March 26, 1957 **H. L. JOHNSON** **2,786,217**

RIVET FORMING MACHINE HAVING OPPOSED PUNCHES
AND AN INDEXIBLE BLANK CARRIER

Filed May 14, 1953 7 Sheets-Sheet 1

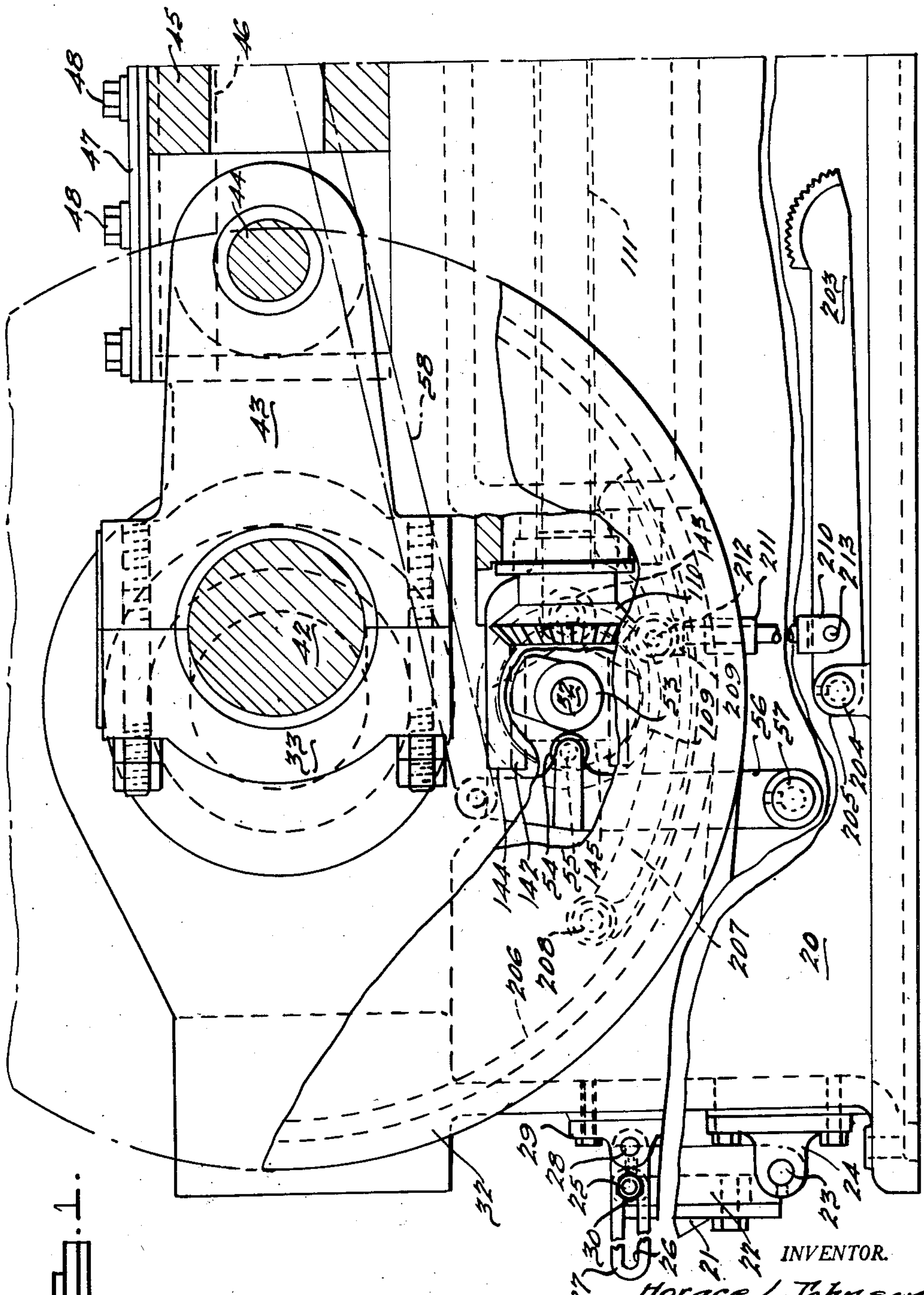

FIG. 1

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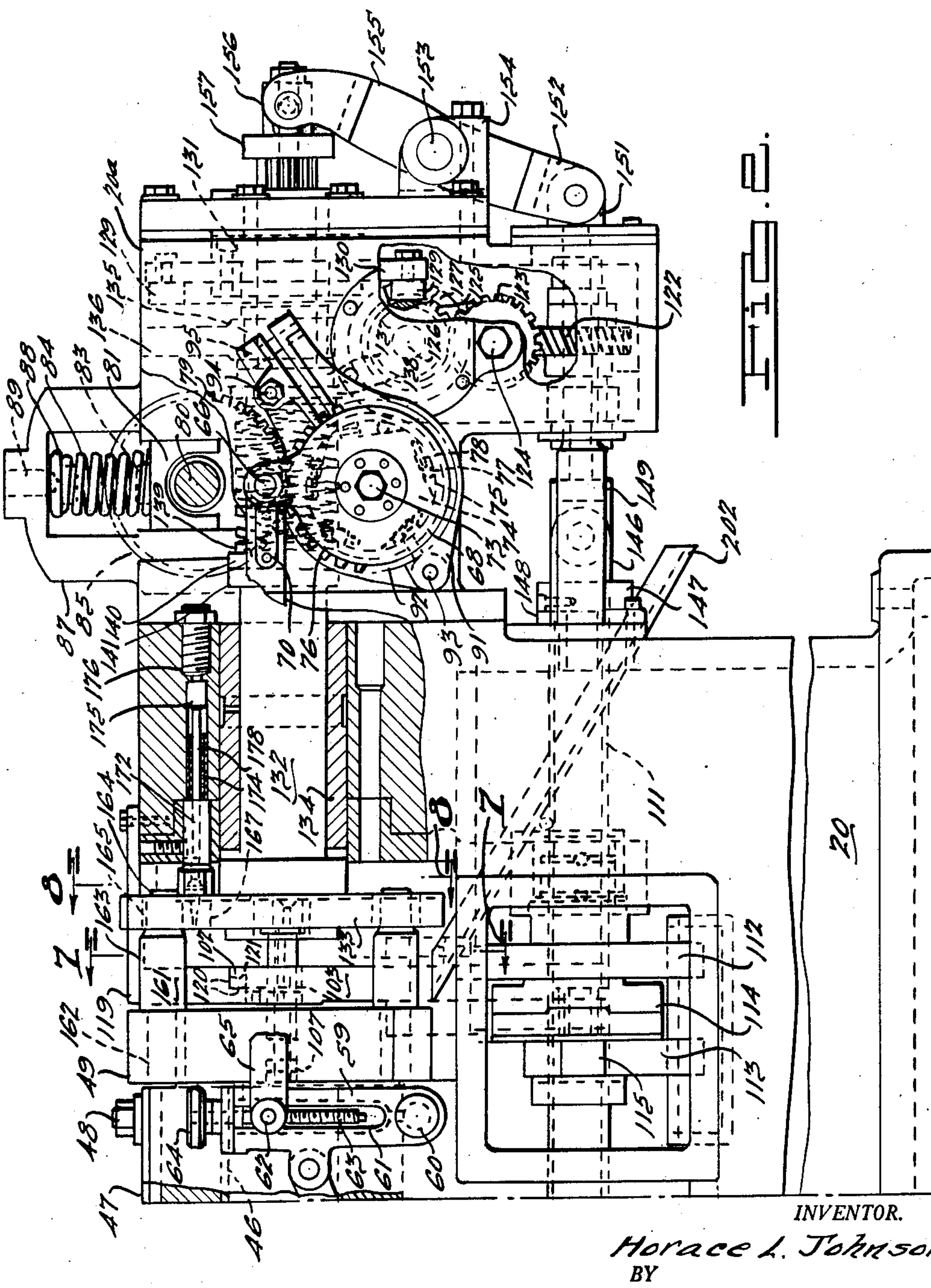

FIG. 2

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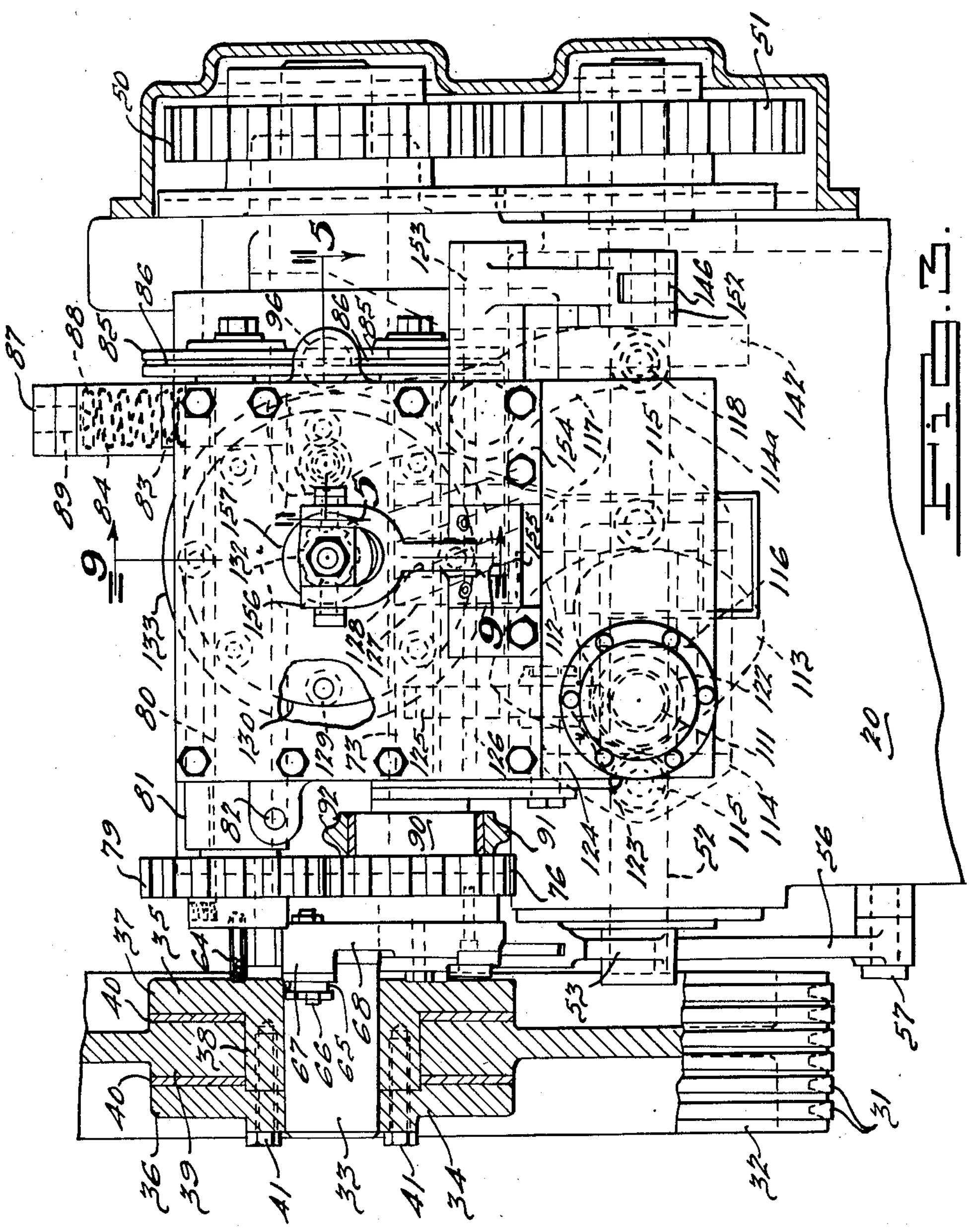

FIG. 3

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RIVET FORMING MACHINE HAVING OPPOSED PUNCHES AND AN INDEXIBLE BLANK CARRIER

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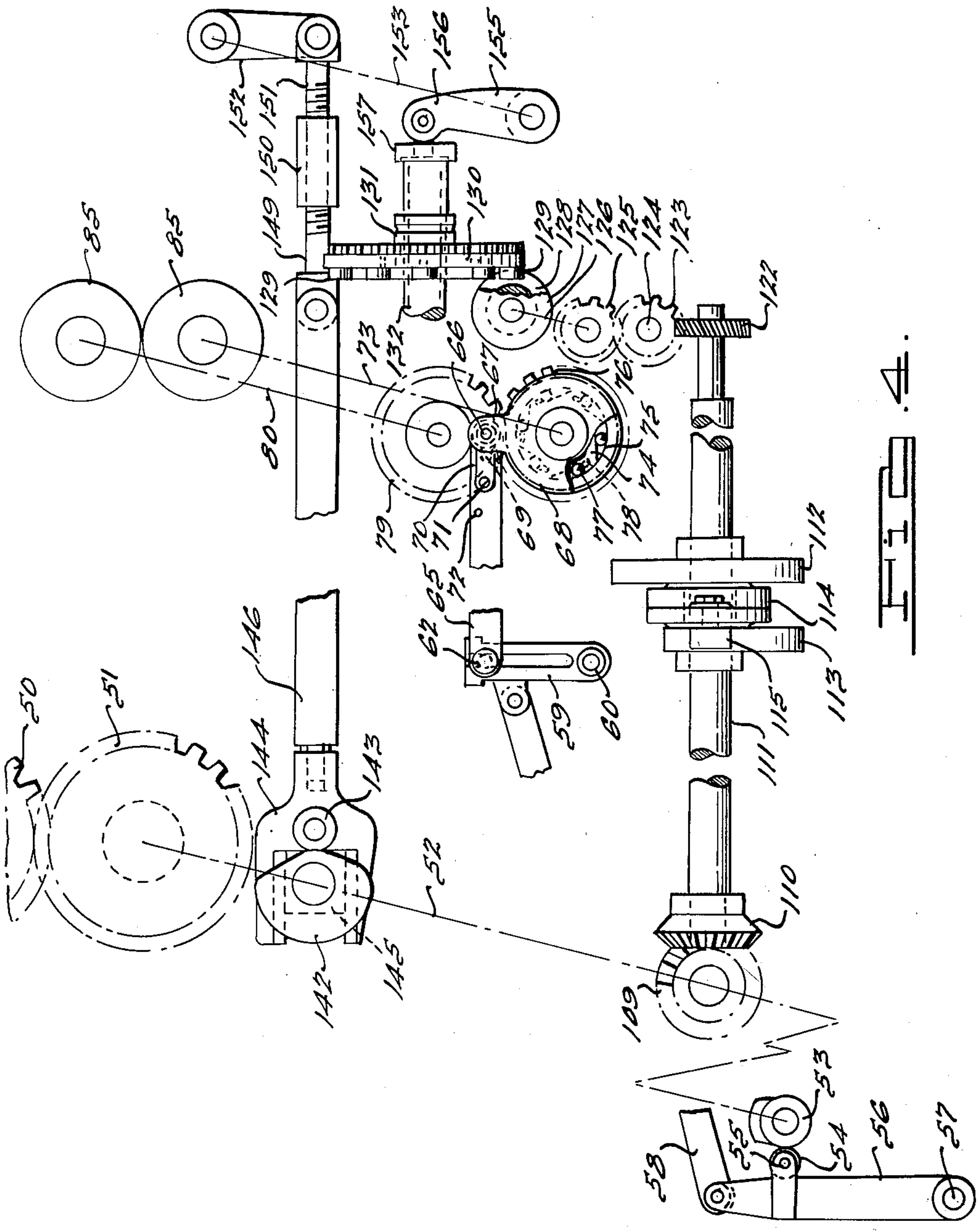

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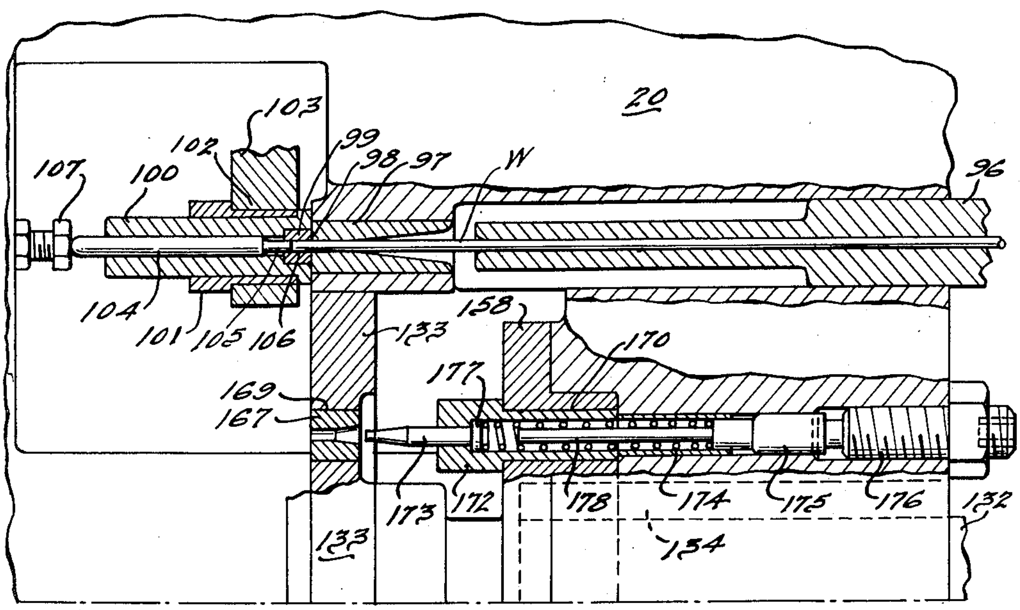

FIG. 5.

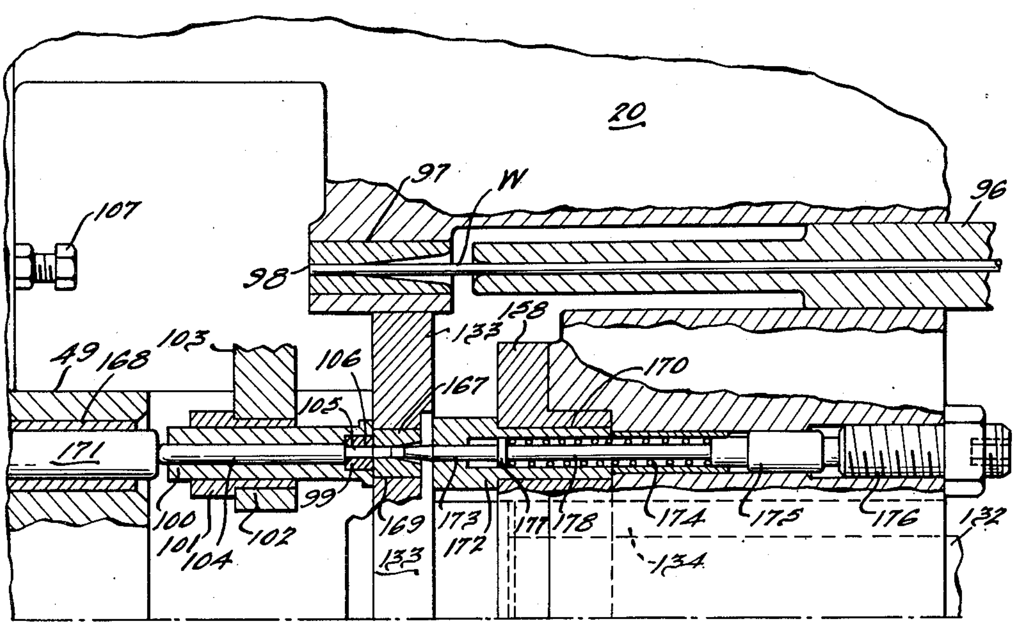

FIG. 6.

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RIVET FORMING MACHINE HAVING OPPOSED PUNCHES AND AN INDEXIBLE BLANK CARRIER

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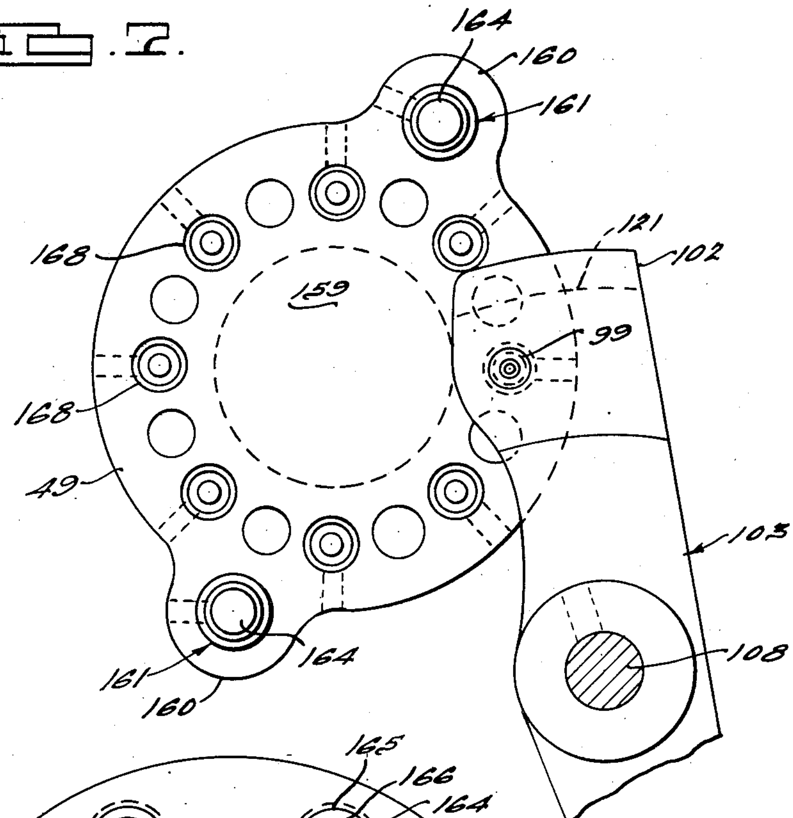
FIG. 7.



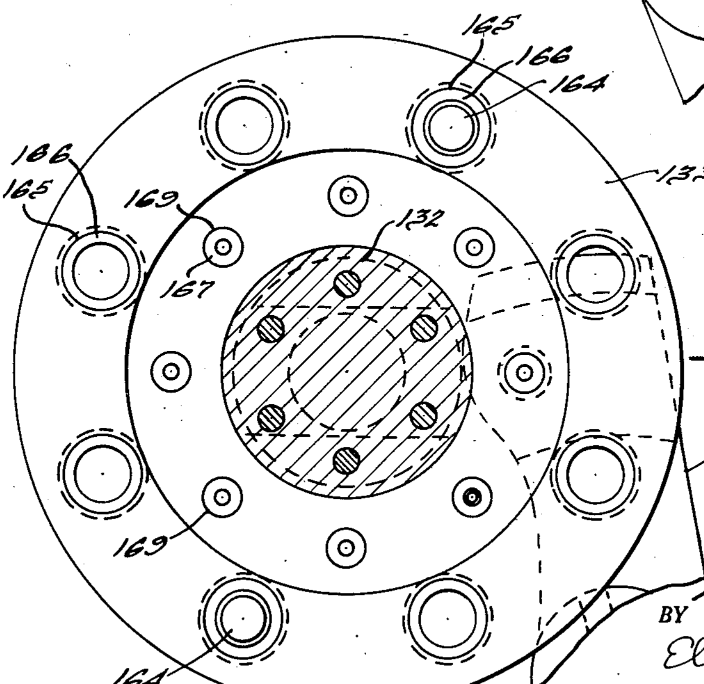


FIG. 8.

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FIG. 9.

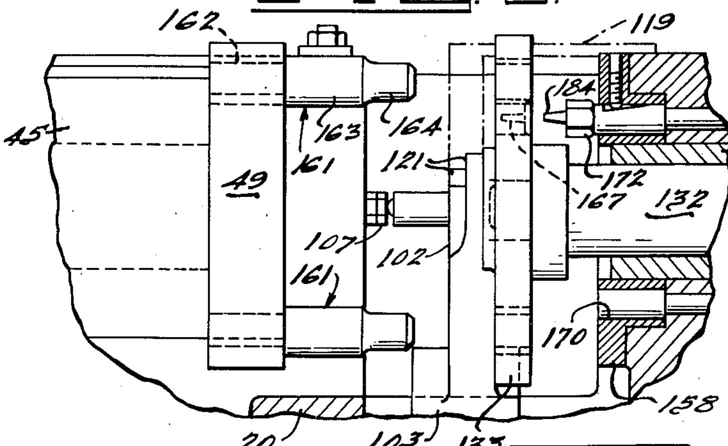
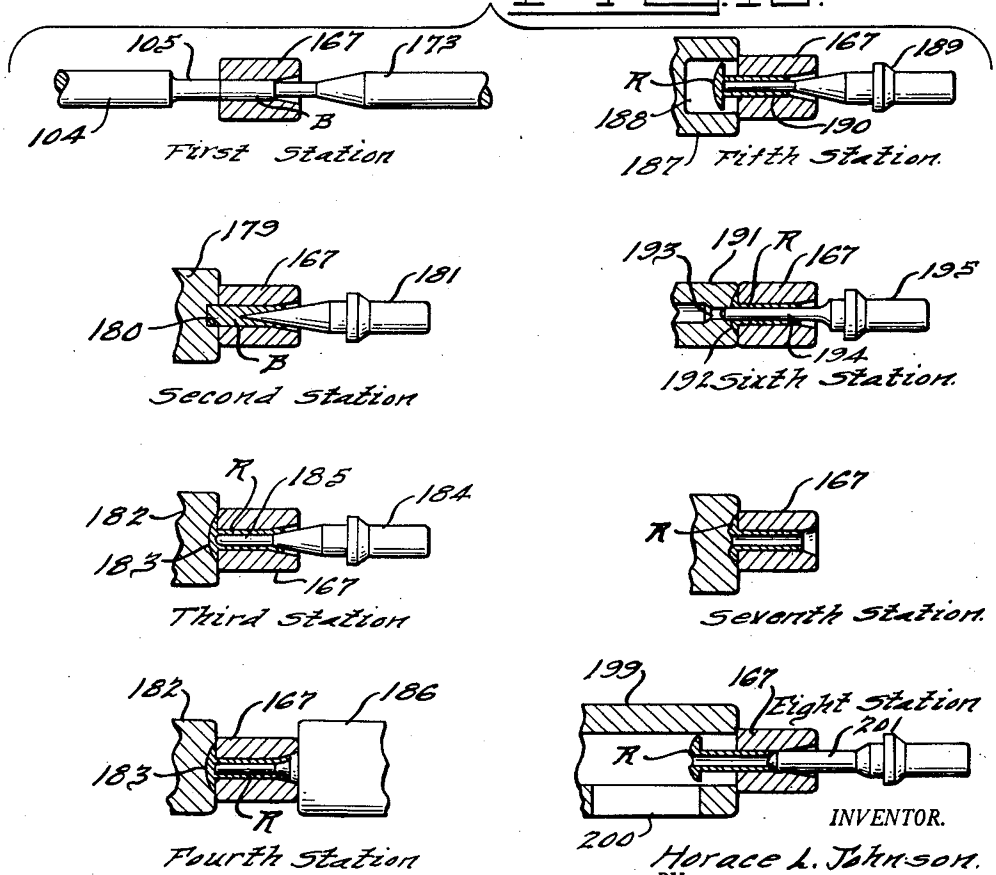


FIG. 10.



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United States Patent Office

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RIVET FORMING MACHINE HAVING OPPOSED PUNCHES AND AN INDEXIBLE BLANK CARRIER

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Application May 14, 1953, Serial No. 355,001

5 Claims. (Cl. 10—13)

This invention relates to a means and method for making tubular rivets, it being an object of the invention to provide a method and means for transforming rivet stock in the form of wire rod into a finished tubular rivet, the transformation to be accomplished by a sequence of progressive heading and forming operations carried on entirely within the mechanism of the machine embodying the invention.

At present tubular rivets are generally manufactured by a process requiring at least two machines. The first machine forms the wire rivet stock into a solid headed rivet blank and the second machine drills the hole to make the rivet tubular. From an efficiency standpoint the present general method of producing rivets is unsatisfactory in that it requires excessive handling of the rivet blank. The rivet blanks must be carried from the first machine to the second and they must be rearranged and fed into a drill jig for the drilling operation. Whether or not the transporting and feeding are done manually or mechanically, the additional handling is time consuming. Also, it is readily apparent that the present method requires multiple machine installations and generally each machine requires a machine operator. All of these multiply the cost of producing the rivets.

Further, the removal of material by the drilling operation to make the rivet hollow or tubular structurally weakens the rivet and thus results in an inferior product.

The present invention has as one of its objects the elimination of all unnecessary handling of the rivet stock and the rivet blanks. The production of tubular rivets in accordance with the process embodied in the present invention requires material handling only twice, once when the reel containing the wire rivet stock is initially positioned relative to the machine and fed into the machine wire feeding mechanism and once again when the tray containing completed tubular rivets is removed from the discharge chute of the machine. There is no intermediate handling required during the manufacturing process.

A further object of the present invention is the production of a tubular rivet having superior structural qualities. Substantially all of the stock in the rivet blank is utilized in making the finished rivet. The hole in the rivet is not drilled but is cold formed and substantially all of the material in the rivet blank is utilized in the production of the rivet. As is well known, the cold forming or working of the metal increases the structural strength to a highly desirable degree.

More particularly, the method embodied in the present invention of making a tubular rivet from wire stock of solid cross-section comprises feeding wire stock into a cut-off die, shearing the stock to form a blank and thereafter feeding said blank into a cylindrical recess in a carrying die, piercing one end of said blank while maintaining the opposite end against deformation, forming said pierced end of the blank into a tubular portion while upsetting the opposite end of the blank to provide a headed portion, and ejecting said blank out of the carrying die. Briefly, the machine embodied in the present invention comprises a wire feeding means, a cut-off means correlated with a means for feeding the cut-off wire or rivet blank into a carrying die, means for performing a series of piercing, forming and heading operations on the rivet blank, and means for indexing the rivet blank through the sequence of operations to be performed thereon.

Other objects, features and advantages of this invention will be apparent from the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference numerals designate corresponding parts in the several views.

Figs. 1 and 2 when placed end to end are a front elevation in part fragmentary and sectional of a tubular rivet forming machine embodying the present invention.

Fig. 3 is an end view of the machine taken from the right end as viewed in Fig. 2.

Fig. 4 is a schematic diagram of the various drive mechanisms embodied in the present invention.

Fig. 5 is an enlarged fragmentary sectional view taken substantially along the line 5—5 of Fig. 3 but showing the parts immediately before they reach the position shown in Fig. 3.

Fig. 6 is an enlarged fragmentary sectional view taken along the line 5—5 of Fig. 3 and showing the parts in the same position as shown in Fig. 3.

Fig. 7 is an enlarged view looking in the direction of the arrows 7—7 in Fig. 2.

Fig. 8 is an enlarged view looking in the direction of the arrows 8—8 in Fig. 2.

Fig. 9 is an enlarged partial section taken substantially along line 9—9 of Fig. 3 looking in the direction of the arrows.

Fig. 10 is a view illustrating the progressive steps embodied in manufacturing a rivet in accordance with the present invention.

Before explaining in detail the present invention it is to be understood that the invention is not limited in its application to the details of construction and arrangements of parts illustrated in the accompanying drawings since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

In the drawings there is illustrated an embodiment of a machine for cold heading and forming tubular rivets in accordance with the objects of the present invention. The illustrative machine comprises a base or frame **20** supporting the various sub-mechanisms which enable the machine to accomplish its function of turning rivet wire stock into a completed tubular rivet. Briefly, the sub-mechanisms include a non-rotatable reciprocating header or ram carrying at selected stations tools adapted to perform external operations on rivet blanks, a fixed head mounting at selected stations tools adapted to perform internal operations on the rivet blanks, an indexable die plate or rivet blank carrying member interposed between said ram and fixed head and movable by and with the ram for a part of the stroke of the latter toward the fixed head, a wire feed mechanism, a cut-off mechanism arranged to cut off a length of wire stock and carry the same into alignment with the indexable die plate so that it may be pushed into a heading or blank carrying die by the ram, an indexing mechanism, and the drive motor, gears and cams necessary to provide the correlated and timed sequence of movements of the sub-mechanisms necessary to produce the finished article.

Motive power for driving the various sub-mechanisms of the present machine is supplied by a single electric motor of which only a fragmentary portion of the base **21** is shown. The base **21** of the motor is bolted to a motor mounting plate **22** which is mounted on the base of the machine to extend in a vertical direction. At its lower end the motor mounting plate **22** is swingably journalled on pins or a shaft **23** carried by a motor mounting bracket **24**, the bracket **24** being directly bolted to the base. At its upper end the motor mounting plate carries a threaded stud **25** which projects through a slot **26** in a link **27**. The link **27** is journalled at its inner end on a pin **28** carried by a motor plate adjusting bracket **29**, the bracket **29** being vertically spaced from the bracket **24** and suitably bolted to the side of the base **20**. A nut **30** is threaded on the stud **25** for locking the mounting plate **22** in any position of adjustment. The stud and slot connection between the upper end of the motor mounting plate **22** and the base **20** is a conventional manner of providing for adjustment of the tension of the belt drive **31** between the drive pulley (not shown) on the motor shaft and the driven pulley **32** on the crankshaft **33** of the machine.

The pulley **32** is constructed and arranged to act as a friction clutch in the even that some part of the machine jams during the operation thereof. Referring particularly to Fig. 3, there is shown an outer pulley hub plate **34** and an inner pulley hub plate **35** which are keyed to the crank shaft **33** in the conventional manner. It will be noted that the disk portions **36** and **37** of the two hub plates **34** and **35** respectively are spaced apart by a cylindrical portion **38** of the inner hub plate **35**. The hub **39** of the driven pulley **32** fits over the cylindrical portion **38** and between the disk portions **36** and **37**. The space between the disk portions **36** and **37** and the hub **39** is taken up by friction disks **40** of suitable material. Bolt means **41** are utilized to maintain the disk portions **36** and **37**, the friction disks **40** and the hub **39** in tight frictional engagement. It will be readily understood that if rotary motion of the crankshaft **33** is prevented by an internal jamming of some of the mechanism of the machine, the pulley **32** will be permitted by the friction disks **40** to slip relative to the pulley hub plates **34** and **35** until the power to the machine may be shut off.

Intermediate its ends the crankshaft **33** is provided with a single crankpin **42** on which is journalled a generally horizontally extending connecting rod **43**. The free end of the connecting rod **43**, the right end as viewed in Fig. 2, is connected by a wrist pin **44** to a horizontally slidable crosshead **45**. The crosshead **45** is slidably guided for reciprocating motion between machined surfaces **46** on the base **20** and gib plates **47** rigidly secured to the machine base **20** by bolts **48**. Securely bolted to the right end of the crosshead **45** is the ram member **49**. This ram member **49** will be more fully explained in detail hereinafter.

Returning to the crankshaft **33**, it will be noted that a crankshaft gear **50** is mounted on the right end of the crankshaft **33**, see Fig. 3. Crankshaft gear **50** is in mesh with a similar gear **51**, hereinafter called the camshaft gear. Camshaft gear **51** is keyed to one end of a shaft **52**, hereinafter called the camshaft. Camshaft **52** extends laterally across the machine as viewed in Figs. 1 and 2. That is, the longitudinal axis of camshaft **52** is spaced below and is parallel with the longitudinal axis of the crankshaft **33**. The rotation of camshaft **52** supplies the actuating power for the wire feed mechanism, the wire cut-off mechanism, the indexing mechanism and the spindle return mechanism. These mechanisms are shown in schematic outline in Fig. 4 and reference to that view is suggested in following the description.

Wire feed mechanism

As stated before, the camshaft **52** carries on one end thereof the camshaft gear **51** through which the camshaft is rotated. On its other or forward end as viewed in Fig. 1, the camshaft **52** has keyed to it wire feed cam **53**. Wire feed cam **53** is designed to periodically engage feed cam roller **54** which is journalled on pin **55** carried intermediate the ends of feed cam lever **56**. The lower end of feed cam lever **56** is swingably mounted on pivot stud **57** mounted in a boss on the base **20**. The feed cam lever **56** is pivotally connected at its upper end to the left end of a longitudinally and upwardly extending feed link **58**. The feed link **58** is pivotally connected at its right end to feed roll operating lever **59**.

The feed roll operating lever **59** extends in a substantially vertical direction and is swingably mounted at its lower end on a pivot stud **60** securely mounted in a boss on the base **20**. The feed roll operating lever **59** is provided with a vertically extending guideway **61** in which a T-slot bolt **62** is mounted. The T-slot bolt **62** is vertically adjustable by stroke adjusting screw **63**. The stroke adjusting screw is rotatable in either direction by means of a manually operable stroke adjusting knob **64**. The T-slot bolt **62** has mounted thereon the left end, as viewed in Figs. 2 and 4, of stroke adjusting link **65**. The stroke adjusting link **65** extends substantially horizontally lengthwise of the machine to a point at which its right end makes a pin and slot connection with a pin **66** carried in a boss **67** on friction feed plate **68**, the link **65** having a slot **69** at said right end. To prevent lost motion movement of the slotted end of the link **65** relative to the pin **66**, a feed locking lever **70** is pivotally mounted on a shoulder stud **71** secured to the link **65**. When the feed locking lever **70** is interposed between the shoulder stud **71** and the pin **66** the relationship of the link **65** to the friction feed plate **68** is such that the friction feed plate **68** is responsive to any movement of the link **65**. When the locking lever **70** is lifted out of contact with the pin **66**, that is, when it is tilted in a position of rest against the stop **72** on the link **65**, the slot **69** permits longitudinal movement of the link **65** relative to the pin **66** and no movement of the friction feed plate **68** occurs.

The friction feed plate **68** is journalled on the end of lower feed roll shaft **73**. Shaft **73** extends laterally across the machine base extension **20***a*. The friction feed plate **68** has bolted thereto feed friction spider **74** which in turn is seated within a counterbore **75** in the hub of feed clutch gear **76**. Feed clutch gear **76** is keyed to the lower feed roll shaft **73** whereas friction feed plate **68** and friction feed spider **74** are movable independently of the gear **76** and the shaft **73**. However, the feed friction spider **75** and the feed clutch gear **76** when assembled with friction clutch rolls **77** and friction clutch springs **78** make up a one-way clutch mechanism for intermittently transmitting movement of feed link **58** to the lower feed roll shaft **73**. In addition, the feed clutch gear **76** is in mesh with upper feed roll shaft gear **79** which is keyed to the upper feed roll shaft **80**.

The upper feed roll shaft **80** is journalled in an upper feed roll shaft retainer **81**. The retainer **81** comprises a laterally extending member pivotally mounted at its left end, as viewed in Fig. 3 on a pin **82** secured to base extension **20***a*. The retainer **81** is provided on its upper surface near the end away from the pivotal mounting with a boss **83** adapted to act as a seat for one end of a compression spring **84**.

At their ends opposite the ends carrying the gears **76** and **79**, the lower and upper feed roll shafts **73** and **80** respectively have mounted thereon feed rolls **85**. Each feed roll **85** is provided with a peripheral groove **86** adapted to retain and guide the wire stock W from which the tubular rivets are to be manufactured.

The aforementioned compression spring **84** is adapted to control the pressure exerted by the upper roll **85** in holding the wire stock W between the two rolls. The compression spring **84** acts in a vertical direction between the upper right end of the shaft retainer **81** and a bridge **87** on the upper side of the base extension **20***a*. The spring **84** carries on its upper end a collar or spring block **88**. The bridge **87** is tapped to receive a pressure adjusting screw **89**, the lower end of which bears against the upper surface of the collar or spring block **88**. Thus, by selectively turning the adjusting screw **89** the pressure of the spring **84** may be adjusted to set the pressure of the feed rolls **85** on the wire stock at any desired amount or to compensate for a change of wire stock from one diameter to another.

The feed clutch gear **76** is provided with a hub portion **90** on the inner end thereof, the left end as viewed in Fig. 3. The hub portion **90** is adapted to be engaged by a lower feed roll brake shoe **91** and an upper feed roll brake shoe **92**, each brake shoe being suitably lined with a brake lining material. As best seen in Fig. 2, the lower and upper brake shoes **91** and **92** respectively are hinged at their left ends on a pin **93** securely mounted in the base extension **20***a*. The upper brake shoe **92** is also held fixed to the base extension **20***a* by a stud **94**. The frictional drag of the brake shoes on the feed clutch gear **76** may be selectively varied by means of an adjusting screw **95** connecting the two brake shoes at the ends thereof opposite their hinged connection. The foregoing braking device acts at all times as a drag brake and ensures that the action of the feed rolls **85** will be slow enough to feed the wire stock firmly and steadily.

Wire-cutoff mechanism

Although the wire feed mechanism is designed to feed a predetermined length of wire stock W for each revolution of the wire feed cam **53**, the accuracy of measurement obtainable is doubtful. Accordingly, provision is made for the accurate measurement and severance of the rivet blank from the wire stock.

The wire stock W after being fed between the wire feed rolls **85** is passed through a wire guide **96** which is a tubular member mounted in the machine base. From the guide **96** the wire next passes through a cut-off quill **97**, the cut-off quill being of hardened steel and having a sharp edge **98** at the exit end of the bore thereof. Figs. 5 and 6 in particular show the structure being described. After passing through the cut-off quill **97** the wire stock W passes into a cut-off die **99**.

Cut-off die **99** is mounted in the right end, as viewed in Fig. 5, of a cylindrical tubular member **100**. The tubular member **100** is carried in a bushing **101** which in turn is mounted in an aperture in the upper end **102** of a swinging arm, hereinafter designated cut-off arm **103**. The tubular member **100** which is a relatively elongated member carries an elongated pin **104** within its bore. The pin **104** has a reduced portion **105** at its right end as viewed in the drawings, which reduced portion is adapted to have a sliding fit within the bore **106** of the cut-off die. In axial alignment with the wire guide **96**, the cut-off quill **97**, the cut-off die **99** and the elongated pin **104** is an adjustable stock stop screw **107**. As the wire stock is fed through the wire guide **96**, through the cut-off quill **97** and then into the bore **106** of the cut-off die **99**, the free end of the wire abuts the end of the elongated pin **104** and moves the pin longitudinally to the left as viewed in Fig. 5. This movement continues until the pin **104** abuts the stock stop screw **107**. It will be apparent that the length of wire fed into the cut-off die **99** may be selectively varied by adjustment of the stock stop screw **107**.

A rivet blank B is severed from the wire rod by being sheared between the adjacent faces of the cut-off quill **97** and the cut-off die **99**. The shearing action takes place as the cut-off arm **103** is swung in a counterclockwise direction, as viewed in Fig. 3, from the position shown in Fig. 5 to the position shown in Fig. 6.

It will be noted that the cut-off arm **103** is pivoted intermediate its ends on a pin **108** journalled in the main base **20**.

A positive means is provided for swinging the arm **103** from its loading station, i. e., its position in Fig. 5, to its unloading station, i. e., its position in Fig. 6. The cyclical movements of the arm **103** originate at the camshaft **52**. A camshaft drive mitre gear **109** is mounted on the shaft **52** inboard of the forward end of the shaft. Gear **109** is in mesh with camshaft driven mitre gear **110** which is keyed to the left end of a longitudinally extending shaft **111**, the axis of rotation of shaft **111** being substantially at a right angle to the axis of rotation of shaft **52**.

Intermediate its ends the shaft **111** has keyed thereto two cams, cut-off cam **112** and cut-off return cam **113**. The cams **112** and **113** are spaced so as to permit cut-off cam yoke **114** to be positioned between them, each cam being in engagement with a roller or follower **115**. One follower **115** is mounted at the left end of the yoke **114** as viewed in Figure 4 and the other is mounted on the yoke intermediate the ends thereof, each follower **115** being on opposite sides of the yoke so as to be engaged by only one of the cams. The yoke **114** is guided and supported for sliding movement between the followers **115** on a cut-off cam yoke slide block **116**. The shaft **111** passes through the center of the slide block **116** and the yoke **114** slides to and fro relatively to the shaft **111** and slide block as the cams **112** and **113** rotatably engage the followers **115**.

At its right end **114***a* the yoke **114** is pivotally connected to the lower end **117** of the cut-off arm **103** by a cut-off arm eccentric pin **118**. The purpose of connecting the yoke **114** and cut-off arm **103** by means of an eccentric pin **118** is to permit the arm **103** to be adjusted relatively to the yoke so that adjustment of the alignment of the bore **106** of the cut-off die **99** with the bore of the cut-off quill **97** may be made when required.

The upper end **102** of the cut-off arm **103** is guided and supported during swinging movement of the cut-off arm by a cut-off arm support **119**. The support **119** is bolted to the top of the base **20** and is provided with guide surfaces **120** which are engaged by corresponding guide surfaces **121** on the upper end of the cut-off arm **103**.

Indexing mechanism

The cyclical movements of the indexing mechanism embodied in the present machine also originate at the camshaft **52**. As has been described in connection with the wire cut-off mechanism, camshaft drive mitre gear **109** is mounted on the shaft **52** inboard of the forward end of the shaft. Gear **109** is in mesh with camshaft driven mitre gear **110** which is keyed to the left end of the longitudinally extending shaft **111**. At its right end shaft **111** has keyed thereon spiral gear **122** which gear is in mesh with index idler gear **123** journalled on index idler gear stud **124**. The index idler gear **123** is in mesh with gear **125** which is keyed to a laterally extending die index cam shaft **126**. The cam shaft **126** is journalled on suitable bearings in the base extension **20***a*. Intermediate its ends the die index cam shaft **126** has keyed thereto die index cam **127**. Die index cam **127** is a cylindrical cam having the cam follower grooves **128** cut into the cylindrical surface. As the cam **127** is rotated the grooves **128** are successively engaged by cam followers **129** on a rotatable index plate **130**. In the present embodiment, the index plate **130** carries eight cam followers **106** indicating that there are 8 indexing movements for each complete revolution of the index plate **130**.

Index plate **130** is bolted to index spline bushing **131** and the latter encompasses and is splined to the right end of the longitudinally extending index spindle **132**. The foregoing splined mounting of the index plate **130** on the index spindle **132** is necessary since the spindle moves longitudinally relative to the index plate during the rivet forming operations as will be more fully explained.

Spindle return mechanism

In the description of the indexing mechanism, brief mention was made of the fact that the index spindle **132** moves longitudinally during the rivet forming operations. As viewed in Fig. 2, the index spindle **132** has on its right end a member which will hereinafter be designated die plate **133**. The structure of die plate **133** will be more fully described later. As the ram **49** moves to the right as viewed in Fig. 2, parts thereof abut the die plate **133** and carry the same to the right also. Thus the spindle

132 must also move longitudinally to the right. Accordingly, the spindle is journalled for axial and rotative movement in spindle bushing 134 which is mounted in the machine base 20. The spindle bushing 134 supports a substantial part of the left end of the index shaft or spindle 132. The index shaft 132 is supported inwardly of the right end in a bushing 135 carried in a bore in a rib 136 of the base extension 20*a*.

Mounted on the spindle 132 in abutting relation to a boss on the left side of the rib 136 is a thrust bearing 137. Immediately to the left of the thrust bearing 137 is a spring collar 138 and to the left of this is a coil spring 139. Threaded on the spindle 132 and in abutting relation to the left end of the spring 139 are an index shaft spring adjusting nut 140 and index shaft spring adjusting lock nut 141. The function of the spring 139 is to buffer the shock of the ram 49 striking the die plate 133 and also to return the die plate 133 and the spindle 132 to their normal position upon retraction of the ram. The pre-load on the spring may be varied by the manipulation of the adjusting nuts, as will be readily understood.

Although the spring 139 will function to restore the die plate 133 and spindle 132 toward their normal or initial position upon retraction of the ram it is deemed desirable to ensure a positive return of the die plate and spindle. This is accomplished through mechanism actuated by a cam carried on cam shaft 52. A spindle return cam 142 is keyed to cam shaft 52 inboard of the camshaft gear 51. As the cam 142 rotates it engages a cam follower or roller 143 which is journalled on return cam yoke 144. The return cam yoke 144 is guided and supported for sliding movement on its left end on return cam slide block 145. As most clearly seen in Fig. 4, cam shaft 52 passes through the slide block 145 and the yoke 144 slides to and fro relatively to the shaft 52 on the slide block 145 as the cam 142 rotates and engages the roller 143. To the right end of return cam yoke 144 there is fastened return bar 146. The return bar 146 passes through an aperture in the machine base 20, being guided by a return arm guide 147 fastened to the side wall of the base. The return arm guide 147 is capped by return arm guide plate 148. Thus, the return bar 146 is guided on all four sides.

At its right end the return bar 146 has a pin and clevis connection with the left end of return arm link (left hand) 149. The latter is connected by return arm adjusting nut 150 to return arm link (right hand) 151, the return arm links 149 and 151 and the adjusting nut 150 forming a toggle bolt assembly to permit the effective length of the return arm 146 to be varied when needed to adjust the stroke. The return arm link 151 has a pin and clevis connection with the lower end of a downwardly extending bell crank lever 152. The bell crank lever 152 is keyed to one end of a shaft 153 which is journalled on a bracket 154 mounted on the end of the base extension 20*a*.

Keyed to shaft 153 is an upwardly extending bell crank lever 155. At its upper end this bell crank lever is provided with a U-shaped portion 156 adapted to straddle the left end of the spindle 132. The legs of the U-shaped portion 156 abut a collar 157 carried on the left end of the spindle 132.

As the cam 142 rotates the bell crank levers 152 and 155 will be rocked at appropriate intervals causing a positive movement of the spindle to the left as viewed in the drawings. Thus, no reliance need be placed on the effectiveness of the spring 139 to accomplish the complete restoration of the die plate 133 and spindle 132 to their normal position upon retraction of the ram 49.

Rivet forming

Referring now to Fig. 9 therein is shown an enlarged fragmentary side elevational of the part of the machine at which the rivet forming operation occurs. Visible in this view are some parts which have been previously identified but not described in too great detail. These parts include the ram 49, the cut-off arm 103 and the die plate 133. One other part prominently shown in Fig. 9 but not heretofore identified is the punch plate 158. The plate 158 which is made of shock-resistant tool steel is fastened to the machine base 20 and is centrally bored to accommodate the spindle bushing 134 and the index spindle 132.

The shape of the face 159 of the ram 49 is best seen in Fig. 7. The face 159 of the ram is substantially circular except for two diametrically opposed ears 160 which project beyond the main perimeter of the ram 49. Each ear 160 is bored to receive an elongated guide pin 161. The guide pin 161 has an end portion 162 adapted to be held in the bore of the ear 160 of the ram, a center portion 163 of larger cylindrical cross-section and another end portion 164 having a tapered or rounded leading edge and adapted to fit into appropriate pilot holes in the die plate 133, as shown in Fig. 2.

As best viewed in Fig. 8, the die plate 133 is provided with 8 equally spaced pilot holes 165, each hole being lined with appropriate wear bushings 166.

As the ram 49 moves to the right from the position shown in Fig. 9, the end portions 164 of the guide pins enter a pair of diametrically opposite holes 165 in the die plate 133 thus ensuring that the die plate is securely held in alignment with the ram 49. As will be explained more fully, upon the end portions 164 of the guide pins 161 entering the guide holes 165 for a substantial part of the length thereof the die plate 133 is carried by the ram 49 to the right toward the punch plate 158. It is during this movement of the ram 49 and the die plate 133 toward the punch plate 158 that each rivet blank undergoes a forming operation. As illustrated, 8 such cyclical movements are required to form a completed tubular rivet.

In Fig. 5 the wire stock W is shown with the free end thereof fed from the cut-off quill 97 into the cut-off die 99. The length of wire received by the cut-off die 99 is predetermined by the setting of the stock stop screw 107 which limits longitudinal movement of the pin 104. As described, the pin 104 has a portion 105 which projects into the bore of the cut-off die 99 from the side opposite the side into which the wire W is fed.

The description of the sequence of movements will be commenced with the parts in the position shown in Fig. 5, that is, with the wire feed complete but just prior to the cut-off swing of the cut-off arm 103. The ram 49 is at this point in its fully retracted position, or stating this in another way, the crank pin 42 has reached the end of the crank back stroke and is just about to begin its forward movement. The sequence of movements will be described in terms of degrees of movement of the crank pin 42 from the zero position, the position at which the forward movement commences.

During the first 90° of crank forward movement, the cut-off arm 103 is swung from the position shown in Fig. 5 to the position shown in Fig. 6. The initial lateral movement of the cut-off die 99 relative to the cut-off quill 97 results in the wire stock being sheared off forming a rivet blank B. The cut-off arm 103 completes its swing toward its unloading position immediately before the ram 49 reaches the halfway mark in its forward travel. Means is provided on the ram 49 to cooperate with pin 104 to eject the rivet blank B from the cut-off die 99 and to insert the blank in a carrying or heading die 167. This means will be explained in greater detail hereinafter. The cut-off arm remains in the position shown in Fig. 6 for approximately the next 135° of crank travel. During this time the crank completes its forward stroke and travels one-fourth of the way back on its return stroke. After this the cut-off arm begins its swing back to the position shown in Fig. 5, that is, the position in which the cut-off die 99 is in alignment with the cut-off quill 97. This return swinging movement of the cut-off arm 103 occurs during the next 90 degrees of movement of the crank. To this point the crank has rotated 315 degrees of its travel. During the remaining 45 degrees of travel the cut-off arm is in a dwell during which time the wire is again being fed into the cut-off die **99**. As the crank reaches the zero position the wire feed is completed and the next cycle is ready to be commenced.

Referring to Fig. 7, it will be noted that the ram **49** is provided with a series of equally spaced holes **168** which are adapted to receive in some instances various punches or rivet head forming tools. The index or die plate **133**, as shown in Fig. 8, is provided with a corresponding series of equally spaced holes **169** adapted to receive the heading dies **167**. The punch plate **158** is also provided with a similar series of holes **170** adapted to receive the various punch tools which form the hollow portion of the rivet.

The location of the aligned holes **168** in the ram and the holes **170** in the punch plate **158** will be referred to as stations. In the illustrated embodiment of the invention there are eight pairs of aligned holes in the ram **49** and punch plate **158**. The die plate **133** has eight heading or carrying dies **167** mounted therein. And it has been previously mentioned that the index plate **130** which is mounted on the same spindle **132** as the die plate **133** has eight followers **129** adapted to engage the grooves **128** in the index cam **127**. The foregoing indicates that there are therefore eight stations at which an operation could be performed on the rivet blank B.

The first station is illustrated in detail in Fig. 6 and diagrammatically in Fig. 10. Referring to Fig. 6, a portion of the ram **49** is shown. At this station in the ram **49** there is mounted a bumper pin **171**. The bumper pin **171** is adapted on the forward movement of the ram **49** to abut pin **104** carried in the tubular member **100** and to drive the pin **104** to the right as viewed in Fig. 6. The portion **105** of the pin **104** thus is caused to enter the bore of the cut-off die **99** and to drive the rivet blank out of the cut-off die **99** into the heading or carrying die **167**. As the transfer of the rivet blank B is being accomplished, the guide pins **161** on the ram and other tools thereon have abutted the die plate **133** and are carrying the same toward the punch plate **158**. The tubular member **100** in which the pin **104** and cut-off die **99** are mounted has previously been described as being mounted in the end **102** of the swinging arm **103** in a bushing **101**. This construction permits the tubular member **100** to bodily move relative to the swinging arm **103** carrying the pin **104** and cut-off die **99** along with it so as to maintain the cut-off die in contact with the face of the heading or carrying die **167** and the end of the portion **105** of the pin **104** in contact with the end of the rivet blank even after the latter has been transferred to the carrying die **167**.

The punch plate **158** at its first station is provided with a back punch holder **172** adapted to receive and guide upset pin **173**.

As the upset pin **173** enters the bore of the carrying die **167**, the rivet blank B thereby becomes trapped between the end of the pin **104** and the end of the pin **173**. The metal blank is thus compressed longitudinally but expands diametrically filling up the bore of the carrying die **167** and thereby being brought up to size as far as the desired outside diameter is concerned.

The upset pin **173** is backed up by a spring **174**, a backing pin **175**, and an adjusting screw **176**. As seen, by a comparison of Figs. 5 and 6, the spring **174** permits the upset pin **173** to move to the right until the head **177** thereon abuts the end of the portion **178** of the backing pin **175**. It will be readily apparent that by moving the adjusting screw **176** inwardly or outwardly the distance the upset pin **173** is permitted to travel to the right against the spring **174** may be varied to suit the length of rivet to be manufactured.

The rivet blank B having been loaded and fitted into the carrying die **167** at the first station, it is now ready to be carried or indexed to the next station.

In terms of crank arm **42** travel, the die plate **133** has been in a dwell or non-rotating position from the 45 degree position of the crank, that is, the crank has travelled one-fourth of its forward travel. It will be recalled that the cut-off arm **103** did not reach the first station or the position shown in Fig. 6 until the crank arm and therefore the ram **49** had travelled a distance equal to half their forward travel. Thus, the die plate **133** had completed its last indexing movement well before the ram **49** and cut-off arm **103** were in position to transfer the rivet blank from the cut-off die **99** to the carrying die **167**. The die plate **133** remains in its dwell or non-rotatable condition for the next 225 degrees of crank travel or until the crank has completed one-half of its return travel. However, due to the action of the spindle return mechanism, as soon as the ram **49** begins its back stroke the spindle **132** and therefore the die plate **133** are bodily shifted to the left from the position shown in Fig. 6 to their original position shown in Fig. 5. This return movement is completed by the time the crank arm **42** has completed one-half of its return travel. Thus, the end of the dwell or non-rotating period of the die plate **133** and the end of the spindle return occurs simultaneously. The die plate **133** is then indexed to carry the newly loaded carrying die **167** to the next station, the die plate being rotated in a counterclockwise direction as viewed in Fig. 8. The indexing movement of the die plate **133** in the illustrated embodiment of the invention begins at the 270 degrees point in the movement of the crank arm **42** and continues as the crank arm completes its one cycle and until the crank arm has travelled 45 degrees of its next cycle.

At its second station the ram **49** is provided with a ram punch **179** having a cylindrical recess **180** therein. The punch plate **158** has mounted therein at its corresponding or second station a flaring punch **181**, that is a punch having a conical point. As the ram **49** is moved forward by the crank **42** and abuts the die plate **133** and carries the same toward the punch plate **158**, the flaring punch **181** penetrates the rivet blank B and begins the piercing thereof. The cylindrical recess **180** in the ram punch **179** is equal in diameter to the rivet blank diameter and therefore permits the displacement of a portion of the rivet blank out of the carrying die **167**. This displaced portion of the rivet blank will provide the material for the upsetting of the rivet head. The flaring operation having been completed the rivet blank B is then carried by the die plate **133** to the next or third station.

At the third station the ram **49** is provided with a ram punch **182** having a semi-spherical seat **183** in the end thereof, the seat **183** having the shape of the rivet head to be formed. The punch plate **158** at this station is provided with a punch **184** having an elongated cylindrical portion **185** tipped with a radius. Thus, as the ram punch **184** is upsetting a head on the rivet blank B the punch **182** is lengthening the hollow within the rivet blank begun by the flaring punch **181**.

At the fourth station, the ram punch **182** is the same as used at the third station. The punch plate **158** is provided at this station with merely a back-up punch **186**. The operation at this station, as illustrated is only a repeat of the head upsetting operation as performed at station 3. It will be readily apparent however that if desired some additional operation could be performed at this station by providing the appropriate ram punch and back-up punch.

At the fifth station the ram may have mounted therein a ram punch **187** as shown. The ram punch **187** has an enlarged cylindrical recess **188** in the end thereof adapted not to engage the formed rivet head. It will be noted that the bore of each carrying die **167** is tapered on the end thereof at which the punches mounted in the punch plate **158** are adapted to enter. In the case of a long rivet blank some of the rivet metal will flow toward the tapered end of the carrying die bore and accordingly the rivet will be flared at the bottom. The fifth station has for its function the straightening of the outer wall of the semi-formed rivet R. The punch **189** carried in the punch plate **158** has an elongated cylindrical portion **190** of sufficient length to bodily push the rivet R partially out of the carrying die **167** on the ram side thereof. As shown the rivet head extends well into the recess **188** within the ram punch **187** and all of the rivet body is within the true cylindrical portion of the bore of the carrying die **167**.

At the sixth station the ram **49** has mounted therein piercing die **191**. The die **191** has a semi-spherical seat **192** in the end thereof contoured to fit the rivet head. The contoured seat **192** leads to a cylindrical bore **193** of a diameter sufficient to receive with a slip fit in the elongated cylindrical end portion **194** of the piercing punch **195**. With reference, to the shape of the rivet at the fifth station, it will be noted that only a thin section of metal prevents the rivet from being totally hollow. At the sixth station this small slug of rivet stock is pushed out and the rivet R is made completely hollow. Except for the little slug of metal lost in this piercing operation all of the original mass of metal in the rivet blank remains in the body of the rivet thereby forming a sturdy and high quality rivet.

Upon arrival at the seventh station the rivet is substantially complete. The ram punch **196** used at this station has a semi-spherical seat **197** having a small button **198** at the base thereof. This button **198** is adapted to press a chamfer on the upper end of the bore in the rivet R thereby removing any burrs or sharp edges resulting from the final piercing operation.

The rivet leaves the seventh station in completed form and it is only necessary to eject the same from the carrying die **167**. This ejection takes place at the eighth station. At this station the ram **49** is provided with a ram punch **199** which consists merely of a tube having an opening **200** in the bottom thereof. The punch plate **158** has mounted therein an ejector punch **201** which is adapted to completely push the rivet out of the carrying die **167** so that it will fall through the opening **200** in the ram punch **199** and drop into the machine discharge chute **202**. The carrying die **167** thus becomes available for reloading.

If the die plate **133** carried only one carrying die **167** with a rivet blank therein, it is apparent that eight revolutions of the crank arm **42** would be required before a single rivet were produced. But it will be understood that normally each time the die plate is indexed one station, a completed rivet is ejected on the next forward movement of the ram and a new rivet blank is loaded into a carrying die **167**. Thus, normally each revolution of the crank arm **42** results in the completion of another tubular rivet.

Although the foregoing description of a rivet forming process has dealt with the forming of a completely hollow or tubular rivet, it will be readily apparent that the present machine may be utilized for manufacturing rivets which have only a hollow stem portion. To manufacture partially hollow rivets it would be necessary only to shorten the punch **184**, also the punch **189** and eliminate the piercing operation at the sixth station.

Thus, the present machine is readily adaptible to the production of completely hollow or partially hollow rivets and long or short ones. Once the dies and punches are in place, the only attention required by the machine is a sufficient supply of wire rod and a periodic removal of the tray of completed rivets. The conversion of the wire rod into completed rivets is completely mechanically controlled and therefore the quality of the rivet is independent of the manual dexterity of the machine attendant.

As a safety feature the machine is provided with a foot operated braking means. This consists of a brake peddle **203** pivotally mounted near the bottom of the machine base **20** on a pin or shaft **204** journalled in a bracket or boss **205** cast into the base. Pivoted to the base **20** in position to engage the inner rim **206** of the pulley **32** is a brake shoe **207**. The brake shoe **207** is pivoted on brake shoe pivot pin **208** mounted in the machine base **20**. Pressure is transmitted from the brake peddle **203** to the brake shoe **207** by means of a toggle bolt arrangement consisting of upper brake operating link **209**, lower brake operating link **210** and brake link adjusting nut **211**. The upper brake operating link **209** is pivotally connected to the brake shoe **207** by a pivot pin **212**. The lower brake operating link **211** has a pin **213** and clevis connection with the brake peddle.

I claim:

1. In a tubular rivet forming machine, a first set of annularly arranged stationary punches, a second set of annularly arranged reciprocable punches, a blank holder interposed between said sets of punches and having openings to receive a set of rivet forming blanks, said blank holder having an indexing position in which it is spaced from said sets of punches, means for indexing said blank holder when disposed in its indexing position thereby to align the blanks with said punches, reciprocating ram means for shifting said second set of punches in unison during a portion of the travel thereof toward and relatively to said blank holder and thereafter shifting said blank holder with said second set of punches during the remainder of the travel of the latter in one direction into operative relation to said first set of punches to cause said sets of punches to operate on said blanks at opposite sides thereof, means for reciprocating the ram means, a reciprocating spindle connected to said blank holder, reciprocable drive means for said spindle, cam operated means controlled by said drive means for shifting said spindle and thereby said blank holder away from said first set of punches into indexing position and in unison with said second set of punches during a portion of the return travel thereof.

2. A tubular rivet forming machine according to claim 1 wherein said ram means is provided with guide members adapted to enter guide apertures in said blank holder for holding said ram means and blank holder in predetermined circumferential relation.

3. In a tubular rivet forming machine, a first set of annularly arranged stationary punches, a second set of annularly arranged reciprocable punches, a blank holder interposed between said sets of punches and having openings to receive a set of rivet forming blanks, said blank holder having an indexing position in which it is spaced from said sets of punches, means including a reciprocable and rotatable spindle connected to said blank holder for indexing said blank holder when disposed in its indexing position thereby to align the blanks with said punches, reciprocating ram means for shifting said second set of punches in unison during a portion of the travel thereof toward and relatively to said blank holder and thereafter shifting said blank holder with said second set of punches during the remainder of the travel of the latter in one direction into operative relation to said first set of punches to cause said sets of punches to operate on said blanks at opposite sides thereof, means for reciprocating the ram means, drive means for imparting rotatable movement to said spindle thereby to index said blank holder, and cam operated means controlled by said drive means for axially shifting said spindle and thereby shifting said blank holder away from said first set of punches into indexing position and in unison with said second set of punches during a portion of the return travel thereof.

4. A tubular rivet forming machine according to claim 3 wherein said drive means includes an index member having a splined mounting on the spindle to provide for axial shifting of the spindle relatively thereto.

5. A tubular rivet forming machine according to claim 3 wherein said ram means is provided with guide members adapted to enter guide apertures in said blank holder

and to abut portions of the latter to cause said ram means to impart shiftable movement to said blank holder.

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