April 17, 1962 C. W. BAUGH ETAL 3,029,665

METHOD AND APPARATUS FOR APPLYING RIVETS

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FIG. 1.

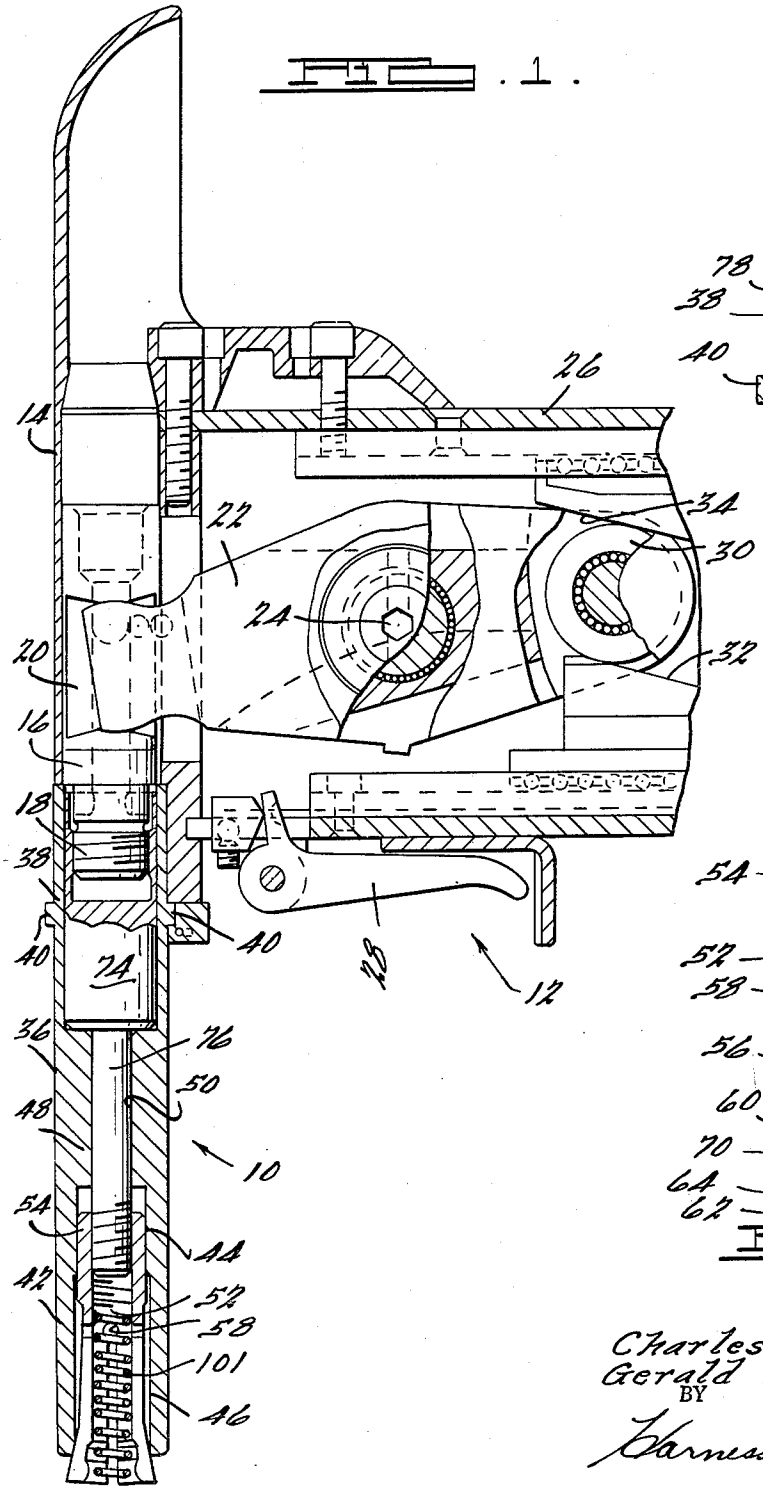
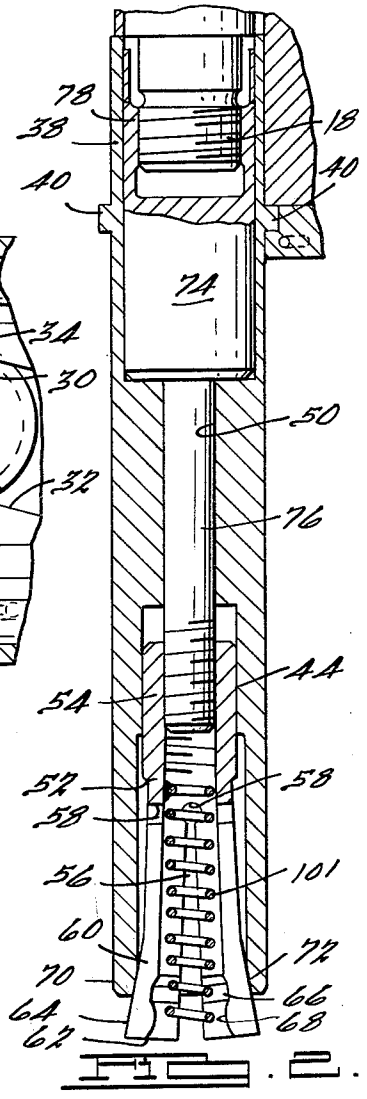


FIG. 2.



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METHOD AND APPARATUS FOR APPLYING RIVETS

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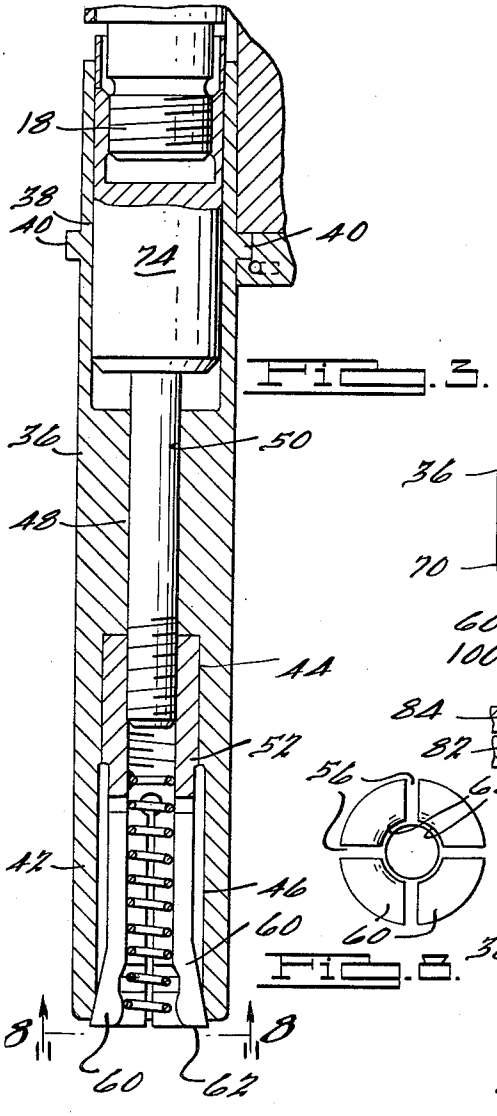


FIG. 3.

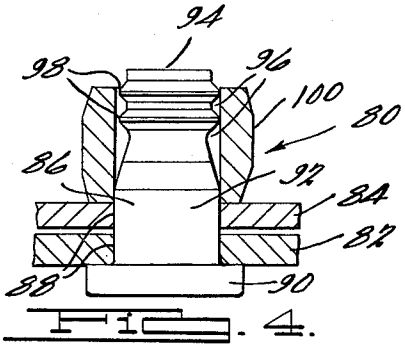


FIG. 4.

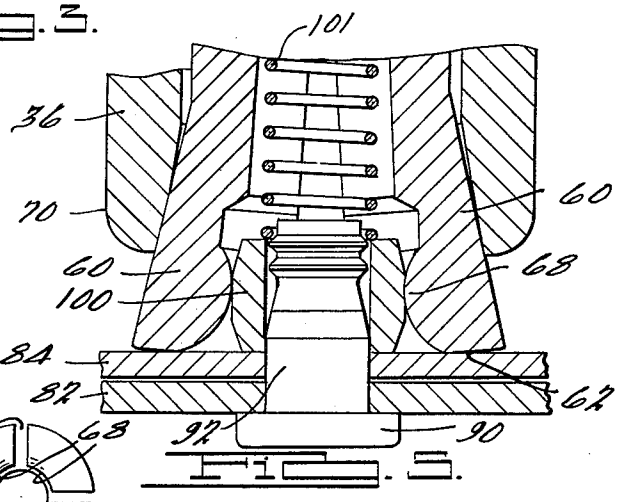


FIG. 5.

FIG. 6.

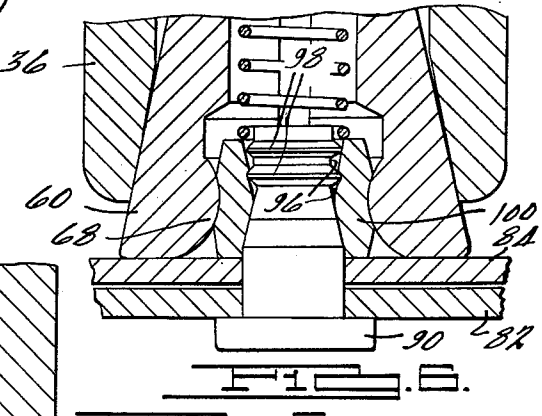
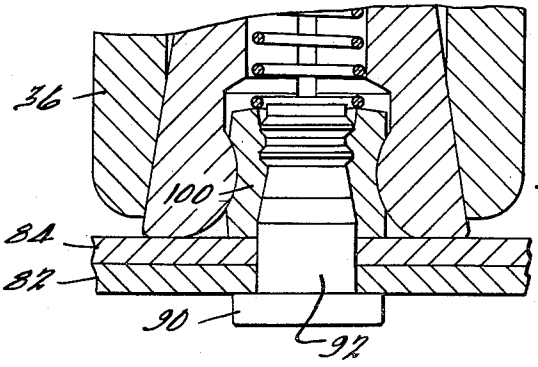


FIG. 7.



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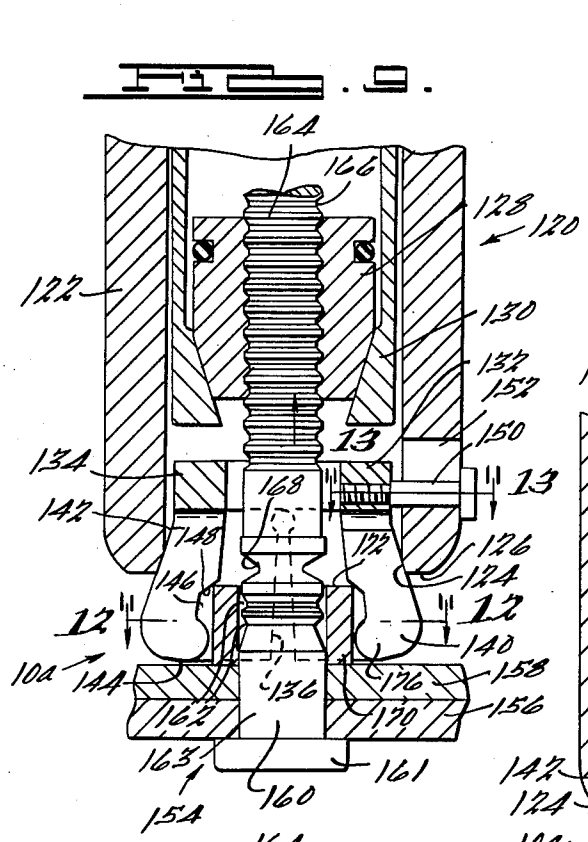

FIG. 9.

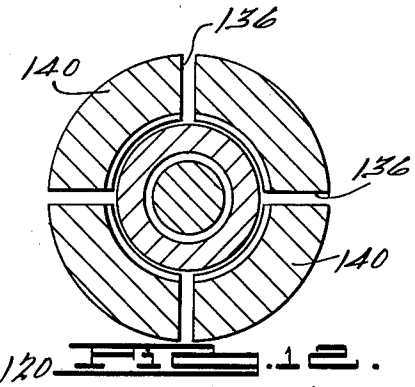

FIG. 12.

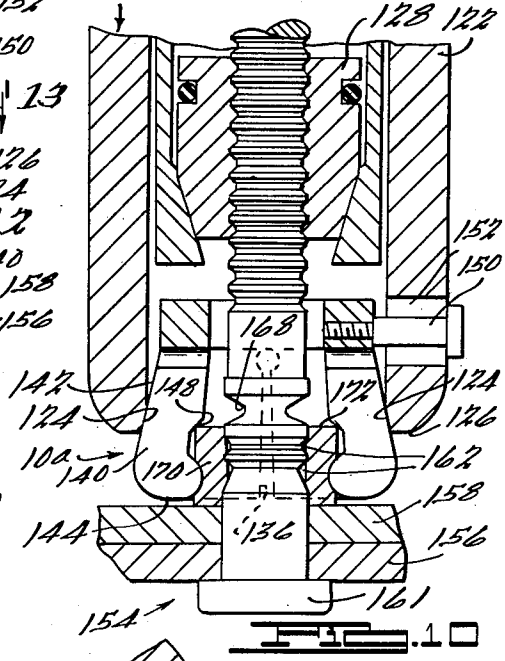

FIG. 10.

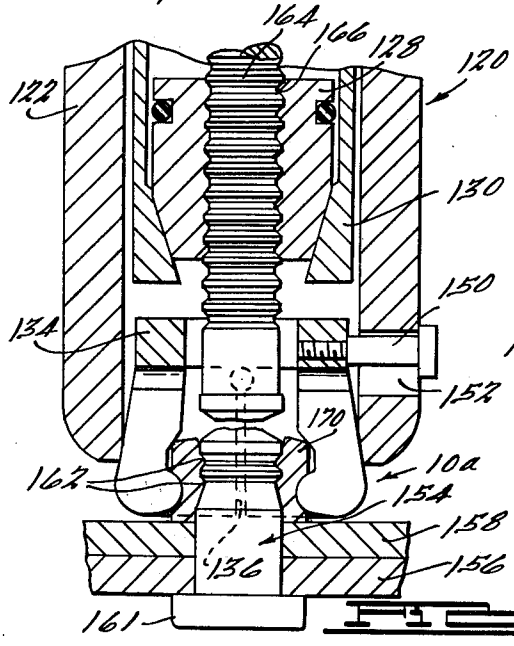

FIG. 11.

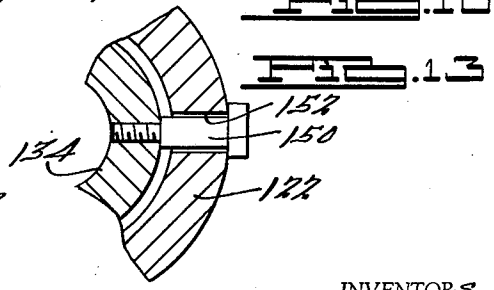

FIG. 13.

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United States Patent Office 3,029,665 Patented Apr. 17, 1962

3,029,665

METHOD AND APPARATUS FOR APPLYING RIVETS

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Filed Sept. 3, 1957, Ser. No. 681,487
4 Claims. (Cl. 78—46)

This invention relates generally to rivets and more particularly to a method and apparatus for applying rivets.

Rivets of one type commonly include a stump or pin having a head and a shank provided with locking grooves. A collar which is first loosely fitted on the shank is adapted to be forced into frictionl engagement with the shank at the locking grooves by a variety of riveting tools. Many of these tools employ an anvil or sleeve which moves longitudinally over the collar to swage the collar into the locking grooves and depend for a desired operation on a particular collar shape. Furthermore, it is well known that the fatigue life of substantially any connector is increased when a tension pre-load is maintained in the connector, that is, when the pin is under a tension load when it has been set.

An object of this invention, therefore, is to provide an improved method and apparatus for applying or setting rivets of the above type.

A further object of this invention is to provide a method and apparatus for applying rivets of the above type by crimping the collar into the locking grooves in a manner such that a tension pre-load is maintained in the pin or stump.

Another object of this invention is to provide apparatus for applying rivets of the above type which is adapted for attachment with rivet guns which are now available and which is useable with rivet collars of different shapes.

A further object of this invention is to provide apparatus for applying rivets of the above type which is simple in construction, economical to manufacture, and efficient in operation in setting rivets in the desired manner.

Further objects, features and advantages of the above invention will become apparent from a consideration of the following description, the appended claims, and the accompanying drawing in which:

FIG. 1 is a fragmentary longitudinal sectional view of one type of a riveting gun, showing the apparatus of this invention in assembly relation therewith;

FIG. 2 is an enlarged fragmentary sectional view of a portion of the structure shown in FIG. 1, and showing the crimping jaws for the apparatus of this invention in an extended spread position;

FIG. 3 is an enlarged longitudinal sectional view, illustrated similarly to FIG. 2, and showing the jaws in a retracted position;

FIG. 4 is a sectional view showing a stump and collar rivet in condition for setting to connect a pair of parts;

FIGS. 5, 6 and 7 are views like FIG. 4 of the rivet shown therein, showing the successive positions of the rivet as the apparatus of this invention is applied thereto;

FIG. 8 is a view looking substantially along the line 8—8 in FIG. 3;

FIGS. 9, 10 and 11 are sectional views corresponding substantially to FIGS. 5, 6 and 7 showing a modified form of the apparatus of this invention in assembly relation with a rivet of the pin and collar type and another type of riveting gun; and

FIGS. 12 and 13 are transverse sectional views looking along the lines 12—12 and 13—13, respectively, in FIG. 9.

With reference to the drawing, the riveting apparatus of this invention, hereinafter referred to as a "crimping mechanism," and indicated generally at 10, is illustrated

in FIG. 1 in assembly relation with a riveting gun 12 of well known type. As best appears in FIG. 1, the gun 12 includes a housing 14 and a piston 16 mounted for reciprocating movement within the housing 14 and having a threaded front end portion 18. The piston 16 is formed on opposite sides with recesses 20, only one of which is shown, for receiving corresponding portions of one end of a fork member 22 supported intermediate its ends on a pivot 24 carried on a handle 26 for the gun 12. The opposite end of the fork 22 carries a roller 30 which is adapted to roll between inclined guides 32 and 34 that are movable within the handle 26 toward and away from the pivot 24. It is apparent that on movement of the guides 32 and 34 away from the pivot 24, the fork 22 is swung in a counterclockwise direction about the pivot 24 for moving the plunger 16 in a forward direction. Likewise, when the guides 32 and 34 are moved toward the pivot 24, the fork 22 is moved in a clockwise direction to move the piston 16 rearwardly. A trigger 28 on the handle 26 operates a hydraulic or other mechanism, in a well known manner, to move the guides 32 and 34 in the desired direction.

The crimping mechanism 10 includes a hollow barrel 36 having a tubular inner end portion 38 provided with diametrically opposite ears 40. The barrel 36 also includes a tubular outer end portion 42 having an inner bore section 44 and an outer bore section 46 which is of a slightly larger diameter than the section 44. An intermediate section 48 of the barrel 36 has a bore 50 extended therethrough which is of a reduced size relative to both the bores 44 and 46.

Positioned within the outer end portion 42 of the barrel 36 is a tubular crimping collet 52 (FIGS. 2 and 3) having an internally threaded inner end portion 54 slidably supported within the bore section 44. The collet 52 is provided with four slots 56 located outwardly of the inner end portion 54 and terminating at their inner ends in holes 58. The slots 56 are equally spaced and thus divide the collet into four elongated jaws or fingers 60 (FIG. 8), each of which is of a width corresponding to substantially one fourth of the circumference of the collet 52. Adjacent its outer end 62, the collet 52 is of a uniformly increasing diameter to provide each jaw 60 with an outwardly inclined outer surface 64 for a purpose to appear later.

Inwardly of the outer end 62 of the collet 52, each jaw 60 has a transversely extended relief groove 66 on its inner side and between the groove 66 and the outer end 62 each jaw is provided with a rounded radially inwardly extended projection or knob 68. An expander plug (not shown) is inserted in the collet 52 prior to heat treating of the collet so that in its final form, the collet is stressed such that the jaws 60 are spread apart as illustrated in FIGS. 1 and 2. To contract the collet 52 or, in other words, move the jaws 60 inwardly toward each other, it is necessary to move the inner end portion 54 of the collet 52 rearwardly in the inner bore section 44 to progressively engage the inclined jaw surfaces 64 with the outer end 70 of the barrel 36, which has a beveled inner surface portion 72 to reduce wear on the jaws 60.

A plunger 74 slidably supported in the inner barrel portion 38 has an elongated stem 76 extended through the reduced bore 50 and threaded into the inner end portion 54 of the collet 52. To move the jaws 60 to fully moved-apart positions, as shown in FIGS. 1 and 2, the plunger 74 is moved to a stop position engaged with the intermediate barrel portion 48. The extent of movement of the jaws 60 in directions to expand the collet 52 is of course adjustable by advancing or retracting the stem 76 within the collet 52 since such adjustment determines the extent of outward movement permitted the jaws 60 by the barrel 36. The contracted position of the collet 52,

corresponding to positions of the jaws **60** in which the jaws are moved inwardly toward each other, is illustrated in FIG. 3 and is defined by the engagement of the inner end portion **54** of the collet **52** with the intermediate barrel portion **48**.

In the assembly of the crimping mechanism **10** with the gun **12**, the barrel **36** is supported on the gun casing **14** in a position in which one of the ears **40** is interlocked with the casing **14** and the end portion **18** of the piston **16** is threaded into an inner end portion **78** of the plunger **74** as shown in FIG. 1. Thus, on operation of the gun **12** to retract the piston **16**, the jaws **60** are moved inwardly toward each other to the stop position of the collet **52** illustrated in FIG. 3. Conversely, on operation of the gun **12** to move the piston **16** outwardly, the jaws **60** are moved apart to the positions illustrated in FIGS. 1 and 2 corresponding to an expanded condition of the collet **52**.

In the operation of the crimping mechanism to set the rivet indicated generally at **80** in FIG. 4, assume that a pair of parts or plates **82** and **84** are to be connected by the rivet **80**. The rivet **80** consists of a stump **86**, extended through aligned openings **88** in the plates **82** and **84** and a collar **100** positioned on the stump **86**. The stump **86** has a shank **92**, which is illustrated as being of a size providing for an interference fit in the openings **88** although it is to be understood that such an interference fit is not required and the mechanism **10** is used with rivets in which a more loose fit is involved. In addition, the stump **86** includes a head **90** located at one end of the shank **92** and positioned in engagement with the plate **82**. Adjacent its terminal end **94**, the shank **92** is formed with locking grooves **96** and ridges **98** for a purpose to appear later. The collar **100** is supported on the shank **92** in a position extended about the shank **92** at the grooves **96** and against the plate **84**.

The gun **12** is first moved to a position in which the collet **52** is positioned about the collar **100** with the outer end **62** of the collet **52** against the plate **84** as shown in FIG. 5. A coil spring **101** positioned within the collet **52** and secured at the inner end thereof to the inner end portion **54** of the collet, has its outer end engaged with the end of the collar **100**. As a result, the spring **101** acts to exert a yieldable force on the collar **100** holding the collar against the adjacent plate **84**. The trigger **28** is then operated to retract the piston **16** to in turn retract the collet **52** relative to the barrel **36**. Concurrently with this manipulation of the trigger **28**, forward pressure is exerted on the gun **12** to maintain the end **62** of the collet **52** against the plate **84**. As a result of this concurrent manipulation of the gun **12** and the trigger **28**, the barrel **36** is in effect moved toward the plate **84** to move the jaws **60** inwardly toward each other as illustrated in FIG. 6.

The curved projections **68** on the jaws **60** thus act to squeeze or crimp the collar **100** as shown in FIG. 6 so that the collar is progressively swaged into engagement with the locking grooves **96**. By virtue of this swaging, the collar **100** is interlocked with the shank **92** at the grooves **96** and the ridges **98**. Continued movement of the barrel **36** toward the plate **84**, therefore, acts to further pinch or squeeze the collar **100** so that the collar material is moved in a direction axially of the collar.

Since the collar is engaged with both the plate **84** and the ridges **98**, the shank **92** is effectively pulled over the length thereof between the head **90** and the ridges **98**. As a result, the plates **82** and **84** are pulled tightly together to insure a complete "pull through" of the stump **86** and eliminate any gap between the plates, as shown in FIGS. 6 and 7. In the final set position of the rivet **80**, the collar **100** has been effectively lengthened as illustrated in FIG. 7 to in turn stretch the shank **92** and apply a tensile pre-load to the stump **86**. In other words, by virtue of the curved projections **68** on the jaws **60**, the collar material is first interlocked with the stump **92** at the ridges **98** and the grooves **96** following which the collar material is further expanded or stretched in an axial direction to apply a tensile pre-load to the stump. Such a pre-load effectively increases the fatigue life of the rivet **80**, and prevents any loosening of the stump or the collar **100** during use of the parts **82** and **84**.

Two locking grooves **96** and ridges **98** are illustrated for the rivet **80** so that the rivet can be used for connecting workpieces **82** and **84** of thicknesses within predetermined limits or grip lengths.

A modified form of the crimping mechanism of this invention, indicated generally at **10*a***, is illustrated in FIGS. 9–13, inclusive. The mechanism **10*a*** is adapted for assembly with a riveting mechanism of well known type, indicated generally at **120**, which includes an outer sleeve or anvil member **122** having an inwardly tapered inner surface **124** adjacent its terminal end **126**. The mechanism also includes a plurality of jaws **128** which are adapted to be contracted and moved rearwardly within the sleeve **122** by a jaw contracting and moving element **130**.

A pull member (not shown) like the plunger **74** for the pull gun **12** illustrated in FIG. 1 is associated with the element **130** for selectively moving the element **130** rearwardly within the sleeve **122**.

The crimping mechanism **10*a*** includes a collet **132** having a tubular inner end portion **134** positioned within the sleeve **122**. The collet **132** is provided with four equally spaced slots **136** extending outwardly from the inner end portion **134** to divide the collet into four jaws or fingers **140** arranged in a circular formation transversely of the collet **132**. Over the length of the jaws **140**, the collet **132** is of a uniformly increasing diameter to provide each jaw with an outwardly inclined outer surface **142** for a purpose to appear later. Inwardly of the outer end **144** of the collet **132**, each jaw **140** is formed with a transversely extended relief groove **146** bounded on its inner side by an inwardly inclined surface **148**.

The collet **132** is initially heat treated like the collet **52** previously described so that the collet is stressed to provide for a natural outward flaring of the jaws **140**. To reduce the substantially circular area bounded by the jaws **140**, they must be manually moved inwardly toward each other. In the illustrated embodiment of the invention shown in FIGS. 9–13, this is accomplished by moving the sleeve **122** toward a position completely surrounding the jaws **140**. The sliding engagement of the inclined sleeve surface **124** with the correspondingly inclined jaw surfaces **142** facilitates the movement of the sleeve member **122** outwardly on the collet **132** to contract the jaws.

The spread position of the jaws **140**, corresponding to an expanded condition of the collet **132**, is illustrated in FIG. 9. The inwardly moved position of the jaws **140**, corresponding to a contracted condition of the collet **132**, is illustrated in FIG. 11. The natural tendency of the jaws **140** to move away from each other and the cooperating sliding surfaces **124** and **142** provide for an automatic movement of the collet **132** from the FIG. 11 to the FIG. 9 position whenever the reaction force on the sleeve **122** is released. A set screw **150** carried by the inner end portion **134** of the collet **132** is guidably supported in a slot **152** in the sleeve **122** to prevent accidental movement of the collet **132** out of an assembly relation with the sleeve **122**.

In the operation of the crimping mechanism **10*a*** to set the rivet indicated generally at **154** in FIGS. 10 and 11, and connect a pair of plates **156** and **158**, the mechanism **10*a*** is initially moved to the position illustrated in FIG. 9. As shown in FIG. 9, the rivet **154** includes an elongated pin **160** formed with a head **161** and a shank **163** extended through the plates **156** and **158**. The shank **163** is formed with locking grooves **162** like the locking grooves **96** formed on the stump **86** and, in addition, is provided with a tail or pull portion **164** formed with pull grooves **166** adapted to be engaged by the jaws **128** on the

riveting mechanism **120**. Between the locking grooves **162** and the pull grooves **166**, the shank **163** has the usual breakneck groove **168**. The rivet **154** also includes a tubular collar **170** supported on the shank **163** at a position extending about the pull grooves **162** and with one end against the plate **158**.

With the mechanism **10***a* in the position illustrated in FIG. 9, the jaws **140** encircle the collar **170** and the inclined jaw surfaces **148** are in engagement with the outer end **172** of the collar **170** for maintaining a pressure against the collar **170** to continuously hold the collar in a position against the adjacent plate **158**. The gripping jaws **128** are in engagement with the pin **160** at the pull grooves **166** and when the riveting mechanism **120** is operated to retract the jaws **128** a pull is exerted on the pin **160**. The reaction force to this pull is applied in an opposite direction through the sleeve **122** to the jaws **140**. Accordingly, the sleeve **122** is moved toward the plate **158** with the sleeve surface **124** sliding on the jaw surfaces **142** to progressively move the jaws **140** inwardly toward each other as illustrated in FIG. 10.

Each jaw is formed with a curved knob or inward projection **176** which acts in response to inward movement of the jaws **140** to squeeze or crimp the collar **170** as shown in FIG. 10 so that the collar, intermediate its ends, is progressively swaged into engagement with the shank **163** at the locking grooves **162**. By virtue of this swaging, the collar **170** is interlocked with the pin **160** at the grooves **162**.

Continued movement of the sleeve **122** toward the plate **158**, in response to pull of the jaws **128** on the shank **163**, acts to further pinch or squeeze the collar **170** so that the collar material is extended in a direction axially of the collar. As best appears in FIGS. 9, 10 and 11, the jaws **140** are of a length outwardly of the inclined surfaces **148** and relative to the length of the collar **170** such that clearance is provided between the outer ends **144** of the jaws **140** and the plate **158** during crimping of the collar **170**. On crimping movement of the jaws **140**, the inclined jaw surfaces **148** ride on the outer end of the collar **170** so as to continually exert the desired force on the collar **170** for maintaining the collar in position against the plate **158**.

The pulling force on the pin **160** provides the desired pull together of the plates **156** and **158** prior to any swaging of the collar **170**. After initial swaging of the collar **170** into the grooves **162**, continued crimping of the collar provides for an elongating of the collar between the grooves **162** and the plate **158**. Since the collar is engaged with both the plate **158** and the pin **160** at the grooves **162**, this elongating of the collar causes a pulling force to be exerted on the pin between the pin head and the grooves **162**. In other words, the collar **170** is lengthened to in turn stretch the pin **160** and apply a tensile pre-load to the pin. Continued pull on the jaws **128** causes the usual fracture of the shank **163** at the breakneck groove **168**. This sequence of operation is insured merely by forming the collar **170** of a material which is of a requisite hardness, without requiring special collar shapes to develop "hold off" as is the case with most riveting apparatus now in common use. If the collar material is too soft, the collar may be swaged into the locking grooves on the shank before the plates to be connected have been pulled tightly together or before the pin has been completely pulled through the plate openings. In the event the collar is too hard, the pin **160** may fracture prematurely before the desired swaging has been accomplished.

From the above description, it is seen that this invention provides crimping mechanisms **10** and **10***a* for applying a collar to the shank of a stump or a pin for a rivet. It is apparent that the mechanisms **10** and **10***a* are not limited to use with a collar of any particular shape. Accordingly, specially shaped collars are not required when setting rivets with the mechanisms **10** and **10***a*. Furthermore, as a result of the fact that the mechanisms of this invention are not limited to use with any particular collar shape, they are readily used to salvage improperly swaged collars which have been applied with rivet setting mechanisms of conventional type.

It is to be understood that while the crimping mechanism **10** has been particularly described with respect to its use with the gun **12**, it is useful with any tool which is operable to apply a pull to the plunger **74** to contract the jaws **60**. Also, the mechanism **10***a* is usable with any rivet setting device which will concurrently apply a pull to the pin **160** and contract the jaws **140**.

Although the invention has been described with respect to several embodiments thereof, it is to be understood that it is not to be so limited, since changes can be made therein which are within the scope of this invention as defined by the appended claims.

What is claimed is:

1. Apparatus for applying a fastener which includes a pin having a head and a shank and locking grooves formed in the shank at a position spaced from said head and a collar disposed on said shank at a position in radial alignment with said locking grooves, said apparatus comprising a tool having a tubular barrel provided with an open end, a tubular collet provided with a plurality of slots extending lengthwise thereof from one end of the collet and terminating short of the opposite end thereof to form a plurality of elongated jaws, said jaws being spaced apart circumferentially of said collet and arranged in a spread-apart formation about the axis of said collet so that at said one end thereof said collet is of a diameter greater than the inner diameter of said open barrel end, said collet being supported in said barrel so that said one end thereof projects out of said open barrel end, said collet and barrel being movable relative to each other in an axial direction to provide for movement of the collet inwardly of the open end of the barrel so that the barrel moves said jaws radially inwardly of the collet at said one end of the collet, said collet having an annular stop therein concentric with the axis thereof and surrounding an axial opening through which said pin can extend so that said stop is positionable about said pin in engagement with one end of said collar.

2. Apparatus for applying a fastener which includes a pin having a head and a shank and locking grooves formed in the shank at a position spaced from said head and a collar disposed on said shank at a position in radial alignment with said locking grooves, said apparatus comprising a tool having a tubular barrel provided with an open end, a tubular collet provided with a plurality of slots extending lengthwise thereof from one end of the collet and terminating short of the opposite end thereof to form a plurality of elongated jaws, said jaws being spaced apart circumferentially of said collet and arranged in a spread-apart formation about the axis of said collet so that at said one end thereof said collet is of a diameter greater than the inner diameter of said open barrel end, said collet being supported in said barrel so that said one end thereof projects out of said open barrel end, means on said tool connected to the opposite end of said collet for effecting a relative movement of the collet and barrel to provide for movement of the collet in a direction inwardly of the barrel so that the barrel moves said jaws radially inwardly of the collet at said one end of the collet, said collet having an annular stop therein concentric with the axis thereof and surrounding an axial opening through which said pin can extend so that said stop is positionable about said pin in engagement with one end of said collar.

3. Apparatus for applying a fastener which includes a pin having a head and a shank and locking grooves formed in the shank at a position spaced from said head and a collar disposed on said shank at a position in radial alignment with said locking grooves, said apparatus comprising a tool having a tubular barrel provided with an open

end, a tubular collet provided with a plurality of slots extending lengthwise thereof from one end of the collet and terminating short of the opposite end thereof to form a plurality of elongated jaws, said jaws being spaced apart circumferentially of said collet and arranged in a spread-apart formation about the axis of said collet so that at said one end thereof said collet is of a diameter greater than the inner diameter of said open barrel end, said collet being supported in said barrel so that said one end thereof projects out of said open barrel end, means on said tool connected to the opposite end of said collet for effecting a relative movement of the collet and barrel to provide for movement of the collet in a direction inwardly of the barrel so that the barrel moves said jaws radially inwardly of the collet at said one end of the collet, said collet having an annular stop therein concentric with the axis thereof and surrounding an axial opening through which said pin can extend so that said stop is positionable about said pin in engagement with one end of said collar, and radially inwardly extending rounded projections on said jaw members at said one end of the collet.

4. Apparatus for applying a fastener which includes a pin having a head and a shank and locking grooves formed in the shank at a position spaced from said head and a collar disposed on said shank at a position in radial alignment with said locking grooves, said apparatus comprising a tool having a tubular barrel provided with an open end, a tubular collet provided with a plurality of slots extending lengthwise thereof from one end of the collet and terminating short of the opposite end thereof to form a plurality of elongated jaws, said jaws being spaced apart circumferentially of said collet and arranged in a spread-apart formation about the axis of said collet

so that at said one end thereof said collet is of diameter greater than the inner diameter of said open barrel end, said collet being supported in said barrel so that said one end thereof projects out of said open barrel end, means on said tool connected to the opposite end of said collet for effecting a relative movement of the collet and barrel to provide for movement of the collet in a direction inwardly of the barrel so that the barrel moves said jaws radially inwardly of the collet at said one end of the collet, said collet having an unobstructed space at the axis thereof extending substantially the full length of said jaws for receiving said shank when said one end of the collet is positioned so that it surrounds a collar on said shank, radially inwardly extending rounded projections on said jaw members at said one end of the collet, and a spring member positioned concentrically within and secured to said collet so that one end of said spring member is adjacent said projections, said spring member being positioned so that it surrounds said unobstructed space and is resiliently engageable at said one end thereof with said collar.

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2,836,888	Hargrove	June 3, 1958