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APPARATUS FOR FORMING A CONTINUOUS ROD OF COMPRESSIBLE MATERIAL

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5 Sheets-Sheet 2

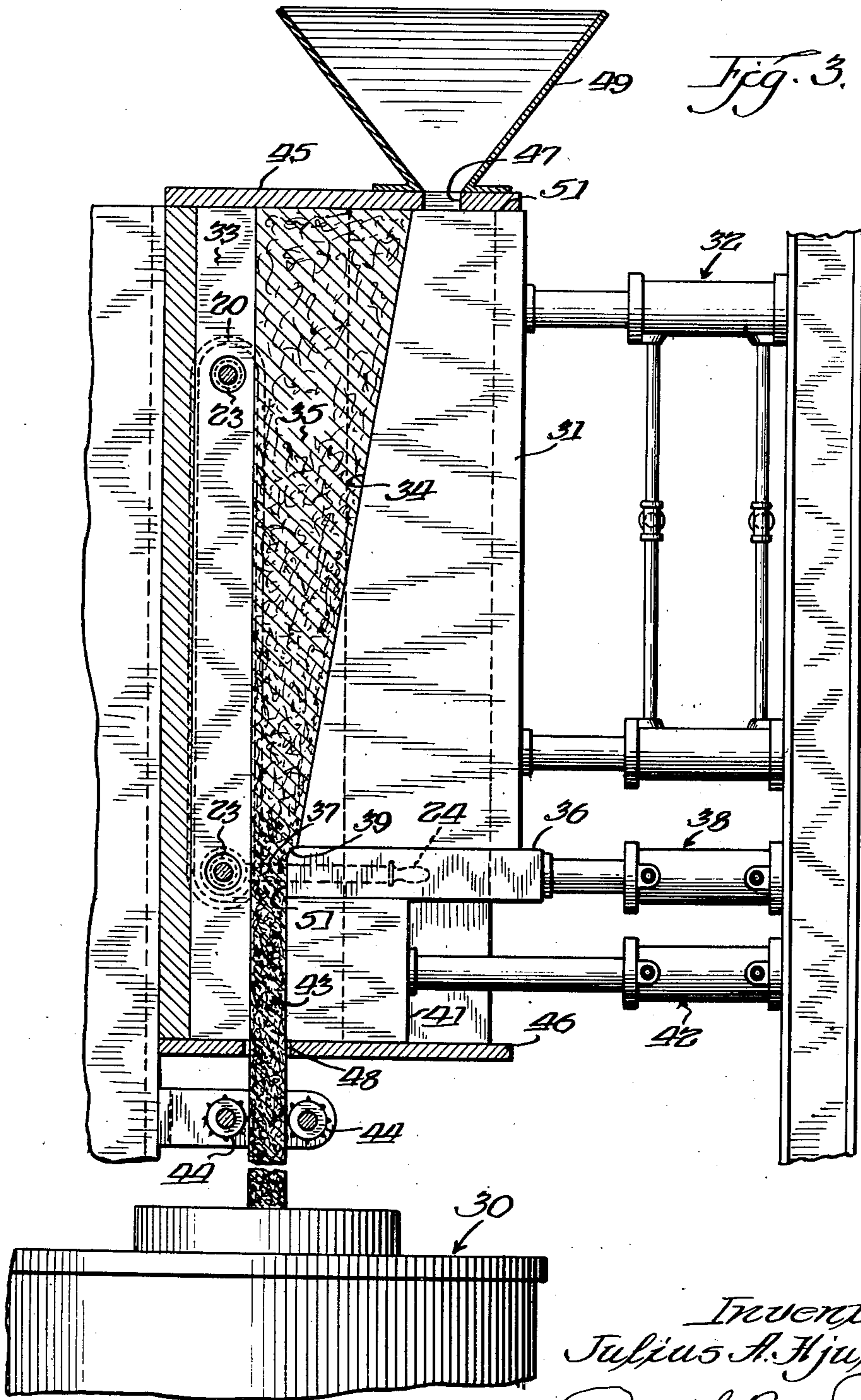


Fig. 3.

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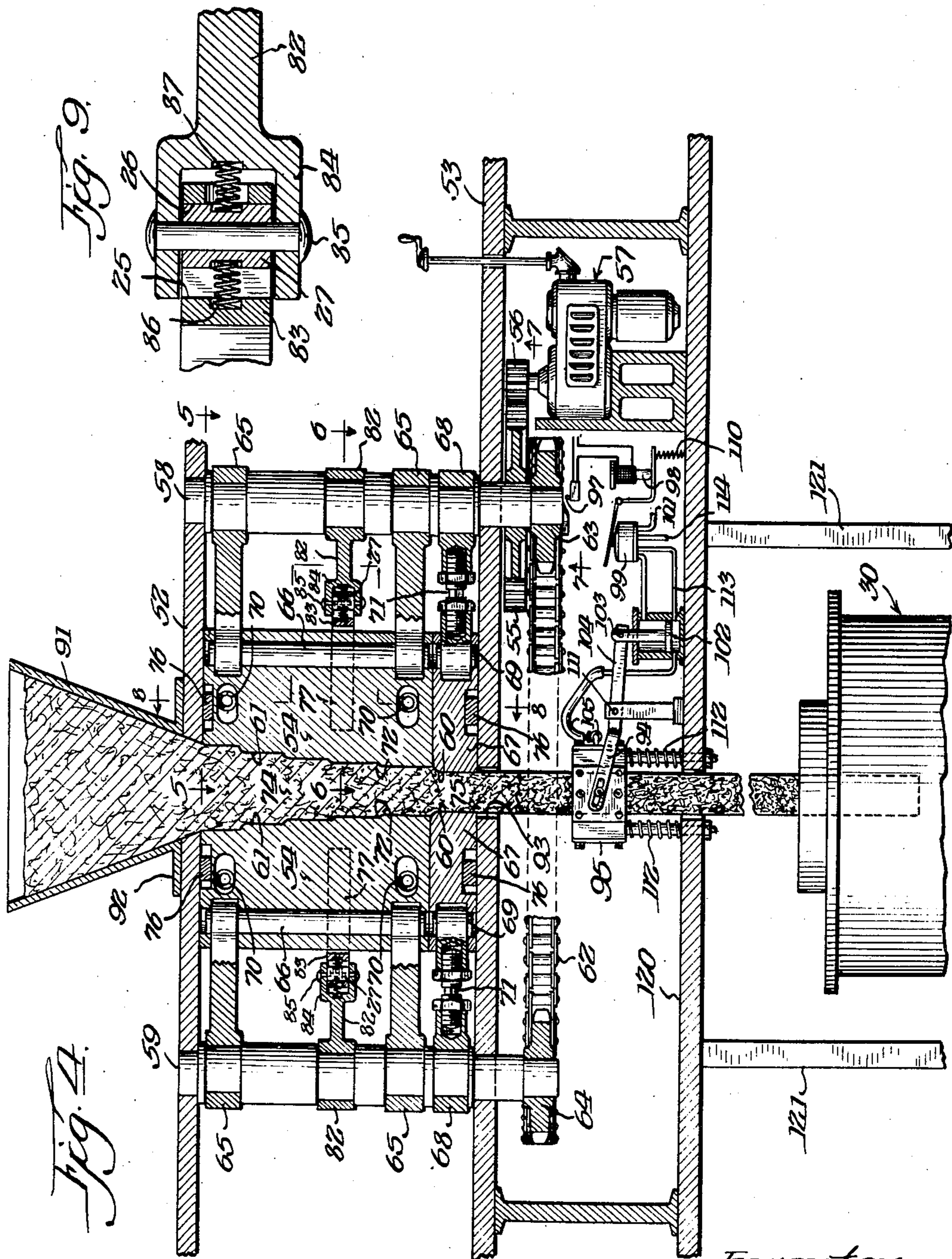


Fig. 9.

Fig. 1.

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5 Sheets-Sheet 4

Fig. 5.

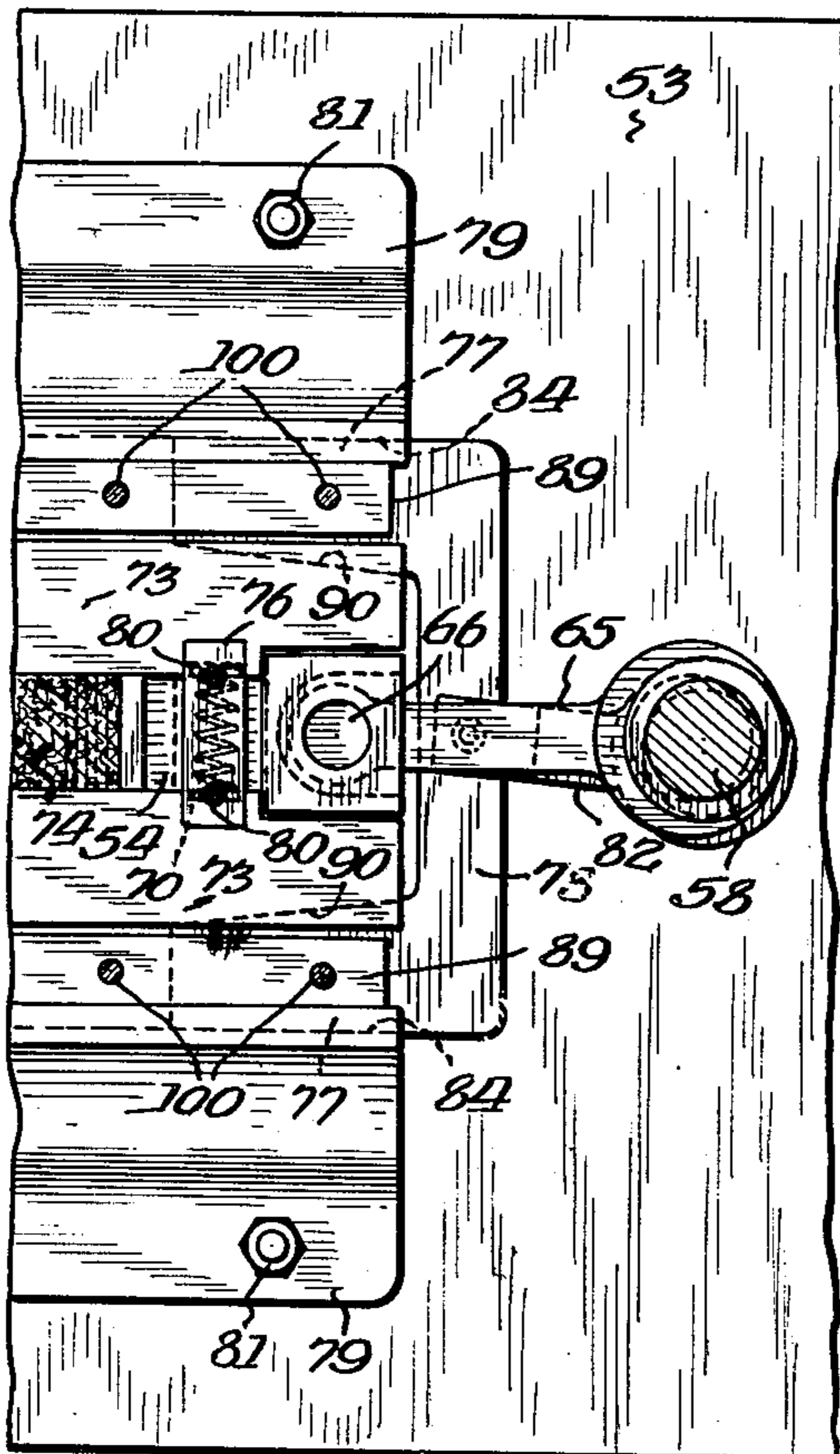


Fig. 6.

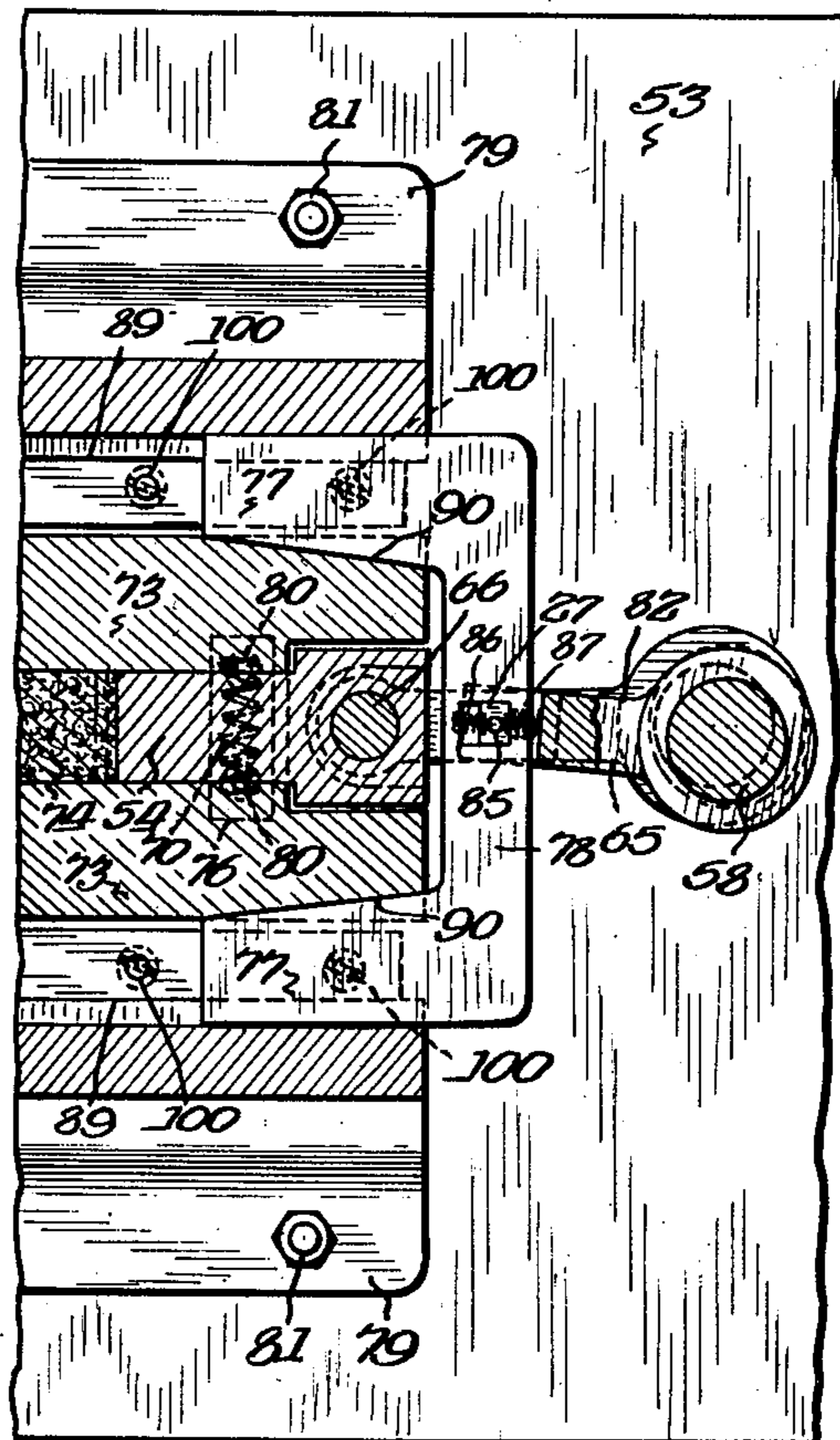
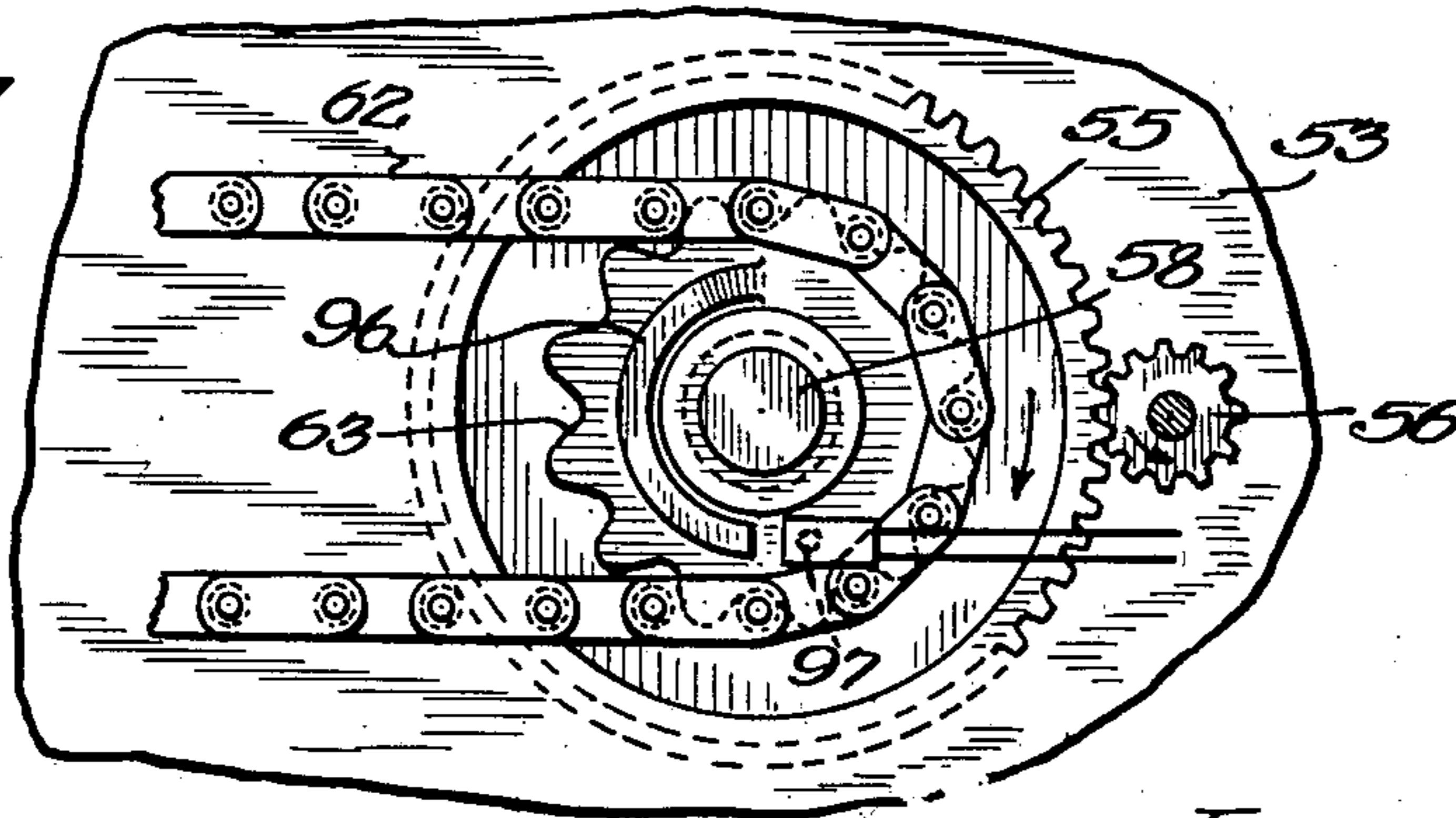


Fig. 7.



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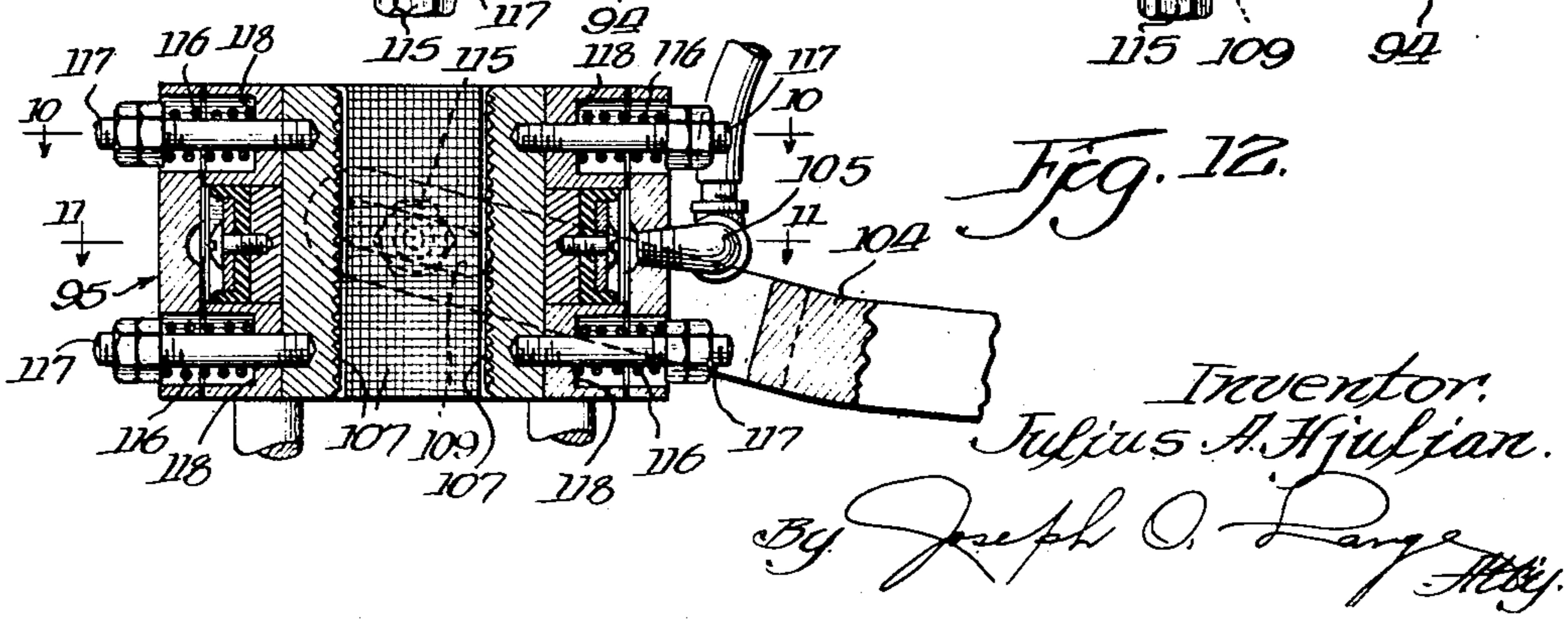
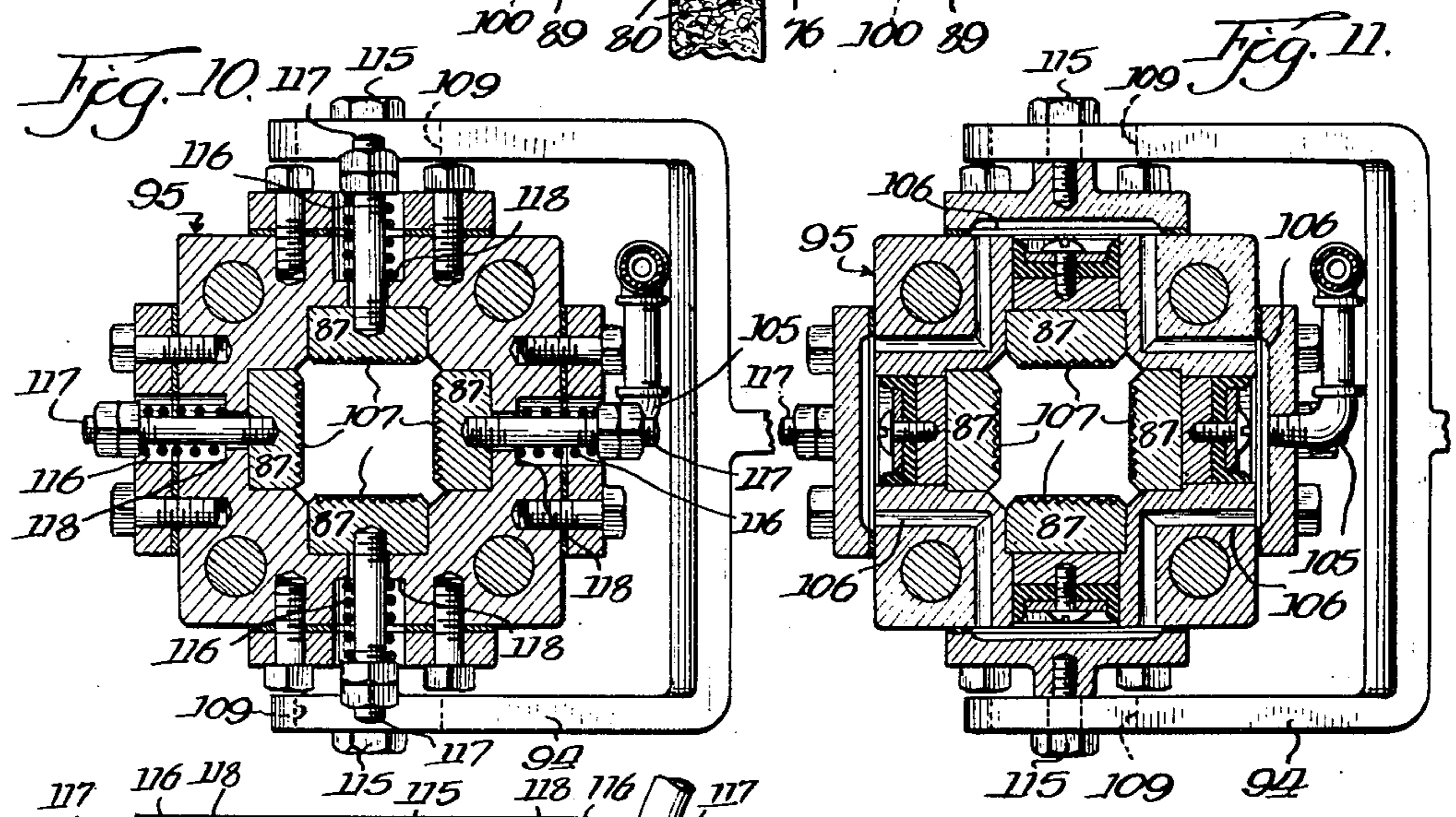
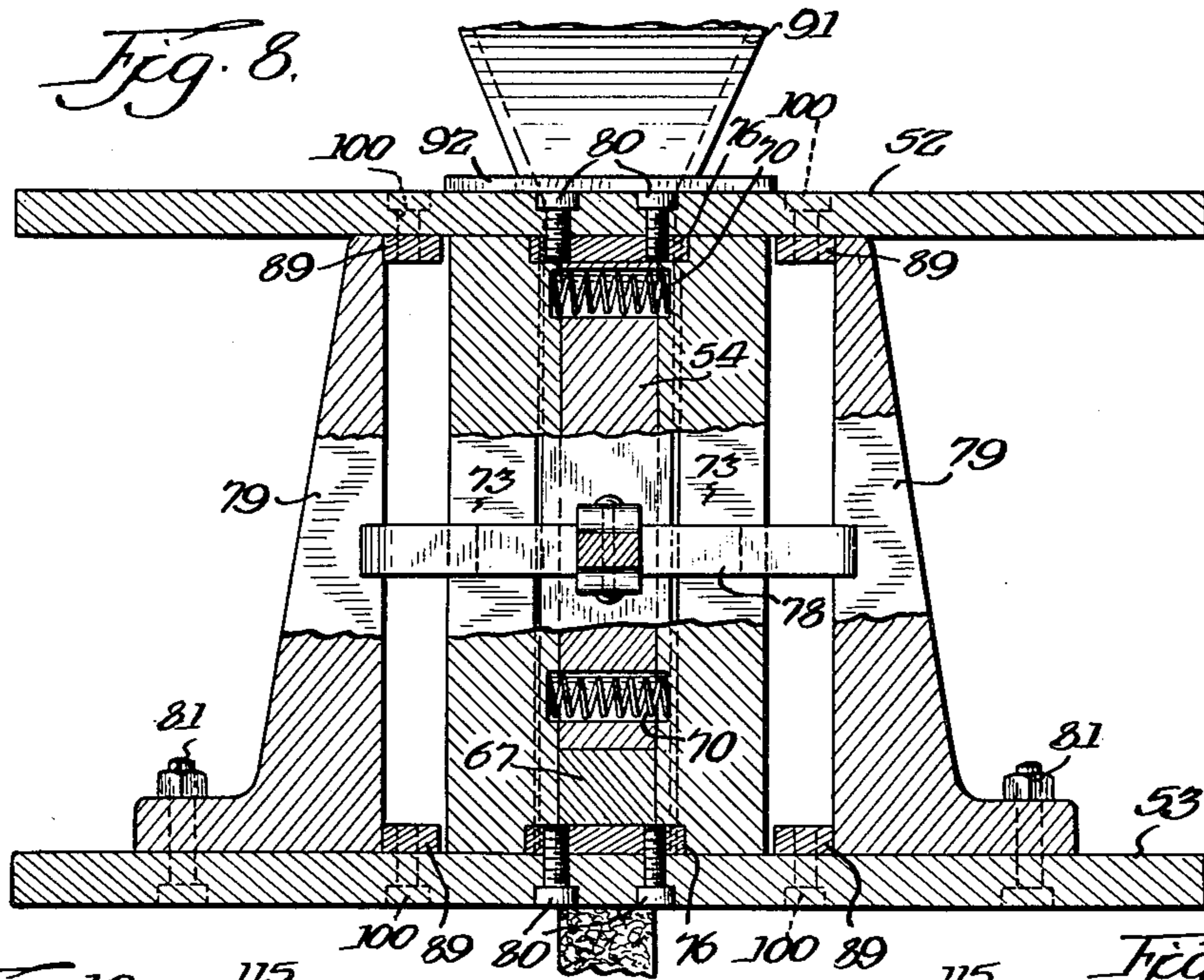
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5 Sheets-Sheet 5



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APPARATUS FOR FORMING A CONTINUOUS ROD OF COMPRESSIBLE MATERIAL

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Application March 8, 1954, Serial No. 414,751

6 Claims. (Cl. 18—12)

The present invention pertains to a method and apparatus for forming a continuous rod of compressible material, and more particularly, it relates to a method of forming a consumable electrode from titanium sponge metal or the like.

In explanation of the background of my invention, it should be noted that heretofore in the art of titanium sponge melting the utilization of electrodes in the electric arc furnace of materials other than titanium itself, usually tungsten, oftentimes resulted in contamination of the resulting titanium ingot. This was mainly occasioned by the formation of low-melting tungsten alloys which ran from the electrode into the melt below with deleterious consequences being imposed on the working properties of the resulting ingot. The alloying metal usually consisted of an impurity in the tungsten electrode, such as nickel, or titanium itself which splattered from the liquid ingot surface as a result of the liberation of trapped gases within the sponge. To obviate these sources of contamination, a consumable electrode of titanium metal itself was utilized assuring an ingot of the highest impurity.

The employment of the consumable titanium electrode, however, was accompanied by difficulties well known to producers of this refractory metal. The abrasive nature of the basic commercial form of the metal, titanium sponge, barred the feasibility of extruding through a die orifice because of the exceedingly limited die life. Consequently, this mode of formation was objectionable from an economic viewpoint. Other attempted solutions to the problem of consumable electrode formation consisted in the sintering of rods of loosely compacted sponge to effect greater strength and rigidity, followed by the welding together of the individual rods. The non-uniform nature of the welded electrode, however, often resulted in burning during the melting operation because of the varied resistance throughout the electrode length.

It is an object therefore of my invention to present a method and apparatus for forming a continuous electrode of titanium sponge or like compressible material which may be infinite in length and which possesses such rigidity and strength as to require no further processing prior to insertion in electric arc furnace.

It is a further object of my invention to present an apparatus for electrode formation which owing to its unique mode of compression extends the die life while enabling the operator to obtain an electrode of any practical density or cross-sectional configuration.

These and further objects will become more apparent upon proceeding with the following detailed description read in the light of the accompanying drawings, in which:

Fig. 1 is a fragmentary longitudinal sectional view of a continuous rod forming apparatus and cooperating hydraulic ram taken on line 1—1 of Fig. 2.

Fig. 2 is a sectional view taken on line 2—2 of Fig. 1, showing the apparatus driving means in elevation.

Fig. 3 is a sectional view of a modified continuous rod forming apparatus showing the hydraulic punch reciprocating members in elevation.

2

Fig. 4 is a sectional view partly in elevation of a third modified continuous rod forming apparatus.

Fig. 5 is a fragmentary sectional view taken on line 5—5 of Fig. 4.

Fig. 6 is a fragmentary sectional view taken on line 6—6 of Fig. 4.

Fig. 7 is a fragmentary bottom plan view taken on line 7—7 of Fig. 4.

Fig. 8 is a fragmentary sectional view partly in elevation taken on line 8—8 of Fig. 4.

Fig. 9 is an enlarged fragmentary sectional view of the punch member expansible joint.

Fig. 10 is a sectional view of the expansible electrode gripping means taken on line 10—10 of Fig. 12.

Fig. 11 is a sectional view taken on line 11—11 of Fig. 12 of the expansible electrode gripping means.

Fig. 12 is a sectional view of the expansible electrode gripping member.

Similar reference numerals refer to similar parts throughout the several views.

Referring now to the drawings and particularly to Figs. 1 and 2, a rod-forming apparatus is depicted comprising an expansible matrix member having twin half portions 1 as seen more clearly in Fig. 2. End plates 2 and 3 define the end limits of the compression chamber 4 in which the titanium sponge or other compressible material is compacted by means of the reciprocating strokes of the punch members 5. The compacting surfaces 6 of the punch members 5 define the upper variable end limit of the compression chamber 4, the inner surface 7 of the matrix halves 1 defines the remainder of the chamber cross-sectional periphery.

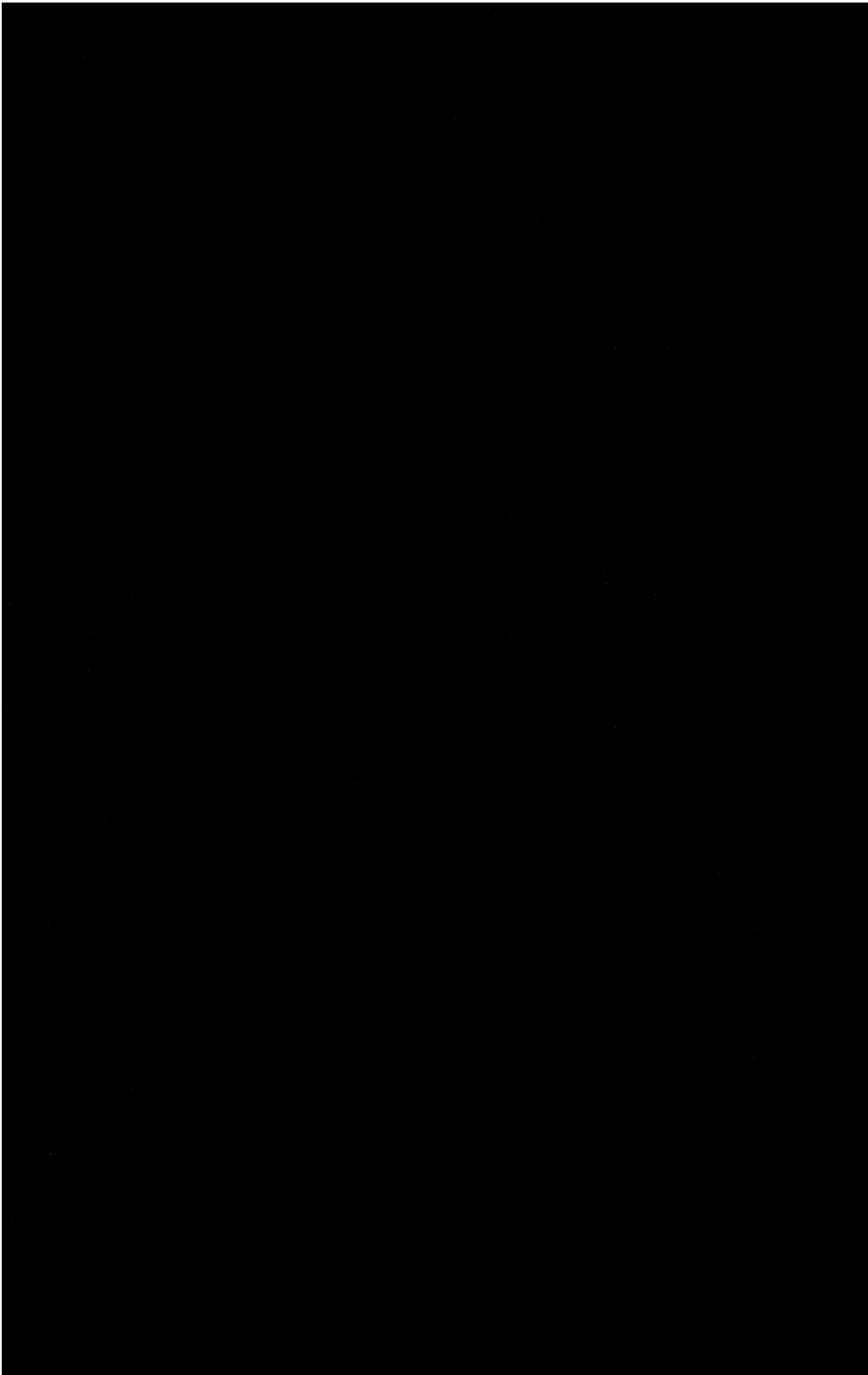
The matrix member and punch member assembly is fixedly positioned in cradle member 8 as illustrated in Fig. 2. The entire assembly is reciprocally and slidably movable on tracks 9 by means of the pinion 11 which is keyed to shaft 18 journaled in foundation 15. The pinion 11 engages the rack 12 attached to the underside of the cradle member 8 and is rotated by gear 13 which is in turn driven by the motor and speed reducer unit 14.

As depicted in Fig. 1, the entire cradle and punch assembly reciprocally moves beneath the hydraulic ram unit 16. Reciprocating ram member 17 alternately drives each of the punch members 5 into the compression chamber 4 thereby compacting small segments of the sponge material with the entire force generated by the hydraulic unit 16.

In the process of compacting the sponge metal, it should be understood that the punches 5 may exercise their compression strokes in any given sequence. Care should be taken, however, to prevent any one punch member from cutting so deep into the sponge as to create a cleavage which will extend into the mass of the finally compacted rod, thereby impairing the inherent strength of the finished electrode. The compressing strokes exerted on the sponge by the punches 5 should therefore be uniform and of gradually increasing magnitude throughout the rod-forming operation.

As will be further noted from Fig. 1, end plate 3 is apertured at 19. A flanged plug 21 is inserted in aperture 19 and fixedly maintained to end plate 3 by bolt members 22. Flanged plug 21 prevents longitudinal expansion of the partially formed rod through aperture 19 during the compacting action of the punches 5. Following formation of the rod in chamber 4, the flanged plug 21 is removed and the completely compacted and formed electrode segment is ready for withdrawal through the aperture 19.

Following formation of the electrode segment in compression chamber 4, it is readily appreciated that the compacted sponge material is tightly wedged between the matrix halves 1. The matrix member is longitudinally



Following the deposition of additional sponge in compression chamber 35, holding punch member 41 engages the recently compacted electrode portion in holding chamber 43; the forming punch member 36 then executes its compacting stroke followed by the compacting stroke of compression punch 31. The newly added sponge is knitted into the previous integrated sponge mass thus enabling a continuous rod or electrode to be formed by a repetition of the above steps.

Attention is directed to the limited face area 51 of forming punch member 36 which enables a comparatively small power source 38 to form a highly compact, continuous rod by virtue of the effective high concentration of compacting force per unit area.

It is apparent that the final electrode cross-sectional configuration is determined by the sponge contacting surfaces of matrix members 33, forming punch 36 and holding punch 41. Edge 34 of the surface of compression punch 31 may be of any practical configuration as it will not affect the final electrode cross-sectional configuration.

It is, of course, readily understood that the illustrated apparatus must be appropriately insulated and an electrical connection effected with the consumable electrode before arcing in the furnace takes place.

Referring now to Fig. 4, a third modification of a continuous rod forming apparatus is depicted comprising opposed compression punch members 54 having compacting surfaces 61 arranged in step-like configuration and joined by fillet portions 72. It is apparent that the purposes of the fillet portions is to obviate cleavages in the electrode cross section which may occur if sharp shoulders were present. Punches 54 may be reciprocally movable by means of the motor and speed reducer unit 57 or other suitable power means. The unit 57 rotatably engages the gear member 55, by means of interposed gear 56, which in turn transmits the rotating power to the twin eccentric shaft members 58 and 59 which are journaled at opposite end limits in cover plate 52 and floor plate 53. Drive chain 62 engaging sprocket wheels 63 and 64 affixed to the lower end limits of eccentric shaft members 58 and 59 assures uniform rotation of the eccentric shaft members and as a consequence, uniform reciprocal movement of the twin compression punch members 54.

The rotary movement of the eccentric shaft members 58 and 59 is translated into reciprocal punch member movement by means of the connecting arm members 65 which are pivotally journaled at one end limit to the eccentric shaft members 58 and 59 and similarly journaled at the opposite end limit to the shaft members 66 which are housed in the die members 54.

Twin forming punch members 67 are reciprocally movable by means of the expansible connecting arm members 68 which are pivotally journaled at one end limit to eccentric shaft members 58 and 59 and similarly journaled at the opposite end limit to the shaft portion 69. The threaded coupling portion 71 allows the length of the connecting arm 68 to be regulated at will.

Thus, the final cross-sectional configuration of the compacted rod or electrode is readily changeable by a simple replacement of the punches 67, and the final density of the compacted rod or electrode is easily controllable by an extension or retraction of the coupling portion 71.

Referring more particularly to Figs. 5 and 6, it will be noted that compression punch members 54 slidably engage wall members 73 and cooperate therewith to form a compression chamber 74. Forming punch members 67 similarly coact with the wall members 73 to effect a forming chamber 75 which is a continuation of the compression chamber 74 more clearly seen in Fig. 4. Spacer plates 76 are affixed by means of the tap bolts 80 as illustrated in Fig. 5, or other suitable means to the cover plate 52 and to the floor plate 53 and maintain the wall members 73 in spaced-apart relationship during the compacting stroke of compression punch members 54 and forming punch members 67. Thus, a slide fit

between said punch members and wall members 73 is assured with a minimum of friction and wear being effected on the slidably engaging surfaces.

Prior to the inward movement of the punch members 54 and 67, wedge members 77 formed integral with yoke member 78 slidably advance in channel portion 84 of anchor plates 79 and channel portion 90 of wall members 73 forcing anchor plates 79, which are affixed by tap bolts 81 or other suitable means to floor plate 53, and reciprocally movable wall members 73 into a predetermined spaced-apart relationship. Thus, the wall members are firmly positioned against the spacer plates 76 during the compression and forming action taking place in chambers 74 and 75 which chambers they define in part. The spring members 70 are obviously forced to contract during this movement by virtue of the sidewise wedging action being exerted by wedge members 77 on wall members 73.

Particular notice will now be given to Fig. 9 in which the expansible joint interposed between wedge yoke member 78 and connecting arm 82 is illustrated. The tongue portion 83 of the yoke member 78 slidably engages the forked end portion 84 of connecting arm 82. Slide block 27 is maintained pivotally movable relative to the forked portion 84 by means of pin member 85 and is free to slide during the normal course of operation in the yoke member channel which has end limits defined by walls 25 and 26. As has been stated, wedge members 77 should have the wall members 73 in the rigid, compression-chamber-forming position upon occurrence of the compression stroke of punch members 54. Consequently, the wedges must enter before the punch members and remain during the compression stroke. It is thus apparent that a delaying device must be resorted to in order to enable the stay of wedges 77 in the anchor plate and wall member channels to be prolonged.

As will be noted from Fig. 4, the yoke connecting arm 82 is journaled to eccentric shaft members 58 and 59 so as to force wedges 77 to slidably engage the wedging channels 84 and 90 (see Fig. 5) before the connecting arm members 65 and 68 force the punch members 54 and 67 to execute their compression strokes. The wedges 77 therefore first advance inwardly. As the shafts 58 and 59 continue to rotate, the yoke connecting arms 82 start to retract. Before wedges 77 begin to retract, however, it will be noted from Fig. 9 that slide block member 27 which is at this time in close proximity to the channel surface 25 must first travel the interposed channel distance between walls 25 and 26 in opposition to spring member 87. In the course of the latter movement, punch members 54 and 67 are executing their compression strokes. After the strokes are completed, the slide member 27 abuts the channel surface 26 at which instant of contact the wedge members 77 and integral yoke 78 are positively withdrawn.

Thus, it is apparent that by employing the expansible joint illustrated in Fig. 9, a delayed-action retraction of wedges 77 is made possible.

Following the compression stroke, the wedge members 77 are retracted from their position between the wall members 73 and anchor plates 79 just prior to the retraction of punch members 67 and 54 by connecting arms 68 and 65. Referring now to Fig. 8, it will be noted that upon withdrawal of wedge members 77, the spring members 70 positioned between and housed at either end limit in opposed wall members 73 force the wall members apart against spacer plate members 89 affixed to cover plate 52 and floor plate 53 by tap bolts 100 or other suitable means.

In the course of the punch member retraction operation, compressible material from which the continuous rod or electrode is to be formed is deposited in the hopper 91 which is affixed to cover plate 52 by means of the flange 92 or other suitable means of attachment. The sponge is then allowed to fill the space in compression

closed herein but is to be accorded the full scope of the claims so as to embrace any and all equivalent devices.

Having described our invention, what we claim as new and desire to secure by Letters Patent is:

1. A mechanical action for artificial limb joints comprising a relatively stationary member and a ratchet segment rotatably mounted on the member, a lever rotatably mounted on the member with the rotational axis adjacent to the circumference of the ratchet segment, a locking bar on said lever having opposite curved faces positioned generally perpendicular to the radius from the rotational axis of the lever, said segment having a series of spaced generally radially extending bar receiving notches with faces complementary to the respective faces of the bar when in bar receiving position, said rotational axis of the lever being at a point adjacent a line tangent to an arc about the axis of said segment struck through the centers of the faces of said notch.

2. A mechanical action for artificial limb joints comprising a relatively stationary member and a ratchet segment rotatably mounted on the member on the axis of rotation of the joint, a lever rotatably mounted on the member with the rotational axis adjacent to and exterior of the circumference of the ratchet segment, a locking bar on said lever having opposite faces positioned generally perpendicular to the radius from the rotational axis of the lever and the faces, said segment being subject to a rotative load and having a series of spaced generally radially extending bar receiving notches with faces complementary to the respective faces of the bar when in bar receiving position, said rotational axis of the lever being within an angular distance of a line tangent to an arc about the axis of said segment struck through the centers of the faces of said notch such that the component of the force resulting from application of a rotative load tending to disengage the bar from the notch is less than the frictional force on the respective contacting faces.

3. A mechanical action for artificial limb joints comprising a relatively stationary member and a ratchet segment rotatably mounted on the member on the axis of rotation of the joint, a lever rotatably mounted on the member with the rotational axis adjacent to and exterior of the circumference of the ratchet segment, a locking bar on said lever having opposite arcuate faces positioned generally perpendicular to the radius from the rotational axis of the lever and the faces, said segment having a series of spaced generally radially extending bar receiving notches with arcuate faces complementary to the respective faces of the bar when at bar receiving position, said rotational axis of the lever being within an angular distance of five degrees inside of a line tangent to an arc about the axis of said segment struck through the centers of the faces of said notch.

4. A mechanical action for artificial limb joints comprising a relatively stationary member and a ratchet segment rotatably mounted on the member on the axis of rotation of the joint, a lever rotatably mounted on the member with the rotational axis adjacent to and exterior of the circumference of the ratchet segment, a locking bar on said lever having opposite arcuate faces of radius of curvature determined by the distance between the rotational axis of the lever and the respective face, said segment having a series of spaced generally radially extend-

ing bar receiving notches with arcuate faces complementary to the respective faces of the bar, said rotational axis of the lever being at a point within an angular distance of 15 degrees on either side of a line tangent to an arc centered at the axis of said segment and through the centers of the faces of a notch in bar engaging position, the faces of said notches having positions wherein said last faces are in engagement substantially throughout their areas with the respective faces of the bar when in bar engaging position.

5. A mechanical action for artificial limb joints comprising a pair of members wherein one member is adapted for attachment to a natural limb, parallel plates on one of the members, the other of said members comprising a tubular sleeve rotatably mounted on said plates providing thereby an articulating joint for said action, a ratchet segment fixed on said sleeve having a series of spaced generally radially extending notches, a lever pivotally mounted at a center of rotation on said one member, a locking bar fixed transversely on the lever, and an alternator connected between the lever and one of said members adapted to releasably hold said bar out of notch engagement position, said bar having opposite notch contacting faces curved in the same general direction and said notches having opposite curved bar engaging faces complementary to and adapted to engage the respective faces of the bar when in bar engaging position.

6. A mechanical action for artificial limb joints comprising a relatively stationary member adapted for attachment to a natural limb, parallel plates on said member and a tubular sleeve rotatably mounted on said plates providing thereby an articulating joint for said action, a ratchet segment fixed on said sleeve having a series of spaced generally radially extending notches, a lever pivotally mounted at a center of rotation on said member, a locking bar fixed transversely on the lever, a spring on said member normally urging said bar toward a notch engagement position, and an alternator connected between said member and the lever adapted to releasably hold said bar out of notch engagement position, said bar having opposite notch contacting faces of arcuate form and of radius determined by the distance between the respective face and said center of rotation of the lever, said notches having opposite bar engaging faces of arcuate form complementary to and adapted to engage the respective faces of the bar when in bar engaging position.

7. A ratchet resistant mechanical action for artificial limb joints comprising a base, a ratchet segment rotatably mounted on the base and a locking bar having a pivotal mounting on said base, said locking bar having opposite segment-engaging faces curved in the same general direction about the axis of said pivotal mounting, said segment having a series of peripheral bar receiving notches with opposite faces respectively complementary to the faces on said bar.

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3. In an apparatus for forming a continuous rigid rod form of compressible material of the character described, the combination comprising a plurality of reciprocally movable compression punch members, at least two opposed reciprocally movable forming punch members, opposed wall members slidably engaging said compression punch and said forming punch members, a plurality of spacer plates maintaining said wall members in spaced-apart relationship during the compacting stroke of said reciprocally movable compression punch and forming punch members, a plurality of spring members housed at either end limit of said wall members laterally moving said wall members thereby to force said wall members apart against said spacer plates upon occurrence of the retraction stroke of said reciprocally movable compression punch and forming punch members.

4. In an apparatus for forming a continuous rod from compressible sponge material, the combination comprising a pair of opposed anchor plates, a pair of opposed laterally movable wall members interposed between said anchor plates, a plurality of reciprocally movable wedge members interposed between said anchor plates and said wall members, a pair of reciprocally movable compression punch members interposed between said wall members, a plurality of stop plates cooperating with said wall members, the lateral outward movement of said wall members being limited during the retraction stroke of said compression punch members and said wedge members by said plurality of stop plates, a cover plate and a floor plate, said stop plates being attached to said cover plate and said floor plate.

5. In an electrode forming apparatus substantially as described, the combination comprising a pair of opposed compression punch members, a pair of opposed forming punch members in vertical axial alignment therewith, laterally movable wall members slidably engaging said compression and said forming punch members, fixedly positioned anchor plate members in substantially spaced apart relation with said wall members, reciprocally movable wedging means forcing said wall members and said anchor plates into a predetermined spaced-apart relationship, actuating means comprising eccentric shaft members, the said compression and said forming punch members and the said wedging means being reciprocally moved by said eccentric shaft members, and expansible connecting means interposed between the said eccentric shaft members and the said wedge members.

6. In an apparatus for forming a continuous electrode from compressible sponge metal, the combination comprising a plurality of opposed compression punch mem-

bers, a plurality of opposed forming punch members in abutting relation with said compression punch members, a cover plate and a floor plate, said forming and compression punch members being interposed between said cover plate and a floor plate, eccentric drive shafts cooperating with said punch members, said forming and compression punch members being reciprocally movable by means of said eccentric drive shafts journaled at either end limit in said cover plate and said floor plate, spring members cooperating with said punch members laterally movable wall members slidably engaging said compression punch and said forming punch members and being maintained in spaced apart relation by said spring members housed at either end in said wall members and traversing said reciprocating compression punch members, anchor plates affixed to said floor plate, said anchor plates defining a channel in which said wall members slidably engage said reciprocating compression punch and forming punch members, the latter members being interposed between said wall members, spacer plates for the wall members, a plurality of wedge members slidably insertable between said anchor plates and said wall members prior to the compression stroke of said reciprocally movable compression punch members and said forming punch members whereby said wall members are forced in abutting relationship with said spacer plates, the latter members being interposed between said wall members and being affixed to said cover plate and said floor plate, said wedge members being reciprocally moved by said eccentric shafts by means of interposed connecting arms, the said connecting arms having expansible joints whereby said wedge members may remain interposed between said wall members and said anchor plates during the compression stroke of said compression punch and said forming punch members, the said wedge members being inserted between said wall members prior to the compression stroke of the said compression punch and said forming punch.

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