March 12, 1957 J. A. HJULIAN 2,784,453

APPARATUS FOR FORMING A CONTINUOUS ROD OF COMPRESSIBLE MATERIAL

Filed March 8, 1954 5 Sheets-Sheet 1

Fig. 1.

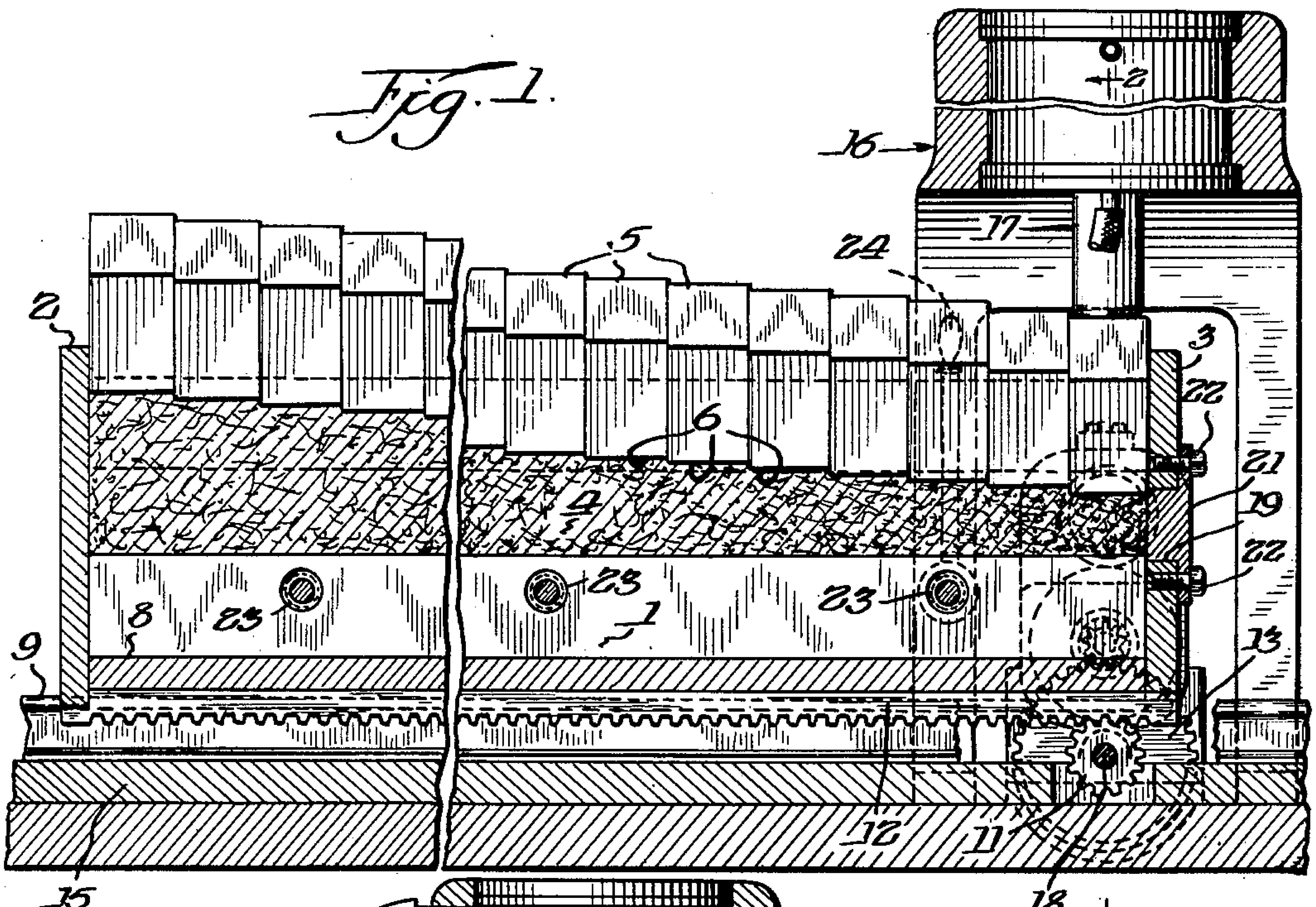
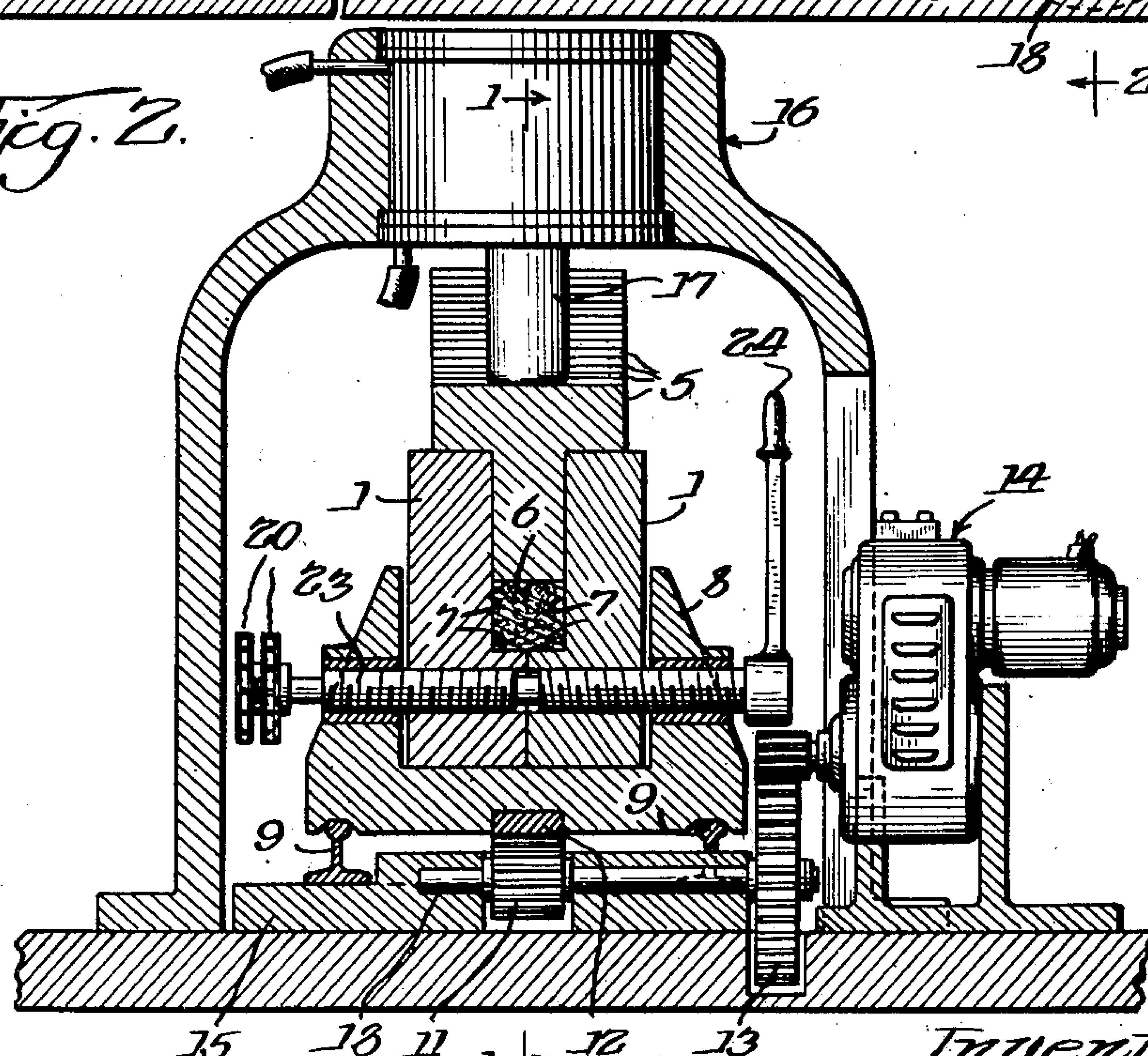


Fig. 2.

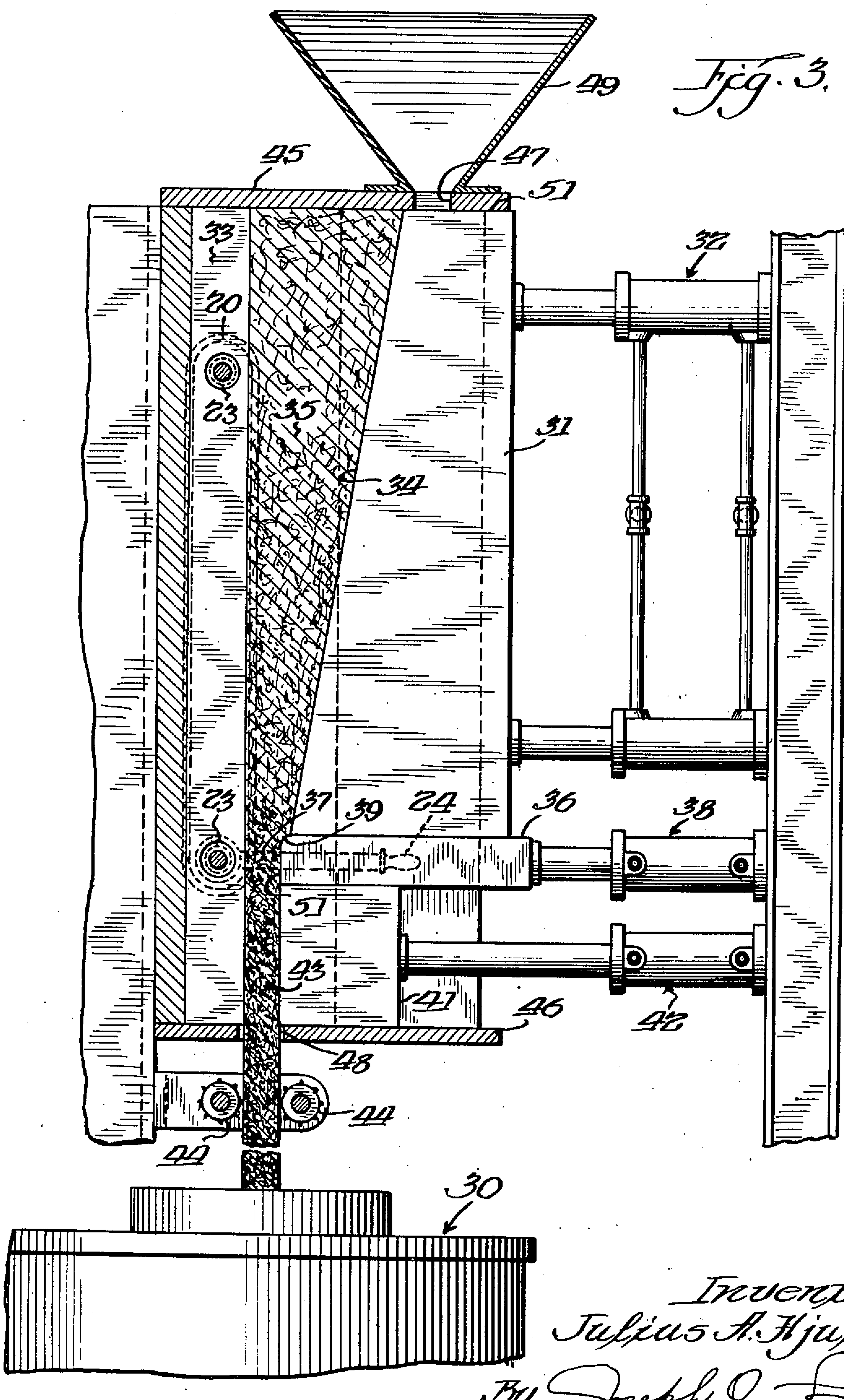


Inventor:
Julius A. Hjulian.
By Joseph O. Lange Atty.

APPARATUS FOR FORMING A CONTINUOUS ROD OF COMPRESSIBLE MATERIAL

Filed March 8, 1954 5 Sheets-Sheet 2

Fig. 3.

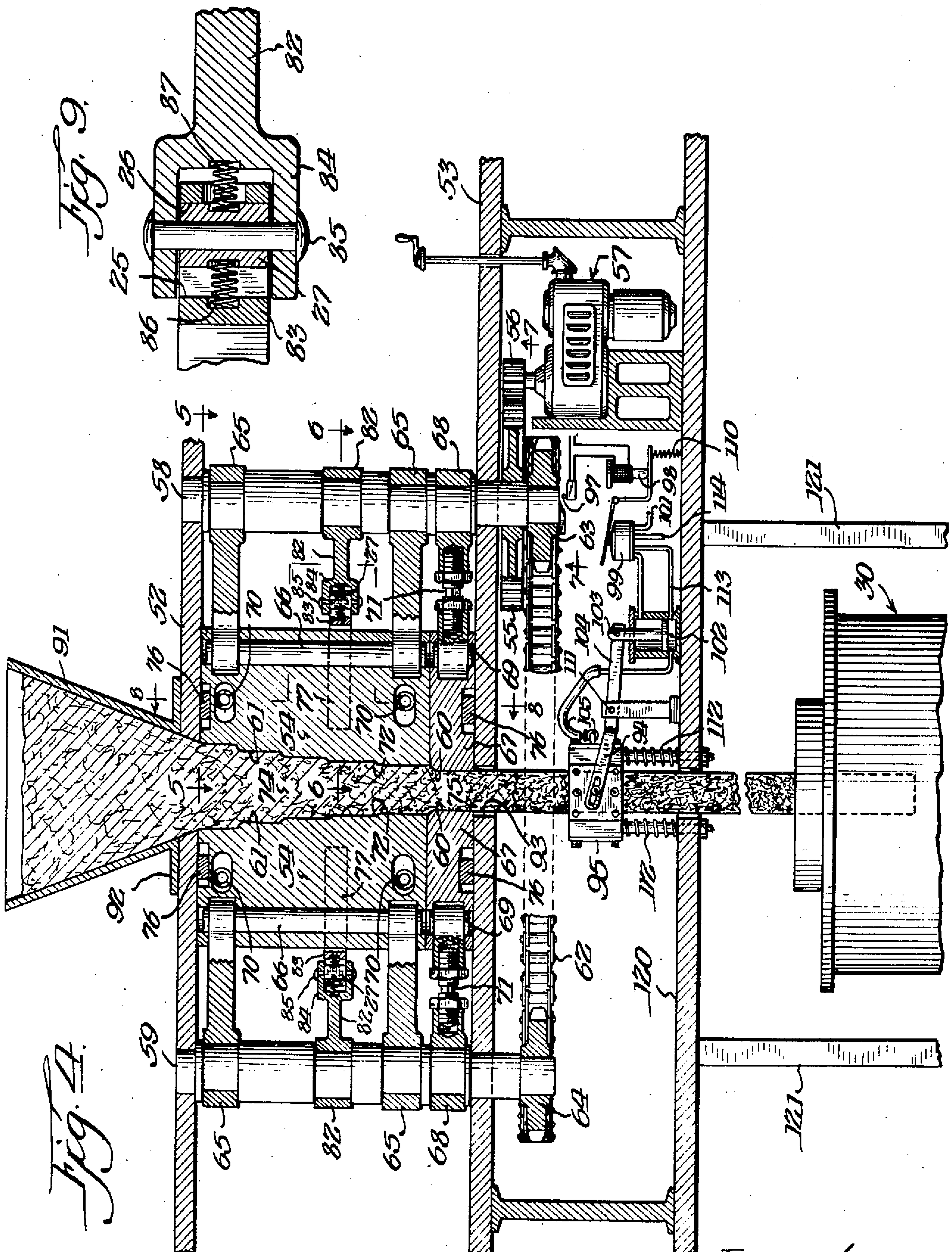


Inventor:
Julius A. Hjulian.
By Joseph O. Lange
Att'y.

APPARATUS FOR FORMING A CONTINUOUS ROD OF COMPRESSIBLE MATERIAL

Filed March 8, 1954

5 Sheets-Sheet 3



Inventor:
Julius A. Hjulian.
By Joseph O. Lange
Atty.

APPARATUS FOR FORMING A CONTINUOUS ROD OF COMPRESSIBLE MATERIAL

Filed March 8, 1954 5 Sheets-Sheet 4

Fig. 5.

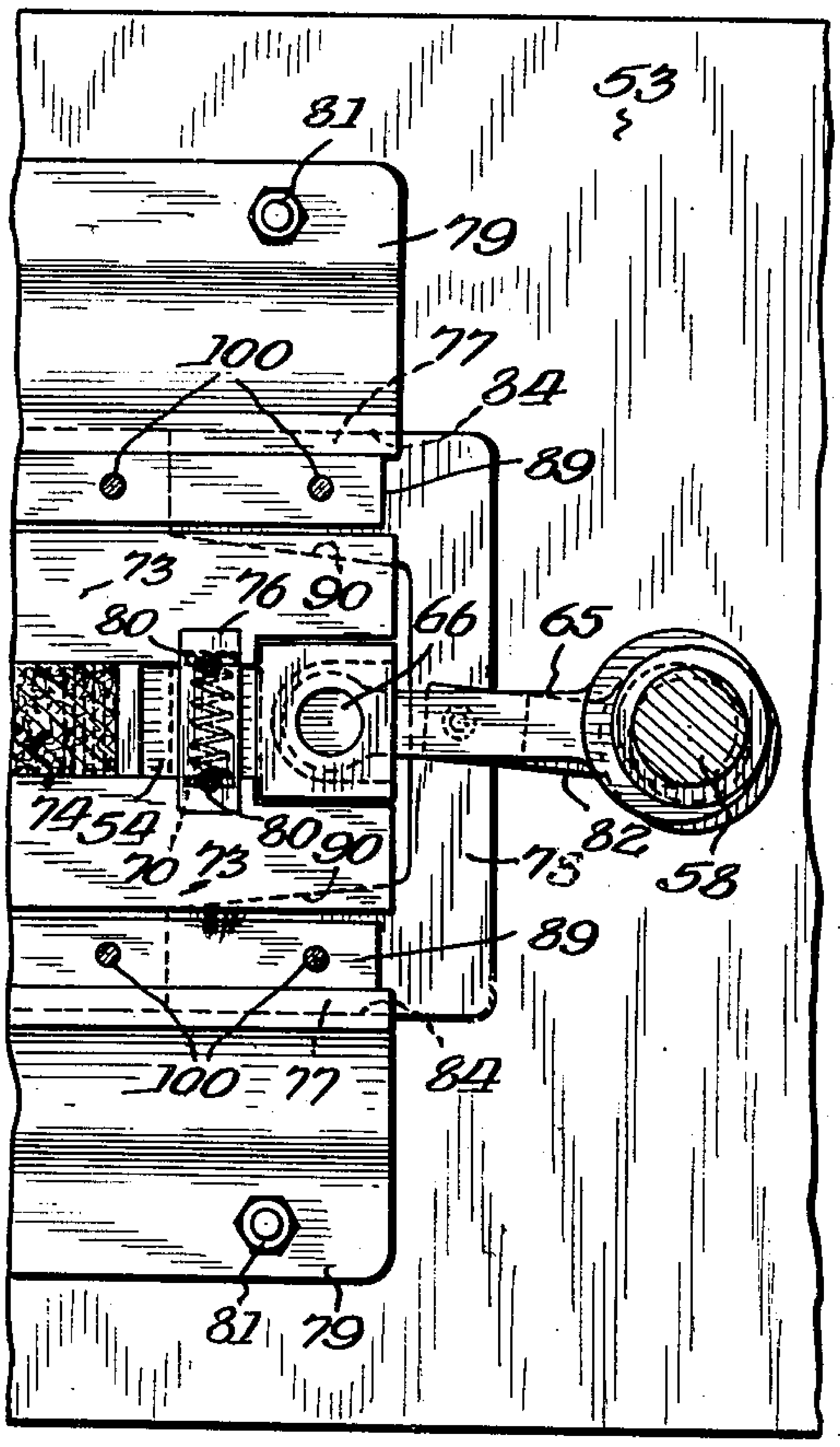


Fig. 6.

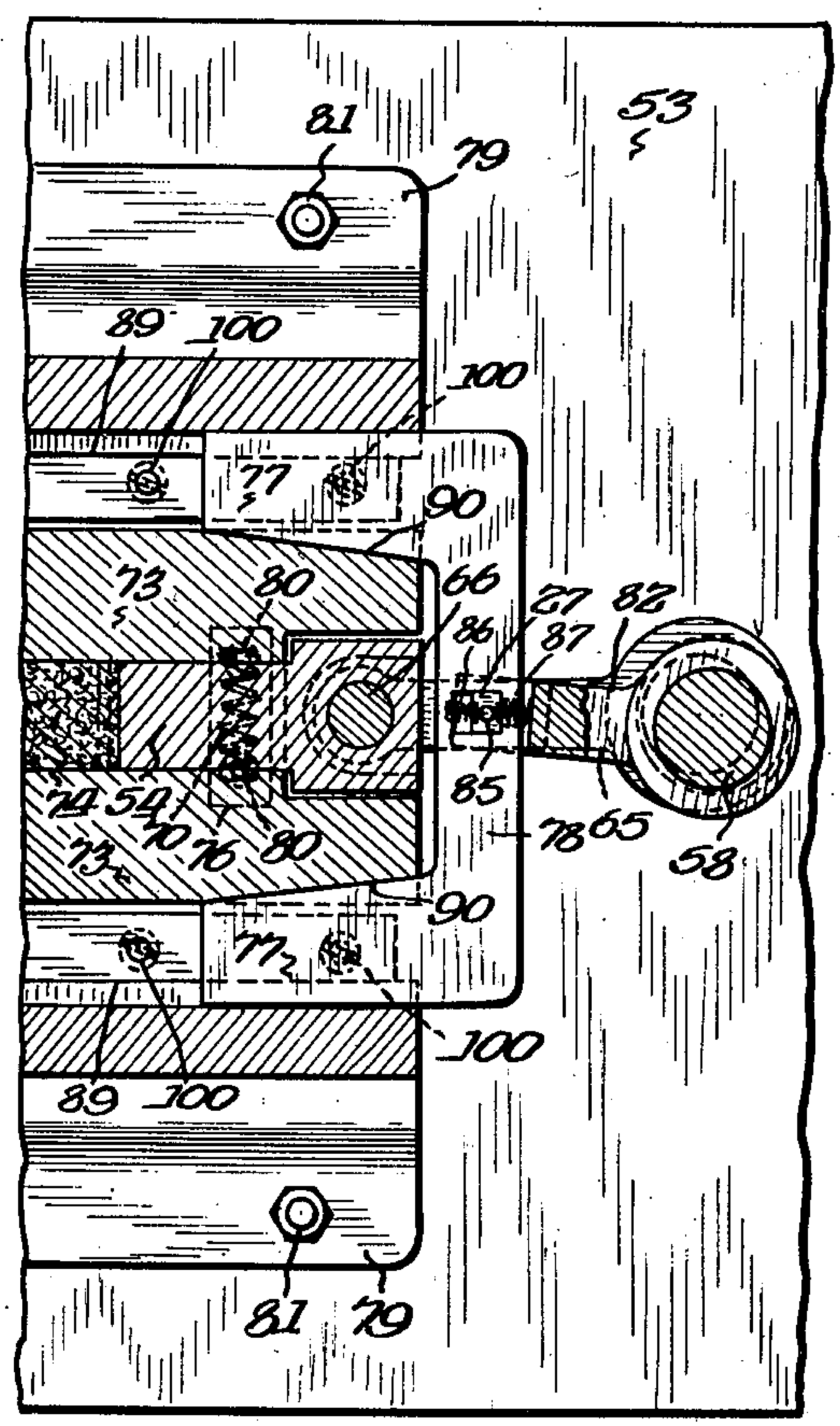
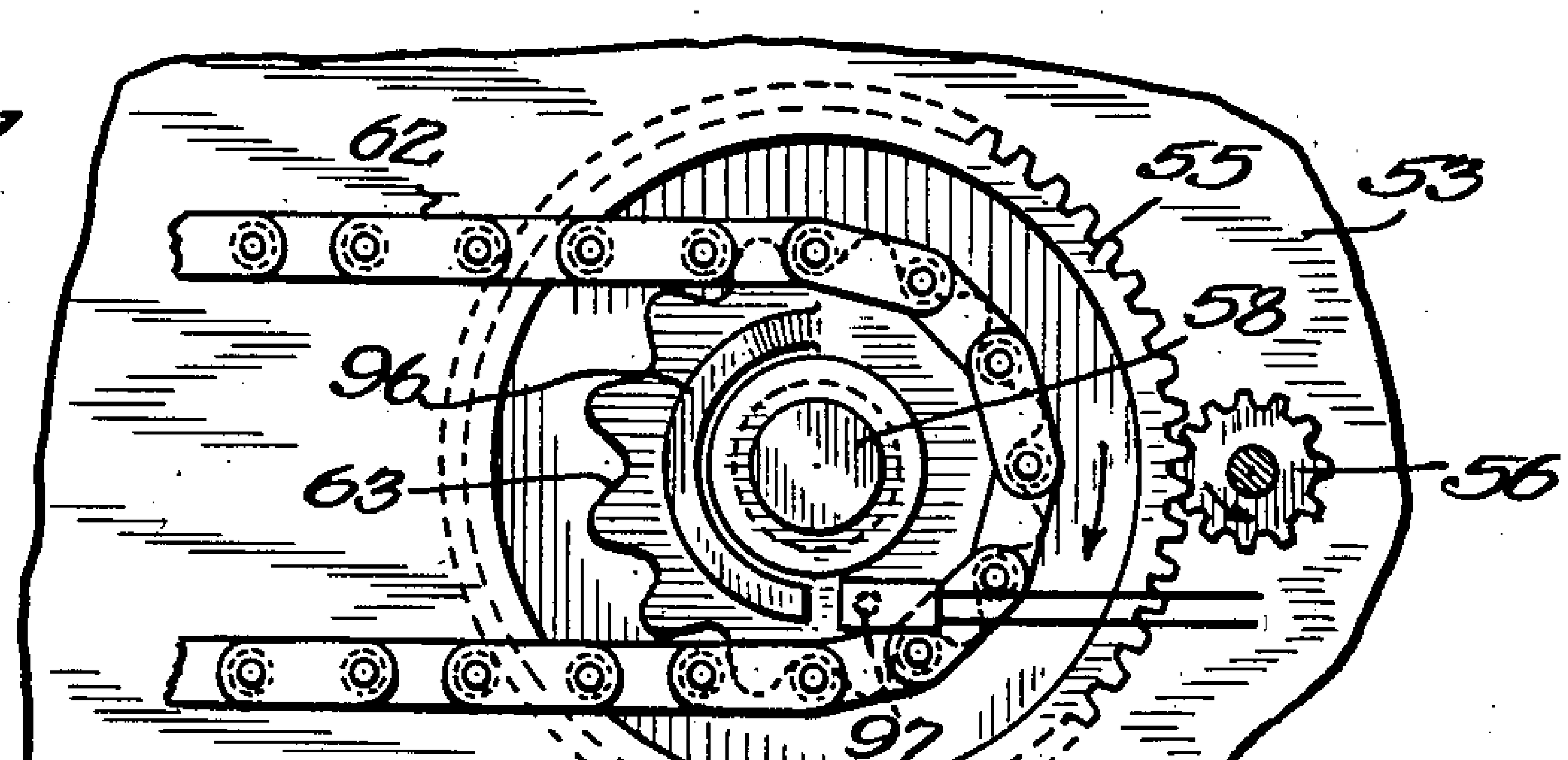


Fig. 7.



Inventor:
Julius A. Hjulian.
By Joseph O. Lange
Atty.

March 12, 1957 J. A. HJULIAN 2,784,453

APPARATUS FOR FORMING A CONTINUOUS ROD OF COMPRESSIBLE MATERIAL

Filed March 8, 1954 5 Sheets-Sheet 5

Fig. 8.

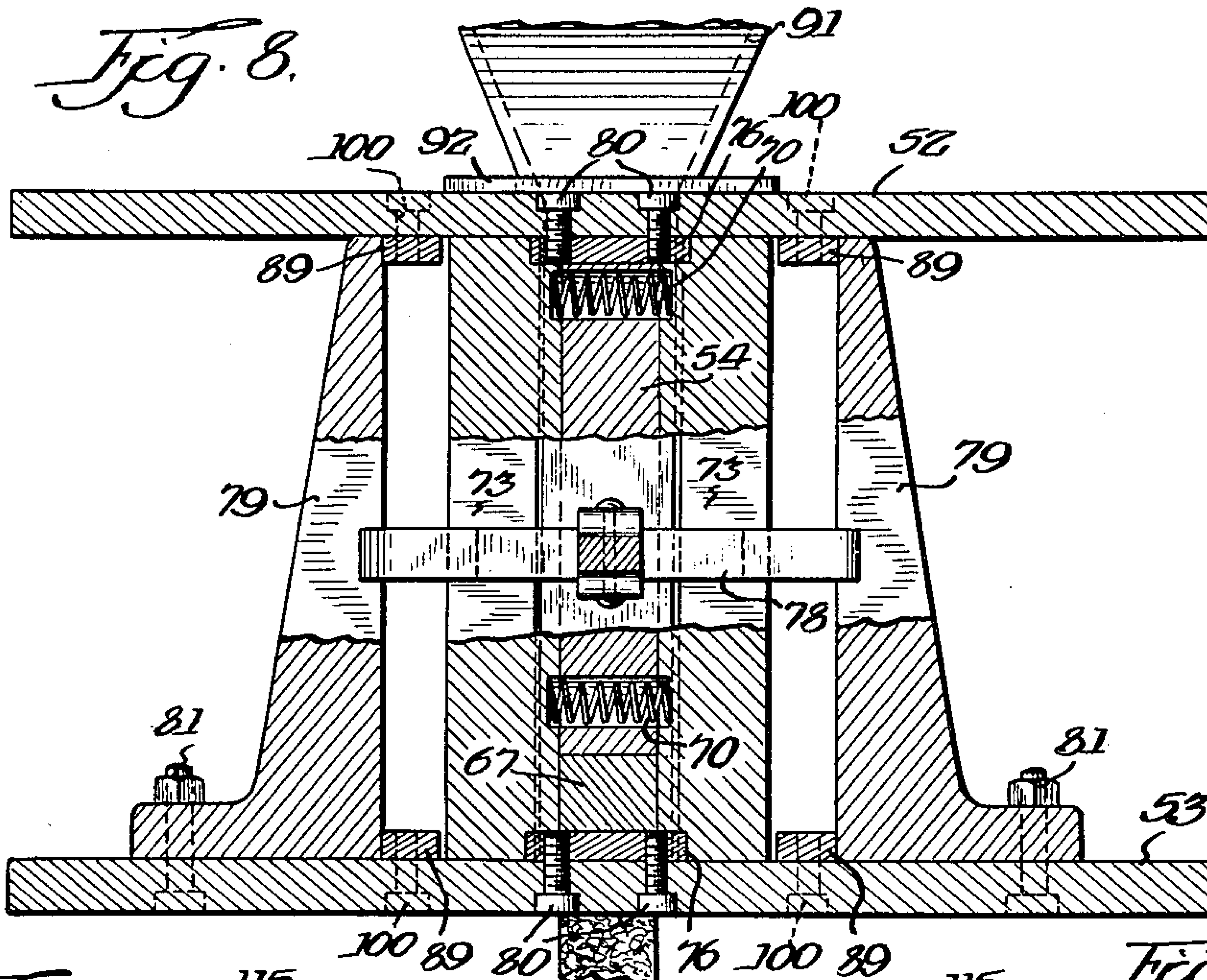


Fig. 10.

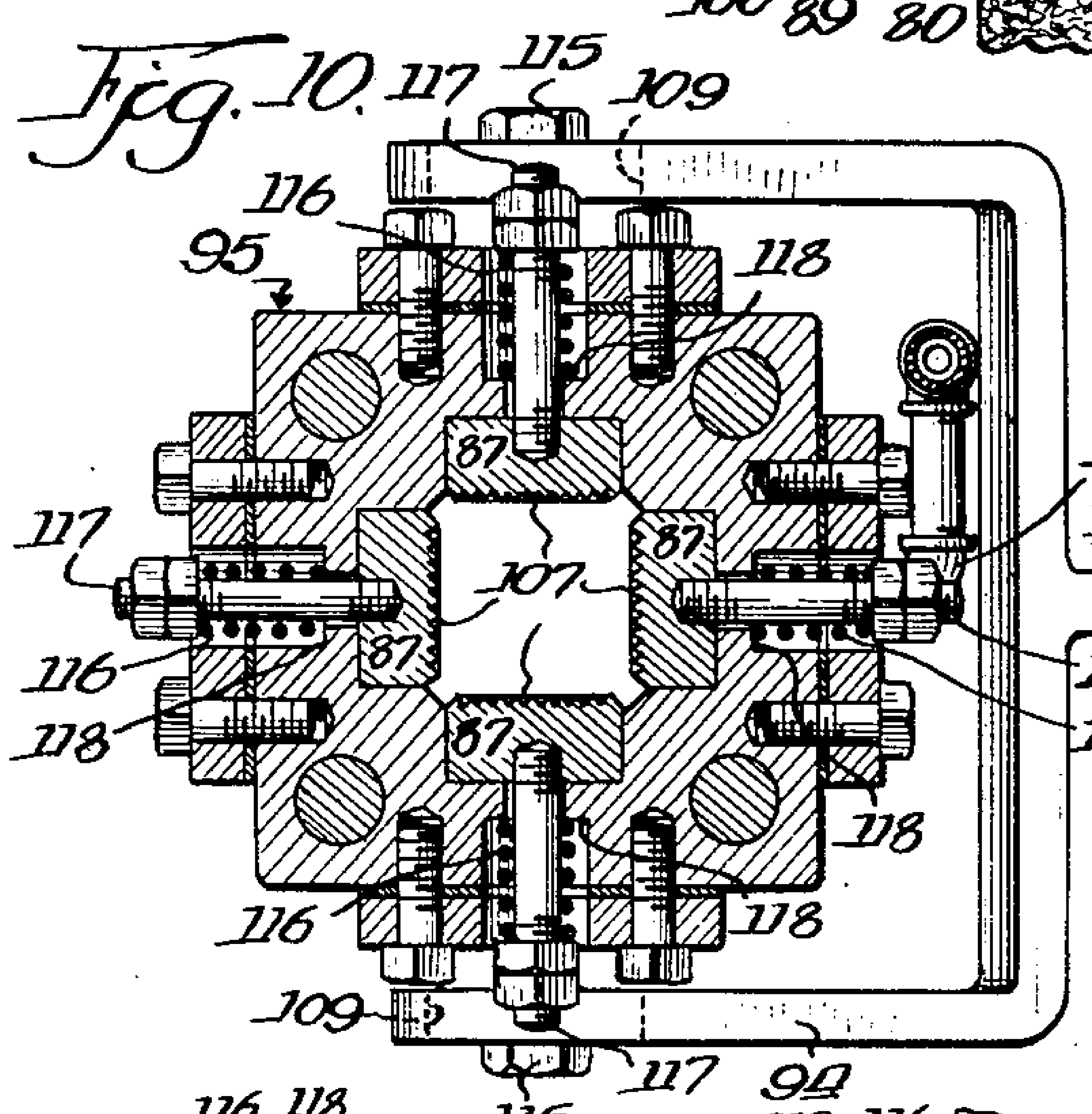
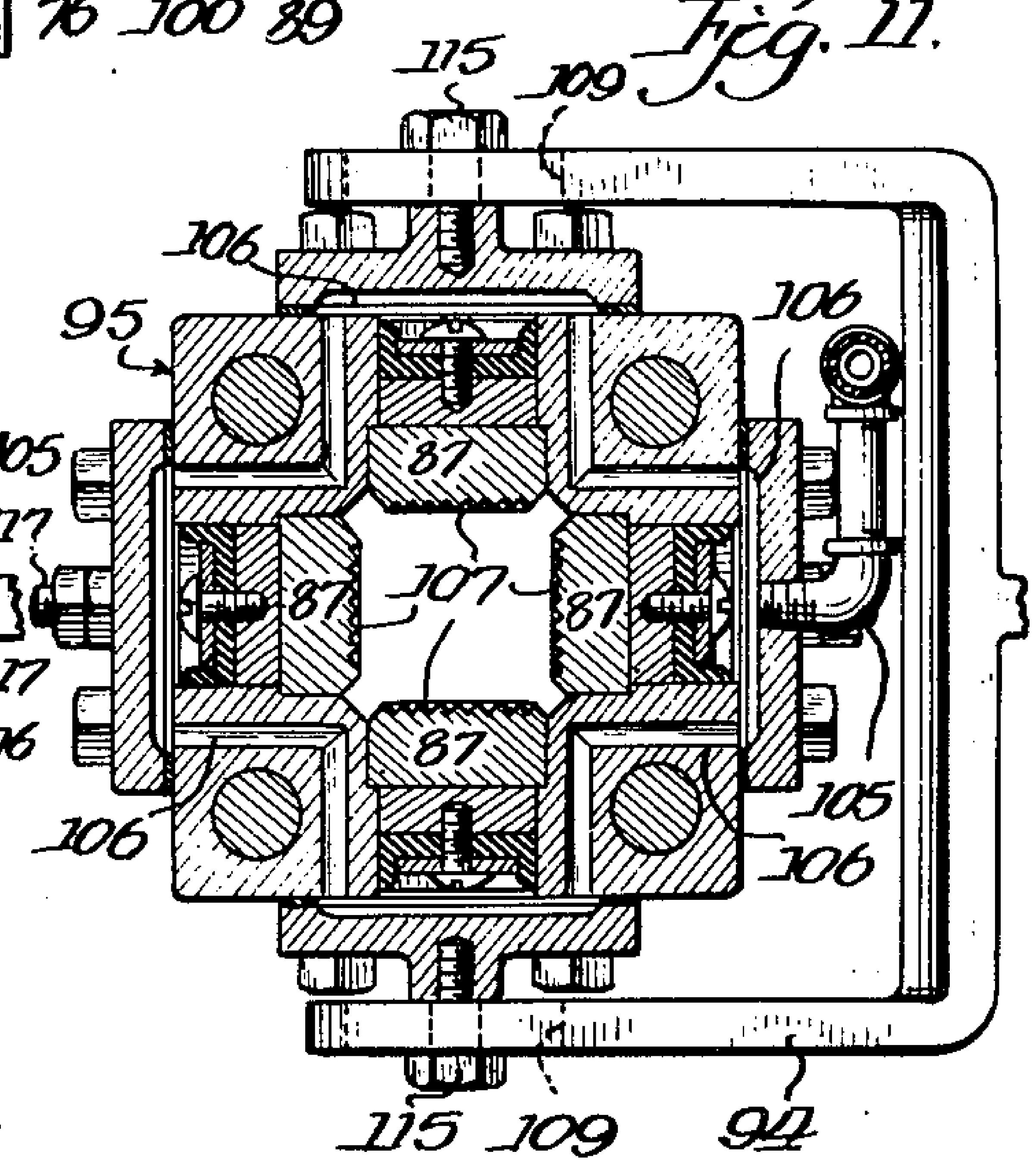


Fig. 11.



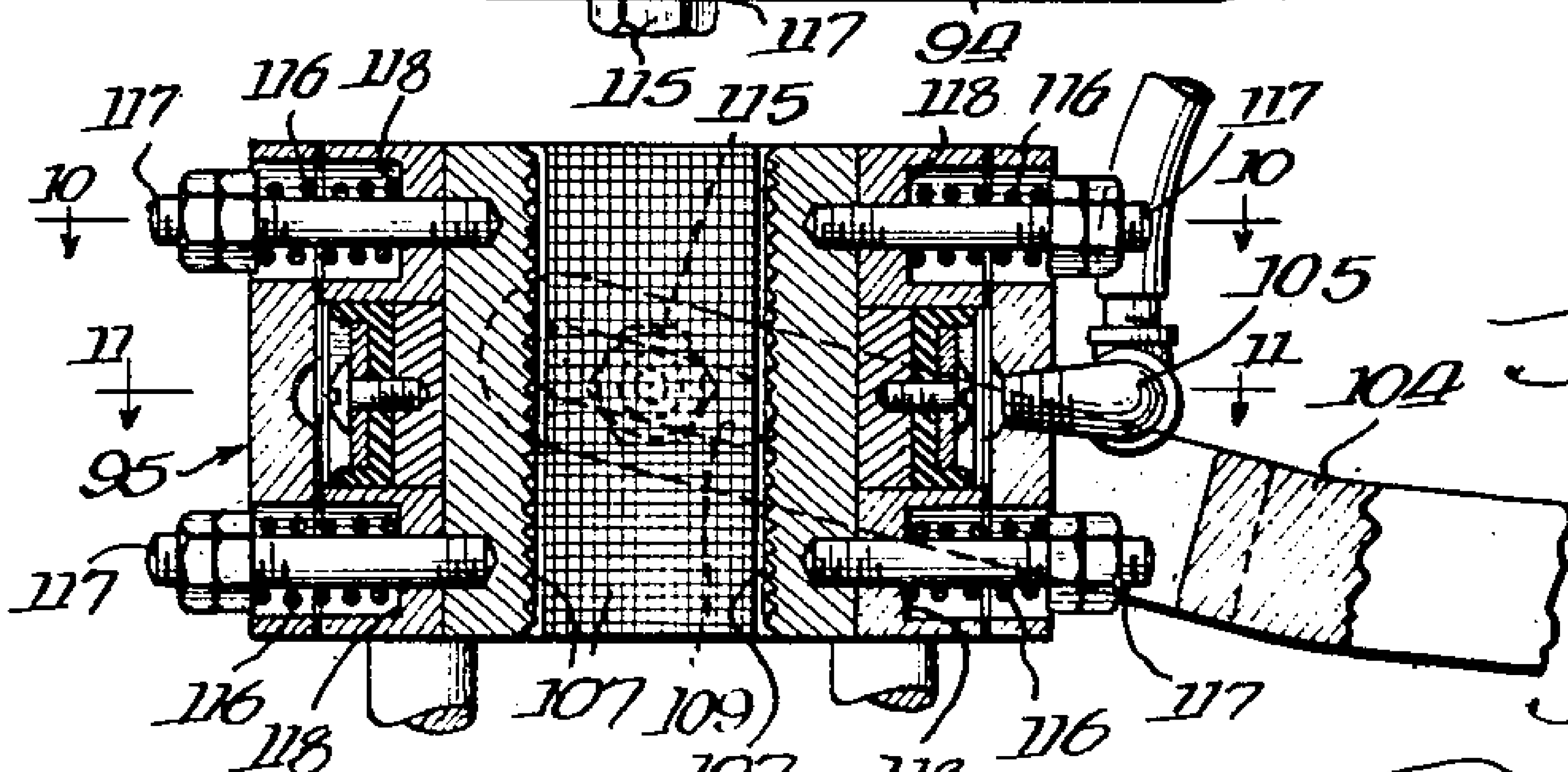


Fig. 12.

Inventor:
Julius A. Hjulian.
By Joseph O. Lange Atty.

2,784,453

APPARATUS FOR FORMING A CONTINUOUS ROD OF COMPRESSIBLE MATERIAL

Julius A. Hjulian, Palos Heights, Ill., assignor to Crane Co., Chicago, Ill., a corporation of Illinois

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.

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** journalled 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

[redacted]

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 journalled 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 journalled at one end limit to the eccentric shaft members **58** and **59** and similarly journalled 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 are pivotally journalled at one end limit to eccentric shaft members **58** and **59** and similarly journalled 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 journalled 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 extending 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 members, 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 journalled 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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