parts 56 59 for the passage of the metal plate 47 through the die. During the travel of the plate 47 through the die its right-hand edge meets the inwardly-inclined wall of the groove 57 of the bottom plate 43 and is deflected downwardly into said groove, the inclination of said wall and the gradually-increasing depth of said groove and the increasing convexity of the member 56 compelling the right-hand portion of the plate 47 to become curled into the locking member 50.

In pulling or pushing the metal plate 47 through the die there would ordinarily be considerable friction generated between the hard metal and the converging and curved walls of the die, and considerable power would have to be exerted to pull or push the plate through the die; but in accordance with a part of my invention I obviate such friction and the expenditure of excessive power in effecting the travel of the plate through the die by providing within the die and along the outer edges of the metal-forming grooves at each side thereof a series of grooved wheels 60, the surfaces of which constitute portions of the surfaces of said grooves, as shown in Figs. 6 to 11, inclusive, and conform to the outline in cross-section thereof, and which wheels by engaging the outer edge portions of the metal plate 47 on its passage through the die facilitates such passage, relieving friction and enabling the movement of the plate with the minimum amount of power. The wheels 60 vary in thickness and in the shape of their annular grooves in accordance with their location and the character of the metal-forming grooves at the points at which they are situated, and, as may be observed in Figs. 10 and 11, the outer walls of the grooves 54 57 are cut away slightly adjacent to the said wheels, as at 61, so that the outer portions of the metal plate may exert their greatest strain while being shaped against the peripheries of said wheels.

The wheels 60 are secured upon vertical shafts 62, which extend upwardly through the die 21 and at their lower ends carry pinion-wheels 63, Fig. 1, engaged by worm-wheels 64 on a central longitudinal shaft 65, which by a train of gear-wheels 66 is connected with the main driving-shaft 32 and receives motion therefrom. The shaft 65, worms 64, pinion-wheels 63, and shafts 62 impart rotary motion to the wheels 60, which

rotate in a direction toward each other and carry their peripheral surfaces against and in the direction of the line of travel of the plates to be treated, thereby aiding in the movement of said plates, as well as in conforming their edge portions into the desired outlines.

It is not necessary that in every instance the wheels 60 should be driven by power, since the pressure of the edge portions of the traveling metal plate against them will effect their rotation; but when power is applied to the wheels 60 said wheels will perform their maximum duty in obviating friction and aiding in the movement of the plate through the die.

I designate the die 21 as the "primary" bending or forming tool, because I also employ a finishing die or block 67, through which the metal plate 47 is pulled and which is shown more clearly in Figs. 1, 2, 12, and 13. The die 67 is composed of matched lower and upper plates 68 69 and is secured upon the bed 20 at a suitable distance in advance of the primary die 21, so that an open space 70 may be left between said dies, within which space the metal plate issuing from the die 21 may, under such tension as it may possess, spring from the shape imparted to it by the die 21. The matrix portion of the finishing-die 67 constitutes a continuation of the matrix portion of the die 21, and the two dies are separated by the space 70 in lieu of being formed in one continuous body, so that the metal plate may, if it should be so disposed, distort itself within the space 70 prior to being subjected to the action of the die 67, this feature of the construction being desirable in the formation of the special piling-section illustrated in Fig. 18, in the formation of which the members 49 50 are of different configurations and on different curvatures and exert different resistances while passing through the dies at their opposite edge portions. I find that the locking member 50 of the piling-section 48 leaves the die 21 in substantially the finished condition shown in Fig. 18 and with little or no tendency to spring outwardly or open or distort itself within the space 70 between the dies, while at the same time the locking member 49 does show a tendency to spring or open outwardly within the said space, but entirely loses such tendency after it has been permitted to thus spring outwardly or distort itself within the open space 70 and is then moved through the die 67.

I preferably provide rods or mandrels 71 72, bridging the space 70 between the dies 21 67, upon which the curled members 49 50 of the metal plate travel from the die 21 to the die 67, these rods 71 72 being screwed into the end of the die 21, as shown in Fig. 3, within the outline of the curved forming-grooves in the die 21, as denoted in Fig. 5, so that as the metal plate issues from the die 21 its edge formations may naturally pass upon the said rods 71 72 and be guided thereby into the die 67. The rod 71 preferably continues entirely through the matrix portion of the die 67, as denoted by dotted lines in Figs. 1 and 12, and the rod 72 may extend through said die 67, although it is not necessary that it should do so, because the larger locking member 50 is not reduced in diameter on its passage through the die 67, but remains of the same diameter it possessed upon issuing from the die 21. The locking member 49 is, however, more closely coiled during its passage through the die 67, and hence it is desirable that the rod 71 extend through said die, so that it may constitute a mandrel around which the walls of said member 49 may be forced by the converging walls of the matrix of said die 67.

The die 67 is formed with a longitudinal groove 73 in line with the passage 46 through the die 21, so as to permit of the proper movement of the grip devices presently to be described.

The matrix portion of the die 67, located at the right of the groove 73, looking at Fig. 13, corresponds with that portion of the exit 45 of the die 21 located at the right of the passage 46 through said die 21, looking at Fig. 5, the groove 54 of the die 21 being, in effect, continued through the die 67 and within said die presenting straight parallel surfaces. That portion of the matrix of the die 67 at the left of the passage 73 looking at Figs. 12 and 13 is of substantially cone shape, with a straight wall 74 at its outer side, as indicated by dotted lines in Fig. 12, and forwardly-converging walls 75 at its other sides. The mandrel 71 is parallel with the straight wall 74, and said wall assures the formation of a straight edge at the side of the piling, while the converging walls 75 operate to further close the coil for the locking member 49 around the mandrel 71, so that when the metal plate leaves the die 67 the locking member 49 may be of the form shown in Fig. 16, said member forming a substantially closed tube.

The die or finishing-block 67 thus receives the metal plate from the die 21 and its main duty is to preserve the formation of the locking member 50 as created by the die 21 and close the locking member 49 to its finished condition and also to deprive said member of the tendency to distort itself it possessed immediately on leaving the die 21. In the formation of the metal plate into the piling-section said section is approximately finished in the die 21 and is completed, especially as to the locking member 49 in the die 67, said member 49 being reduced in diameter and closed on its passage through the die 67. The form and diameter of the locking member 49 as it leaves the die 21 is clearly represented by the form of the exit-opening

at the left-hand portion of Fig. 5, and the form of the locking member 49 as it leaves the die 67 is represented by the left-hand portion of the exit-opening represented in Fig. 13.

The grip devices are shown more clearly in Figs. 1, 14, and 15 and comprise a base member 76 to pass below the metal plate 47 to be treated and an upper member 77, which is bifurcated at its rear portion and has pivotally secured between its arms some eccentric dogs 78 to engage the upper surface of the plate 47 and compel it to follow the grip device as the latter is engaged in pulling the same. Between the outer bifurcated arms of the member 77 is hinged a bar 79, which corresponds with the general outlines of the tail portion of the lower member 76 and is adapted to lie upon the metal plate 47. At the forward end of the grip is provided a vertical bolt 80 to receive the end of the chain 28, connected with the sprocket-wheel 29. The grip shown, with its tail portion and hinged bar 79 in cross-section, corresponds with the outline of the groove 46, extending through the die 21, and groove 73, extending through the die 67, and is adapted to fill said grooves and also in the present instance to engage the full length of the plate 47 to be pulled through the machine. The grip and its parts are adapted to travel in the grooves 26 27 of the bed-plate at opposite ends of the machine.

In the operation of the machine the chain 28 is loosened from the sprocket-wheel 29 and the grip and its parts are pushed through the dies 67 21 and into and along the groove 26 at the receiving end of the machine until the hinged bar 79 has passed sufficiently beyond the shaft 37 to permit it to be turned upwardly, and thereupon the plate 47 to be treated is fed upon and to the grip and said bar 79 turned downwardly upon the same, as shown in Fig. 15. The chain 28 is thereupon restored to the sprocket-wheel 29, and power is applied through the belt-wheel 31 to the shaft 32 and mechanism connected with said shaft, with the result that the sprocket-wheel 29 will act through the chain 28 to pull the grip and the plate 47 into engagement with the feed-rollers 35 36 and thence into and through the dies 21 67. The feed-rollers 35 36 facilitate the movement of the plate through the dies, and the grooved wheels or rollers 60 coöperate in shaping the plate and moving the same through the dies. The plate 47 is fashioned by the dies 21 67 during its travel through the same in the manner hereinbefore explained in detail. The grip and its parts may be pushed entirely through the die 21 to engage the plate 47, and this is a feature of great benefit, since thereby the plate at its advancing end may be of full width in lieu of being cut into a long and tapering outline and pushed through the die or dies to the grip. The grip and its coacting parts fill the groove 46 in the die 21 and groove 73 in the die 67 during the fashioning of the plate 47 in said dies, and this is of great advantage, since otherwise said plate, due to the edge pressure on the same, would likely buckle up within said grooves.

I have illustrated my invention as embodied in a machine for producing the special sheet-piling sections shown, but do not confine the same to the production of metal sheet-piling nor in every instance to the special matrix formations provided within the dies 21 67, since the machine may be employed for bending or fashioning metal plates to be used otherwise than for piling and also for the production of piling-sections varying in their outlines from those illustrated in the drawings. With each change of shape in the outlines of the metal sheet-piling the matrix portions of the dies must vary accordingly. Nor do I limit the invention in every instance to the employment of the die 67, but in instances in which the outline of the piling-section is such that the metal plate exerts unequal resistances during its passage through the die 21 and is likely to distort itself after leaving said die I recommend the employment of the die 67 and its separation by an open space from the die 21, so that the advancing end of the metal plate may spring from the intended shape as much as may be before it is subjected to the setting and finishing action of the die 67. The "space" between the dies 67 21 is described as open because it permits the metal plate to distort itself at said space, the metal being there relieved from the restraint of the close matrix forming-surfaces of the die 21; but it is to be understood that the same space would exist if the dies 67 21 were in one continuous body with the space formed at the proper place within the same to grant said relief to the metal plate.

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

1. In a metal-plate bending or forming machine, a die through which the plate is to be passed for shaping the same, and a grip device for engaging the upper and lower surfaces of said plate at the entrance end of said die and pulling the plate through said die, said die having a longitudinal groove extending above and below the passage through it for the plate through which the grip may travel; substantially as set forth.

2. In a metal-plate bending or forming machine, a die through which the plate is to be passed for shaping the same, and a grip device for engaging the plate and pulling it through said die, said die having a groove through it through which the grip may be moved, combined with means for keeping

said groove filled during the travel of the plate so that the latter may not crowd therein; substantially as set forth.

3. In a metal-plate bending or forming machine, a die through which the plate is to be passed for shaping the same, and a grip device for engaging the plate and pulling it through said die, said die having a groove through it through which the grip may be moved, and said grip device being adapted to engage the full length of the plate and keep said groove filled during the travel of the plate; substantially as set forth.

4. In a metal-plate bending or forming machine, a die through which the plate is to be passed for shaping the same, and a grip device for engaging the plate and pulling it through said die, said die having a groove through it through which the grip may be moved, and said grip comprising a lower member having an extended tail portion, an upper member having means for engaging the plate, and a hinged member over said tail portion; substantially as set forth.

5. In a metal-plate bending or forming machine, a die through which an initially flat metal plate is to be passed for shaping the same and which die has a matrix adapted to coil the opposite edges of said plate and preserve that portion of same between the coiled edges flat, means for moving the plate through said die, and a finishing-block through which the plate is passed after leaving said die, a free space being left between said die and block for said coiled edges of the plate to spring from the shape intended for them if they should be so inclined; substantially as set forth.

6. In a metal-plate bending or forming machine, a die through which the plate is to be passed for shaping the same, means for pulling the plate through said die, and a finishing-block through which the plate is pulled after leaving said die, said block being separated by a space from said die, and said die and block having a groove through them through which the means for pulling the plate may pass; substantially as set forth.

7. In a metal-plate bending or forming machine, a die through which the plate is to be passed for shaping the same, means for pulling the plate through said die, and a finishing-block through which the plate is pulled after leaving said die, said block being separated by a space from said die, and said die and block having a groove through them through which the means for pulling the plate may be passed for engaging the plate at the entrance end of said die, combined with means for keeping said groove filled during the travel of the plate so that the latter may not crowd therein; substantially as set forth.

8. In a metal-plate bending or forming machine, a bed, a die mounted thereon through which the plate is to pass for becoming shaped, and a grip device for engaging the plate and pulling it through said die, said die having a groove through it through which the grip may be moved for engaging the plate at the entrance end of said die, and said bed having longitudinal alined grooves for said grip device at opposite ends of said die, a recess of the width of the plate to be treated at the entrance end of said die and a recess of the width of the finished product at the delivery end of the machine; substantially as set forth.

9. In a metal-plate bending or forming machine, a die through which an initially flat metal plate is to be passed for shaping the same and which die has a matrix adapted to coil the opposite edges of said plate and preserve that portion of same between the coiled edges flat, and a grip device for engaging the upper and lower surfaces of said plate at the entrance end of said die and pulling the plate through said die, said die having a longitudinal groove extending above and below the passage through it for the plate through which the grip device may travel; substantially as set forth.

10. In a metal-plate bending or forming machine, a die through which an initially flat metal plate is to be passed for shaping the same and which die has a matrix adapted to turn the opposite side edges of the plate in a direction from the face of the plate and coil said edges into tubular form, while preserving that portion of the plate between the coiled edges flat, and a grip device for engaging the upper and lower surfaces of said plate at the entrance end of said die and pulling the plate through said die, said die having a longitudinal groove extending above and below the passage through it for the plate through which the grip device may travel; substantially as set forth.

11. In a metal-plate bending or forming machine, a die through which an initially flat metal plate is to be passed for shaping the same and which die has a matrix adapted to gradually turn the opposite edges of the plate in a direction from the face of the plate and coil the same into tubular form, while preserving that portion of the plate between the coiled edges flat, one of said coils being turned inwardly over upon the surface of the plate, while the other projects outwardly beyond the edge of the body portion of same, combined with a grip device for engaging the upper and lower surface of said plate and pulling the same through the die; substantially as set forth.

12. In a metal-plate bending or forming machine, a die through which an initially flat metal plate is to be passed for shaping the same and which die has a matrix possessing converging forming-surfaces at its sides to gradually coil the opposite edges of said plate, while preserving that portion of the

plate between the coiled edges flat, combined with wheels mounted within said die with their peripheral edges in line with and constituting portions of the said forming-surfaces, and a grip device for engaging the metal plate at the entrance end of said die and pulling the plate through said die, said die having a longitudinal groove extending above and below the passage through it for the plate through which the grip may travel; substantially as set forth.

13. In a metal-plate bending or forming machine, a die through which the plate is to be passed for shaping the same, the matrix portion of said die having converging forming-surfaces to act upon said plate, combined with wheels mounted within said die with their peripheral edges constituting a portion of the die-forming surfaces, means for rotating said wheels, and means for moving the plate through the die; substantially as set forth.

14. In a metal-plate bending or forming machine, a die through which an initially flat metal plate is to be passed for shaping the same and which die has a matrix possessing converging concave forming-surfaces at its sides to gradually coil the opposite edges of said plate, while preserving that portion of the plate between the coiled edges flat, combined with wheels having concave peripheries mounted within said die with their peripheral edges in line with and constituting portions of the said forming-surfaces, and a grip device for engaging the metal plate at the entrance end of said die and pulling the plate through said die, said die having a longitudinal groove extending above and below the passage through it for the plate through which the grip may travel; substantially as set forth.

15. In a metal-plate bending or forming machine, a die through which the plate is to be passed for shaping the same, the matrix portion of said die having converging concave forming-surfaces to act upon said plate, combined with wheels having concave peripheries mounted within said die to form parts of said forming-surfaces, means for rotating said wheels, and means for moving the plate through the die; substantially as set forth.

16. In a metal-plate bending or forming machine, a die through which an initially flat metal plate is to be passed for shaping the same and which die has a matrix possessing forming-surfaces at its sides to act upon the opposite edges of said plate, while preserving that portion of the plate between the edges flat, combined with wheels mounted within said die with their peripheral edges constituting portions of said forming-surfaces, and a grip device for engaging the metal plate at the entrance end of said die and pulling the plate through said die, said die having a longitudinal groove extending above and below the passage through it for the plate through which the grip may travel; substantially as set forth.

17. In a metal-plate bending or forming machine, a die through which the plate is to be passed for shaping the same, the matrix portion of said die having forming-surfaces to act upon said plate in shaping the same, combined with wheels mounted within said die with their peripheries constituting a portion of said surfaces, means for rotating said wheels, and means for moving the plate through the die; substantially as set forth.

18. In a metal-plate bending or forming machine, a die through which an initially flat metal plate is to be passed for shaping the same and which die has a matrix possessing at its opposite sides converging forming-grooves whose surfaces engage and shape the edge portions of the plate and which grooves gradually increase in depth toward the exit end of the die, and said die being adapted to preserve that portion of the plate between the coiled edges flat, combined with a grip device for engaging the upper and lower surfaces of said plate at the entrance end of said die and pulling the plate through said die; substantially as set forth.

19. In a metal-plate bending or forming machine, a die through which an initially flat metal plate is to be passed for shaping the same and which die has a matrix possessing at its opposite sides converging forming-grooves whose surfaces engage and shape the edge portions of the plate and which grooves gradually increase in depth toward the exit end of the die, and said die being adapted to preserve that portion of the plate between the coiled edges flat, combined with a second die set in advance of said first-mentioned die and having matrix forming-surfaces to further act upon an edge portion of the plate, and a grip device adapted to engage the upper and lower surfaces of the plate at the entrance end to the first-mentioned die and pull the plate through both of said dies, said dies having a longitudinal groove extending above and below the passage through them for the plate through which the grip may travel; substantially as set forth.

20. In a metal-plate bending or forming machine, a die through which the plate is to be passed for shaping the same, the matrix portion of said die having converging forming-grooves whose surfaces engage and shape the edge portions of the plate and which grooves gradually increase in depth toward the exit end of the die, combined with a second die set in advance of said first-mentioned die and having matrix forming-surfaces to further act upon the edge portions of the plate, rods bridging the space between said dies within the outline of the curved portions of the matrices of same so as to receive

and guide the coiled edge portions of the plate during the travel of the latter, and means for moving the plate through said dies; substantially as set forth.

21. In a metal-plate bending or forming machine, a die through which an initially flat metal plate is to be passed for shaping the same and the matrix portion of which die has at its opposite sides converging forming-grooves which gradually increase in depth to shape the edge portions of the plate, while preserving that portion of the plate between the coiled edges flat, one of said grooves being extended outwardly and thence laterally inwardly on a curved line to coil one edge of the plate over upon the body of same, and the other groove being extended outwardly and thence laterally beyond the body of the plate and thence inwardly on a curved line to coil the other edge of the plate and carry the outer portion of the coil beyond the edge of the flat portion of the plate, combined with means for moving the plate through said die; substantially as set forth.

22. In a metal-plate bending or forming machine, a die through which the plate is to be passed and whose matrix portion at its opposite edges has converging forming-grooves to shape the edge portions of the plate, said grooves gradually increasing in depth and one of said grooves being extended upwardly and inwardly on a curved line and the other downwardly and inwardly on a curved line, combined with a second die set in advance of said first die and having at the opposite edges of its matrix curved surfaces to receive the edge portions of the plate, the surfaces at one edge of said matrix being on converging lines to further coil the edge of the plate, and means for moving the plate through said dies; substantially as set forth.

23. In a metal-plate bending or forming machine, a die through which the plate is to be passed and whose matrix portion at its opposite edges has converging forming-grooves to shape the edge portions of the plate, said grooves gradually increasing in depth and one of said grooves being extended upwardly and inwardly on a curved line and the other downwardly and inwardly on a curved line, combined with a second die set in advance of said first die and having at the opposite edges of its matrix curved surfaces to receive the edge portions of the plate, the surfaces at one edge of said matrix being on converging lines and encompassing a core to further coil the edge of the plate, and the surfaces at the other edge of said matrix being substantially straight and extending around a core, and means for moving the plate through said dies; substantially as set forth.

Signed at New York city, in the county of New York and State of New York, this 8th day of October, A. D. 1906.

JOHN R. WILLIAMS.

Witnesses:

CHAS. C. GILL,

ARTHUR MARION.