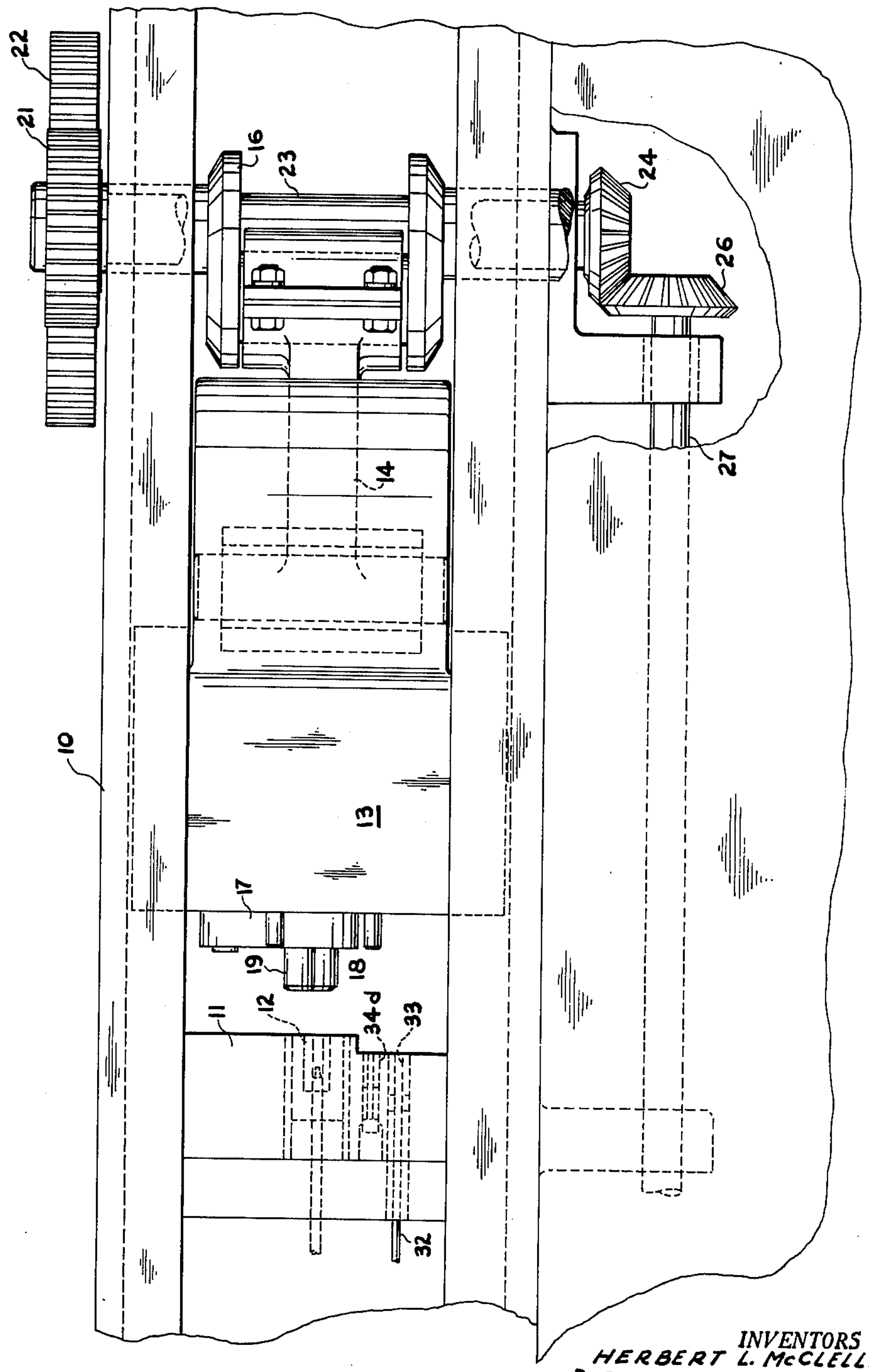
METHOD AND APPARATUS FOR FORMING HOLLOW RIVETS

Filed June 25, 1962 8 Sheets-Sheet 1

Fig. 1



INVENTORS
HERBERT L. McCLELLAN
& ROBERT E. WISEBAKER
BY
RICHEY, McNENNY & FARRINGTON
H. F. McNenny
ATTORNEYS

Aug. 17, 1965 H. L. McCLELLAN ETAL **3,200,424**

METHOD AND APPARATUS FOR FORMING HOLLOW RIVETS

Filed June 25, 1962 8 Sheets-Sheet 2

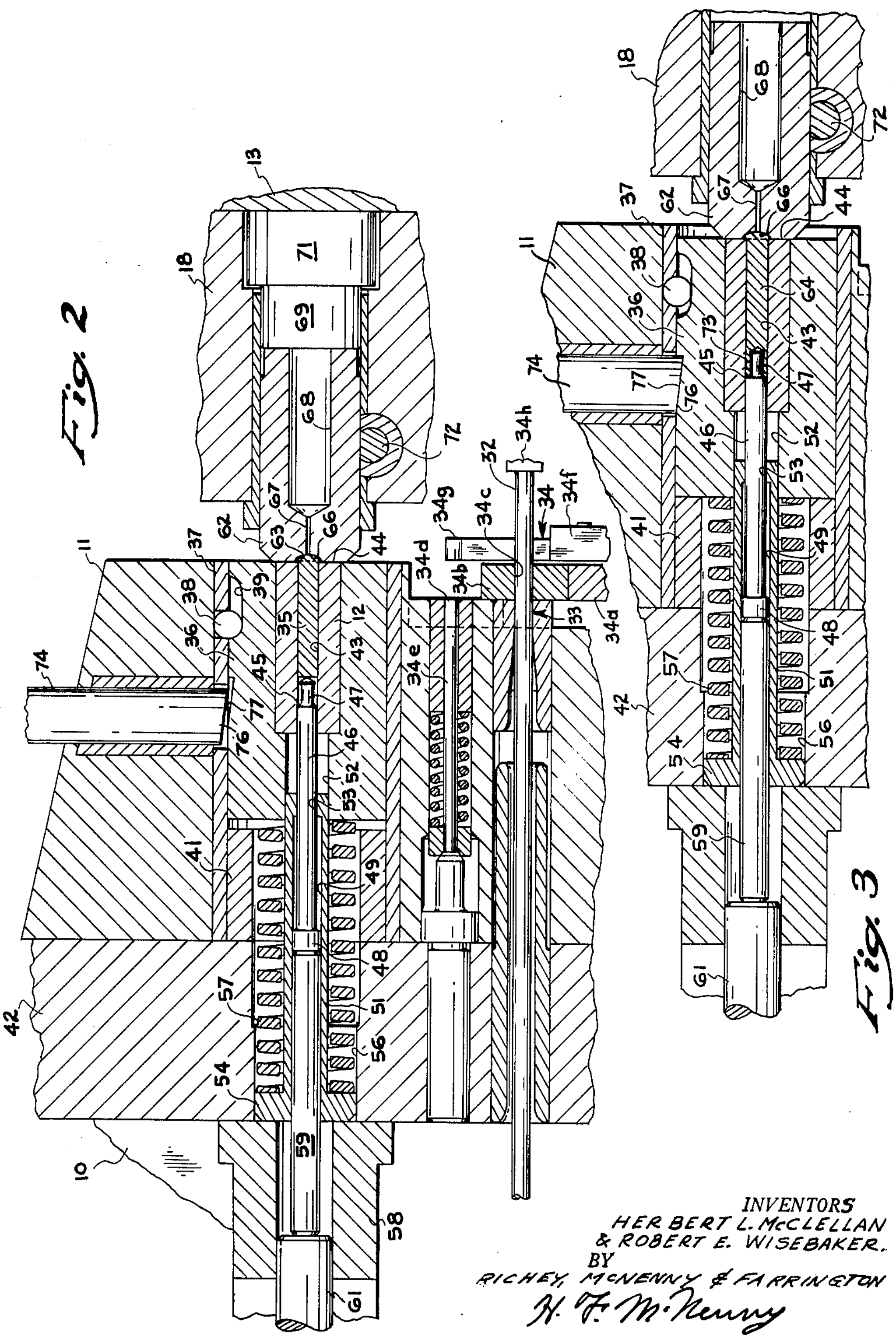


Fig. 2

Fig. 3

INVENTORS
HERBERT L. McCLELLAN
& ROBERT E. WISEBAKER.
BY
RICHEY, McNENNY & FARRINGTON
H. F. McNenny
ATTORNEYS

METHOD AND APPARATUS FOR FORMING HOLLOW RIVETS

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8 Sheets-Sheet 3

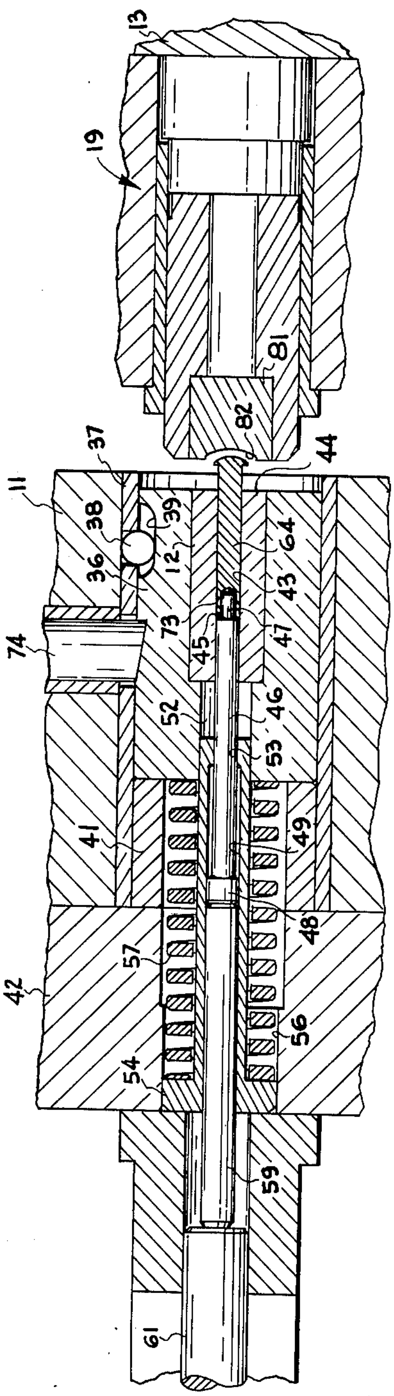


Fig. 4

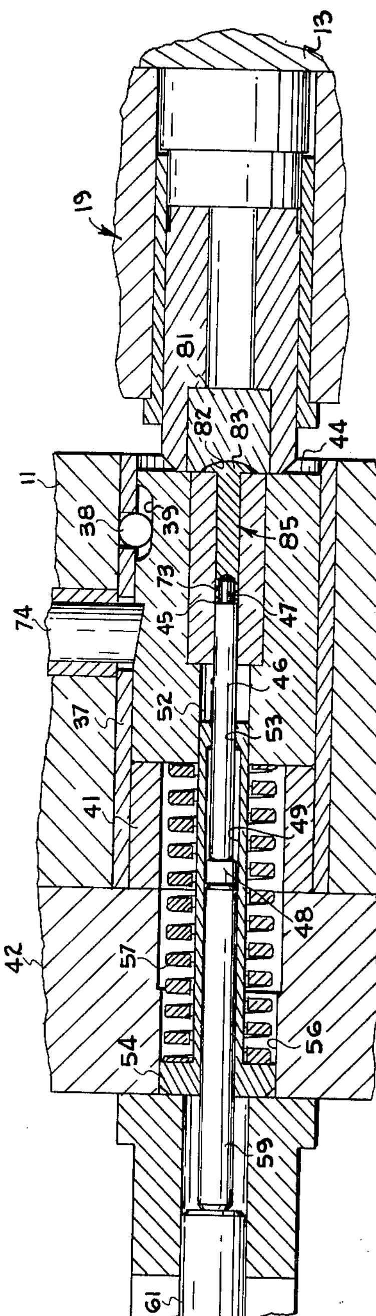
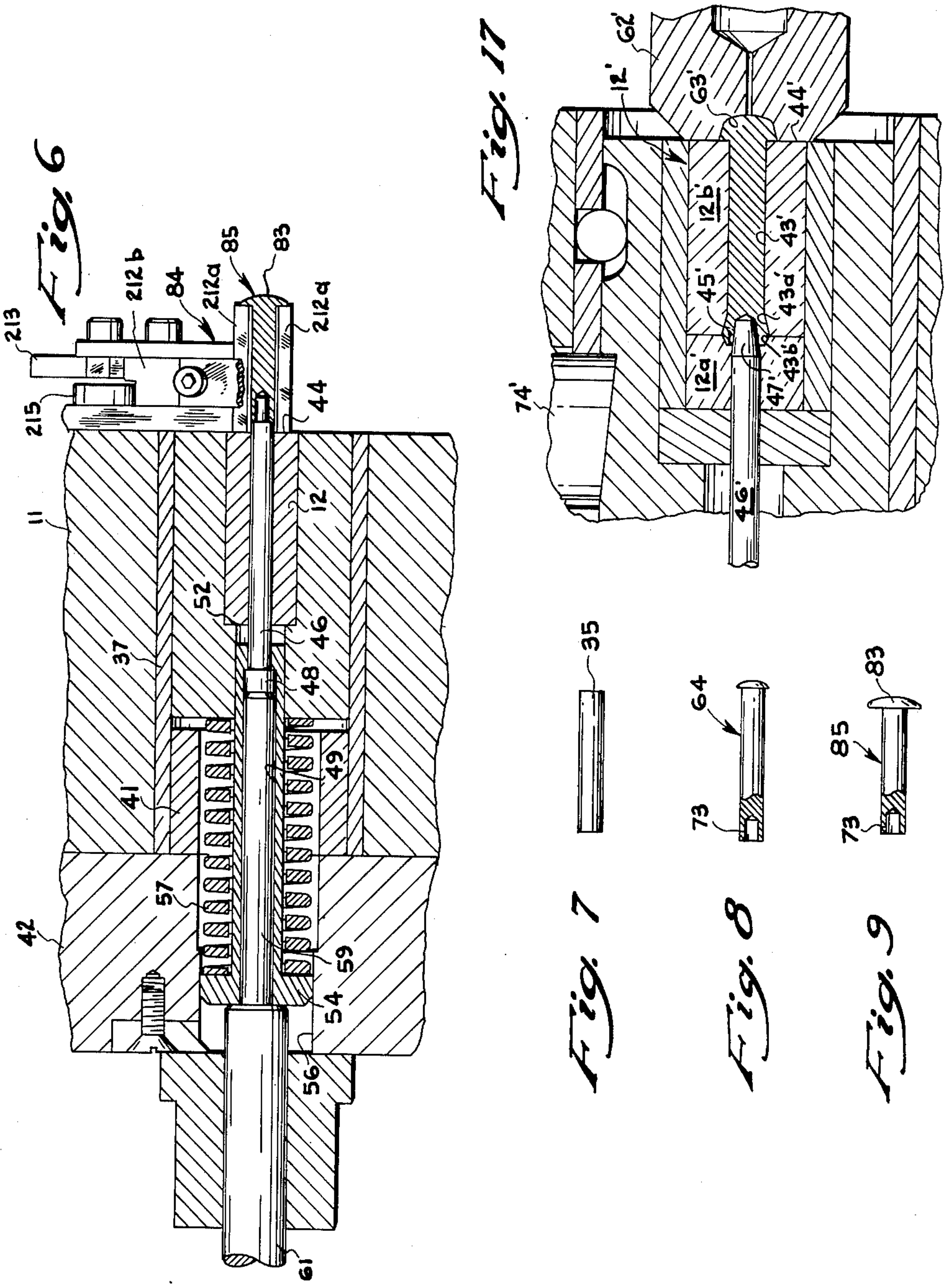


Fig. 5

INVENTORS
HERBERT L. McCLELLAN
& ROBERT E. WISEBAKER.
BY
RICHEY, McNENNY & FARRINGTON
H. F. McNenny
ATTORNEYS

METHOD AND APPARATUS FOR FORMING HOLLOW RIVETS

Filed June 25, 1962 8 Sheets-Sheet 4



INVENTORS
HERBERT L. McCLELLAN
& ROBERT E. WISEBAKER
BY
RICHEY, McNENNY & FARRINGTON
H. F. McNenny
ATTORNEYS

Aug. 17, 1965 H. L. McCLELLAN ETAL 3,200,424

METHOD AND APPARATUS FOR FORMING HOLLOW RIVETS

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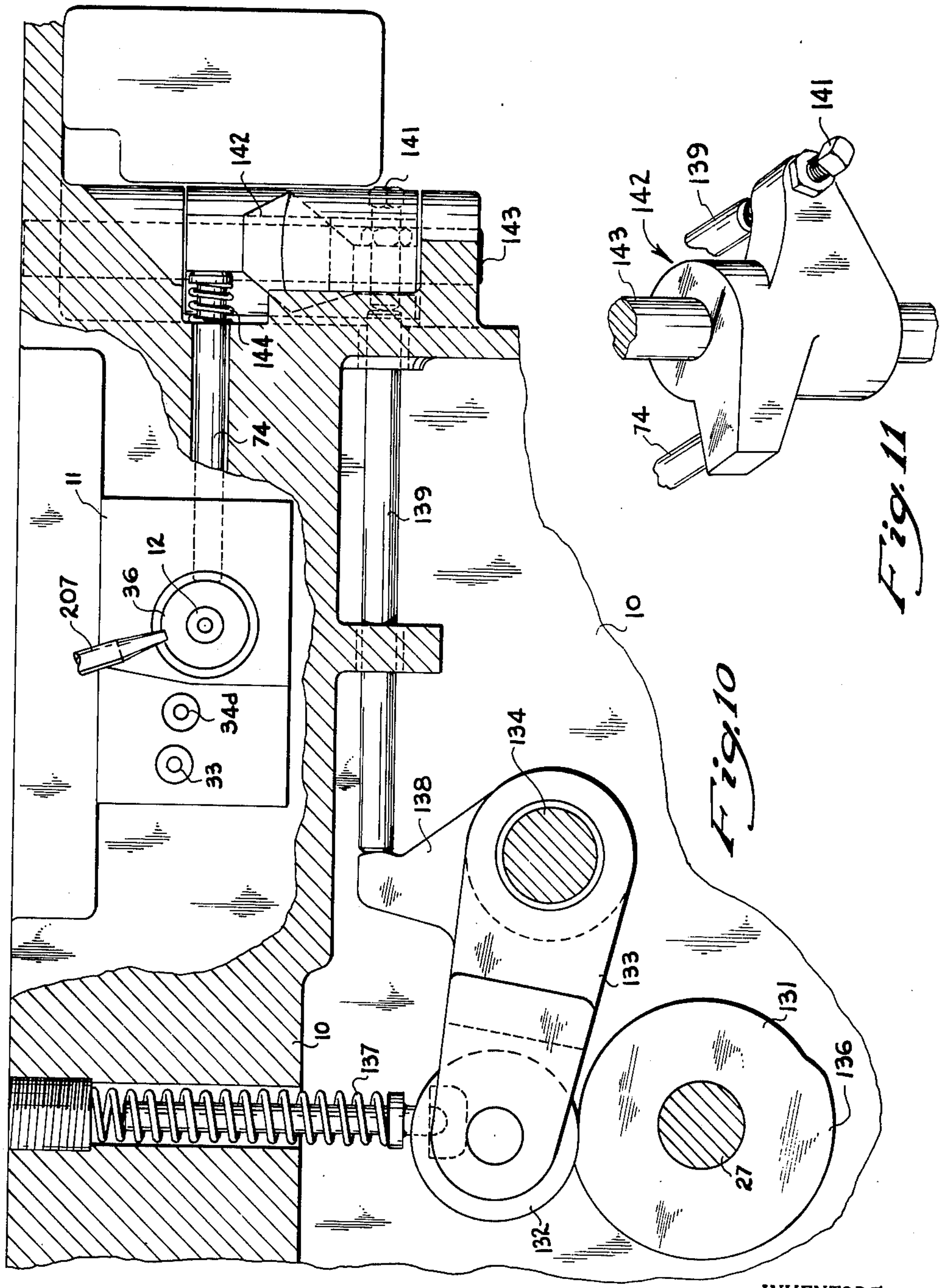
8 Sheets-Sheet 5



INVENTORS
HERBERT L. McCLELLAN
& ROBERT E. WISEBAKER.
BY
RICHEY, McNENNY & FARRINGTON
H. F. McNenny
ATTORNEYS

METHOD AND APPARATUS FOR FORMING HOLLOW RIVETS

Filed June 25, 1962 8 Sheets-Sheet 6

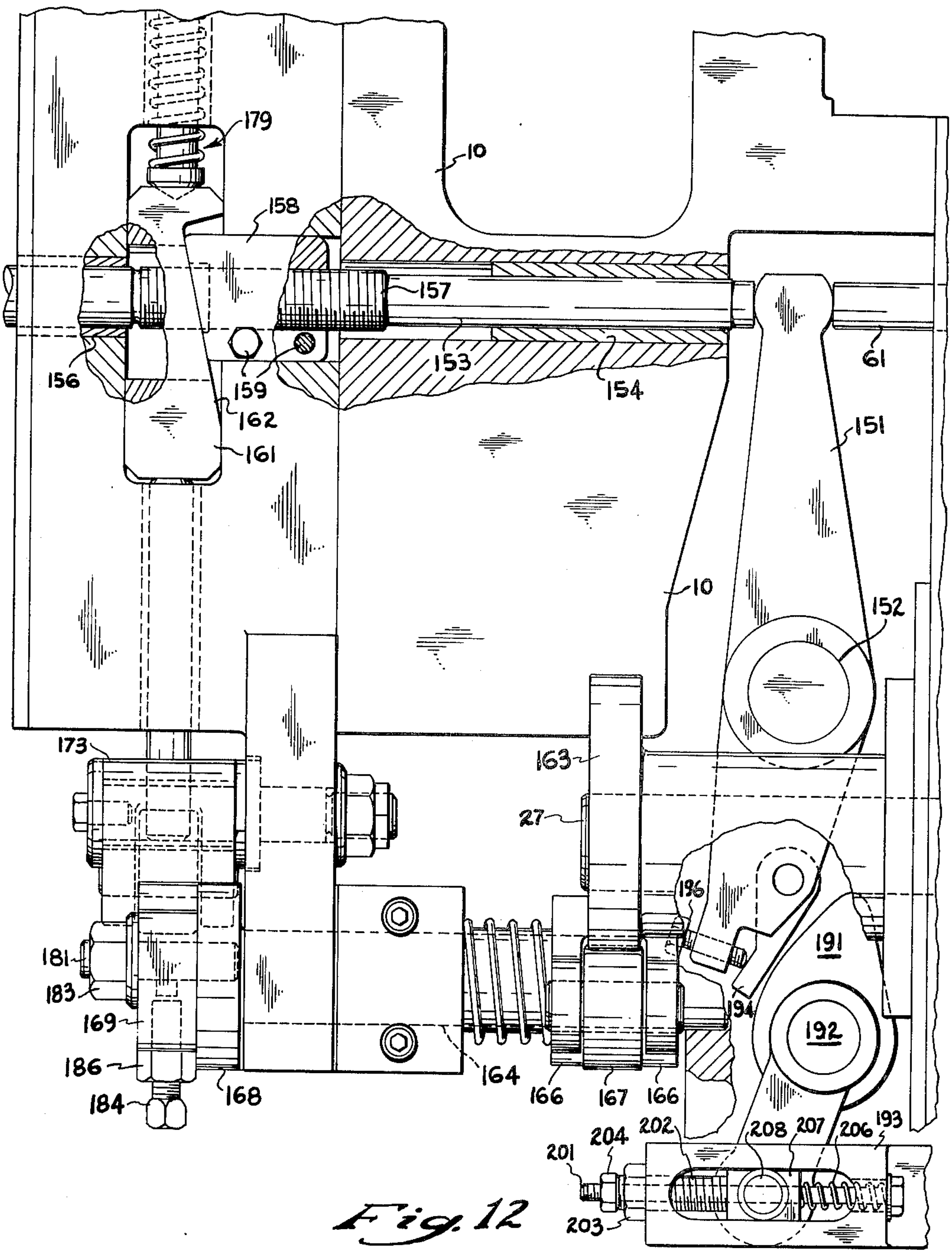


Fig. 12

INVENTORS
HERBERT L. McCLELLAN
& ROBERT E. WISEBAKER
BY
RICHEY, McNENNY & FARRINGTON
ATTORNEYS

METHOD AND APPARATUS FOR FORMING HOLLOW RIVETS

Filed June 25, 1962 8 Sheets-Sheet 7

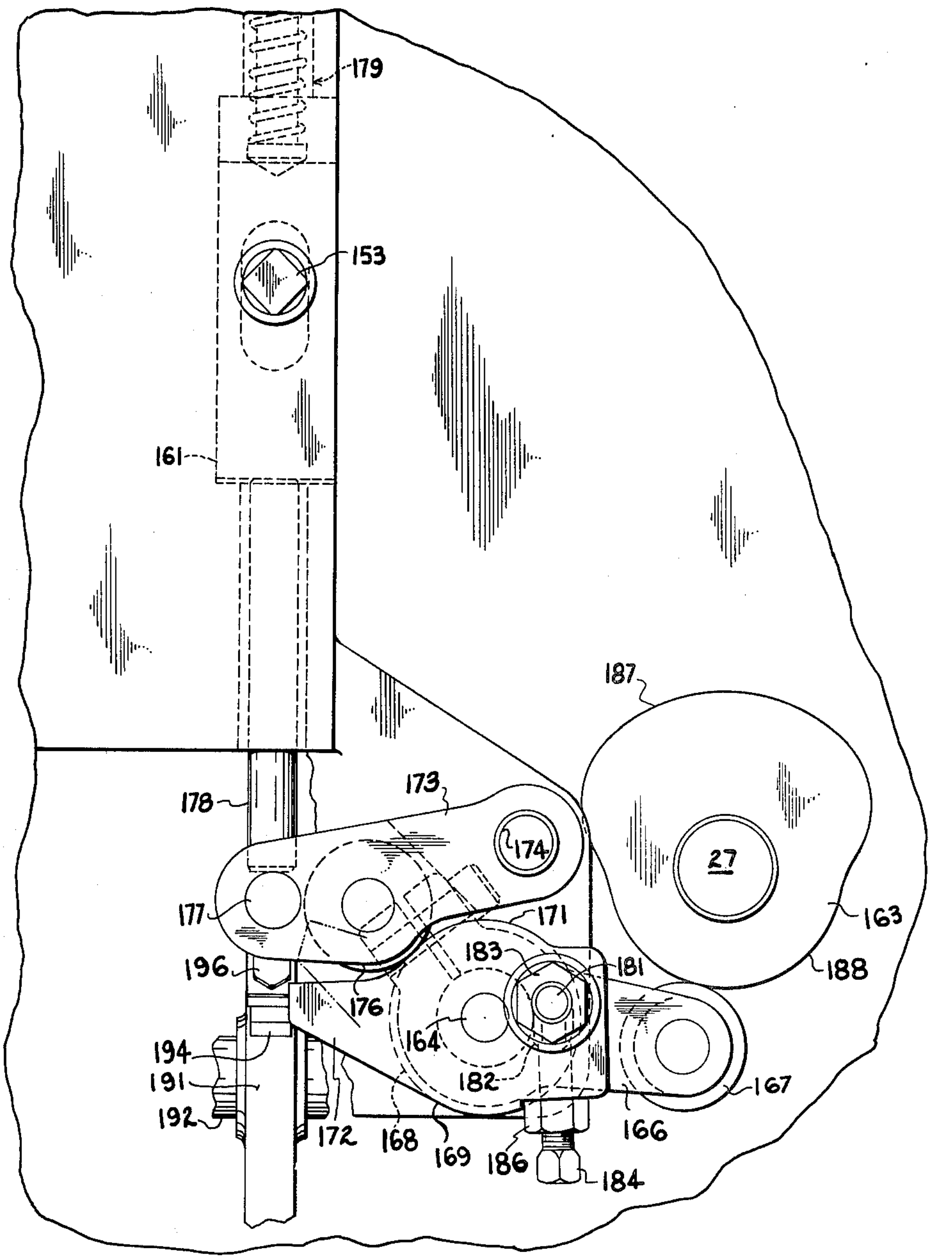


Fig. 13

INVENTORS
HERBERT L. McCLELLAN
& ROBERT E. WISEBAKER
BY
RICHEY, McNENNY & FARRINGTON
H. F. McNenny
ATTORNEYS

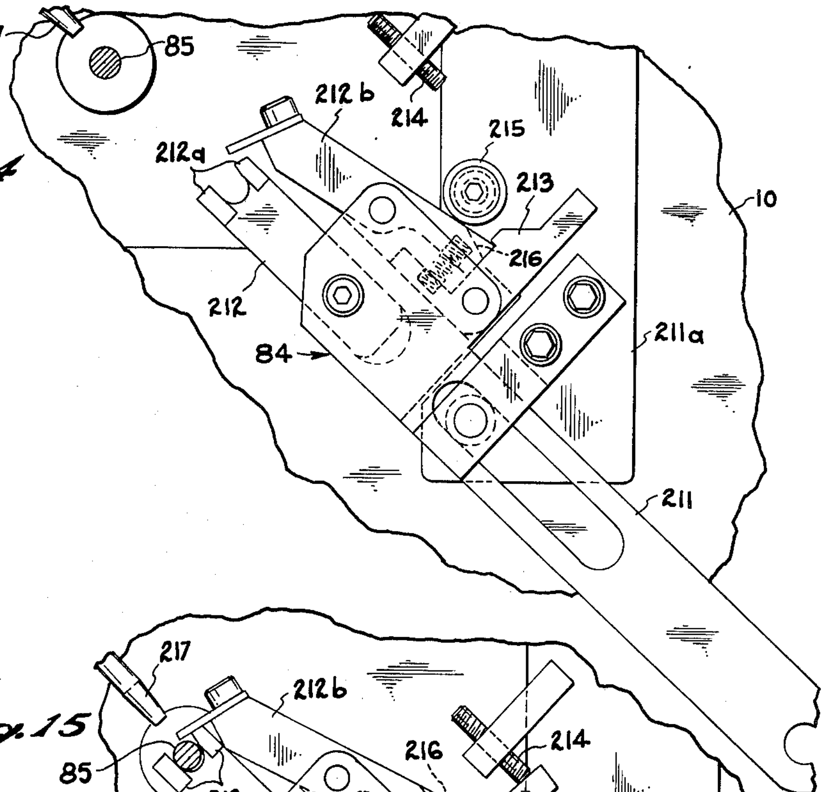


Fig. 14

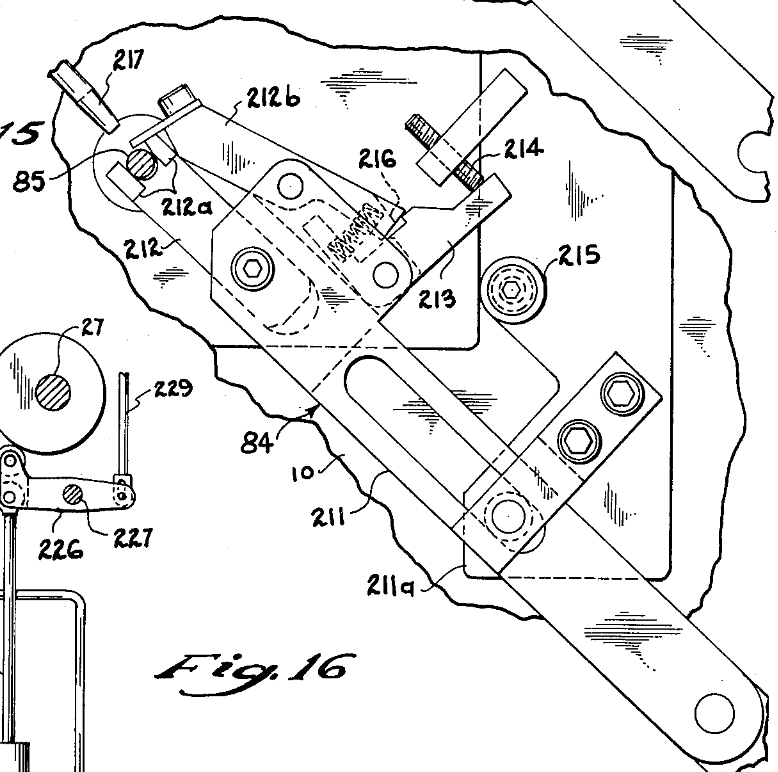


Fig. 15

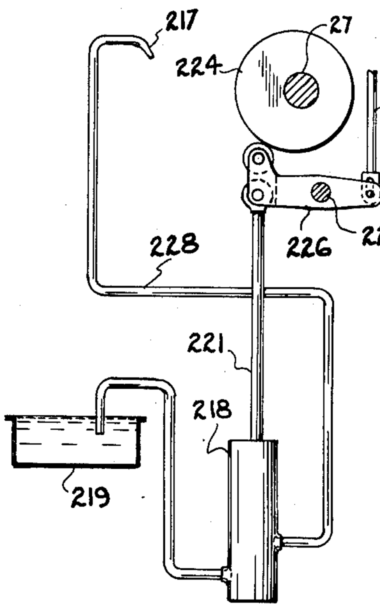


Fig. 16

INVENTORS
HERBERT L. McCLELLAN
& ROBERT E. WISEBAKER
BY
RICHEY, McNENNY & FARRINGTON
H. F. McNenny
ATTORNEYS

United States Patent Office

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3,200,424

METHOD AND APPARATUS FOR FORMING HOLLOW RIVETS

Herbert L. McClellan and Robert E. Wisebaker, Tiffin, Ohio, assignors to The National Machinery Co., Tiffin, Ohio, a corporation of Ohio

Filed June 25, 1962, Ser. No. 204,986
10 Claims. (Cl. 10—12.5)

This invention relates generally to a method and apparatus for forging headed articles having a tubular shank, such as rivets, and more particularly to a novel and improved method and apparatus whereby such articles can be accurately formed in the single die of a double blow header.

In the past various methods and apparatus have been conceived to manufacture headed articles having tubular shanks, such as rivets, in a single die. Such methods and apparatus, however, generally encountered difficulties resulting from the fact that metal flow is required at two locations, namely the extrusion to form the tubular shank and upsetting to form the rivet head. When the manufacture of such articles has been attempted within a single die machine, article uniformity has been poor since the location of the metal flow was inconsistent in that in some blanks more metal would flow into the extruded tubular shank leaving insufficient material to form a well-filled head or insufficient metal would flow into the extruding location resulting in excessive material in the heading area and as a consequence, excessive flash and the like.

Because of these difficulties, rivets have generally been manufactured in progressive headers wherein the extruding operation was completed in one die and the heading operation in other dies. Because such progressive headers require the ejection and transfer of the blank between dies, the rate of cyclic operation of the machine is limited and the machine cost is relatively high. By use of the method and apparatus incorporating this invention, it is possible to accurately form headed articles with tubular shanks, such as rivets, within a single die of a high speed double blow header so that the machine cost is reduced and the output rate is increased. This substantially reduces the unit cost of the rivets manufactured.

The tools and dies are arranged so that during the first working stroke the tubular shank is extruded until it strikes the shoulder on the pin, thus assuring that the desired shank length is accurately maintained. In the second working stroke of the header, the upsetting is performed without further extrusion to form the required head. By thus separating the extruding and heading operations so that each occurs in a separate stroke, is is possible to accurately and economically manufacture such articles within a single die.

Still a further advantage is achieved in an apparatus incorporating this invention since means are provided to permit easy adjustment to compensate for die wear or to permit the manufacture of rivets of various lengths within a single set of dies. In addition, the manufacture of rivets having different head shapes is possible by the mere substitution of a single heading tool in the second stroke tool holder while still using the same dies and the same tools in the first stroke tool holder. This flexibility which is achieved with minimum labor and tooling greatly enhance the commercial value of the machine incorporating this invention.

It is an important object of this invention to provide a novel and improved method and apparatus for manufacturing headed articles having a tubular shank such as rivets and the like.

It is another important object to this invention to provide a novel and improved method and apparatus for accurately producing rivet like articles in a single die.

It is another important object to this invention to provide a novel and improved method and apparatus for forming rivet like articles in a double blow header.

It is another important object to this invention to provide a novel and improved method and apparatus for forming articles having a head and a tubular shank with sequential blows of tools on a blank contained within a die wherein the tubular shank portion is formed by extrusion during the first blow and thereafter a head is upset on the blank contained within the die by the second blow.

It is another object of this invention to provide a novel and improved method and apparatus for forming rivet like articles in an automatic forging machine wherein variations in the mass of the blanks being worked appear on the outside diameter of the head where the variations in stock diameter and cut off length results in a minute difference dimensionally and the part requirement is not dimensionally strictly held.

It is still another object of this invention to provide a novel and improved double blow header having a sliding die in combination with locking means to prevent movement of the die during a portion of the cycle of the machine.

It is still another object of this invention to provide a novel and improved apparatus for forming rivet like articles having means to adjust the operation of the apparatus to readily compensate for tool and die wear and to permit the manufacture of a variety of rivet sizes and types with a minimum change in tooling.

It is still another object of this invention to provide a a double blow header having a die and a tool in the die adjustably operable to move the blank relative to the die between the first and second working blows on the blank.

It is still another object of this invention to provide a double blow header having a sliding die and a punch projecting into the inner end thereof in combination with means operative to control the relative positions and movements of such die and punch.

Further objects and advantages will appear from the following description and drawings wherein:

FIGURE 1 is a plan view of a double blow header incorporating this invention;

FIGURE 2 is an enlarged fragmentary section taken through the die and first stroke tool illustrating the position of the elements at the beginning of the first working stroke;

FIGURE 3 is a fragmentary view similar to FIGURE 2 illustrating the position of the elements at the end of the first working stroke;

FIGURE 4 is a fragmentary section taken through a die illustrating the structure of the second working stroke tool and the position of the elements illustrated immediately before the heading operation;

FIGURE 5 is a section similar to FIGURE 4 illustrating the position of the elements at the completion of the heading stroke;

FIGURE 6 is a fragmenary section illustrating the position of the elements at the beginning of the stripping operation;

FIGURE 7 illustrates the blank before the first working operation;

FIGURE 8 is a view of the intermediate blank formed during the first working stroke;

FIGURE 9 is a view of the completed rivet;

FIGURE 10 is a view partially in section illustrating the linkage which operates to lock the die against movement during the second working stroke;

FIGURE 11 is a fragmentary perspective view of the rocker arm in the die locking linkage;

FIGURE 12 is a fragmentary view partially in section of the linkages which operates to move and position the punch and knockout member in the die;

FIGURE 13 is a fragmentary view of the adjustment linkage for advancing the punch and knockout between the first and second working strokes;

FIGURE 14 is a fragmentary view of the stripper mechanism in the retracted position;

FIGURE 15 is a fragmentary illustration similar to FIGURE 14 illustrating the stripper in the extended position;

FIGURE 16 is a schematic illustration of the pump and drive for lubricating the punch; and

FIGURE 17 is a fragmentary view of the modified dies and tools for forming tapered hole rivets.

A preferred embodiment of the invention includes a main frame **10** which supports a die breast **11** on which a sliding blank working die **12** is mounted. A header slide **13** is supported in the frame for reciprocating movement toward and away from the die breast **11** and is driven by the usual connecting rod **14** and crank **16**. The crank **16** carries a fly wheel and is power driven by a V belt drive arranged in a manner known in the art. A tool carrier **17** is pivoted on the header slide **13** and supports first and second stroke tool holders **18** and **19** respectively.

Essential parts of the machine are driven at half crankshaft speed in the preferred embodiment of this invention. To this end there is a driving pinion **21** keyed to the crankshaft **16** which meshes with a halfspeed gear **22** keyed to a cross shaft **23**. The cross shaft **23** carries a bevel gear **24** that meshes with a complementary gear **26** keyed to a longitudinally extending half-speed accessory and cam shaft **27**. The halfspeed shaft **27** operates the shear, transfer and knockout advancing mechanism as well as the drive means for shifting the tool carrier between either of its two alternate work positions. The drive mechanism for shifting the tool carrier **17** is not illustrated; however, reference may be made to the copending application of Robert G. Friedman, Serial No. 786,805, filed January 14, 1959, and now U.S. Patent No. 3,031,698 issued May 1, 1962, for a detailed description of such a drive mechanism.

Wire stock **32** is fed into the machine at a shearing station **33** wherein a shear and transfer mechanism **34** cuts measured lengths or blanks **35** from the stock **32** and transfers them to the blank working die **12** in which the blank is worked on two successive working strokes of the header slide **13**. The halfspeed shaft **27**, which operates the shear and transfer, rotates with one half the speed of the crankshaft **16**, so it operates the shear and transfer mechanism **34** in a manner to position a blank **35** in the die **12** on every other forward stroke of the slide **13**.

The shear and transfer mechanism includes a cutter arm **34*a*** on which is mounted a cutter plate **34*b*** having a bore **34*c***. The arm **34*a*** oscillates between the position shown in FIGURE 2 wherein the bore **34*c*** is aligned with the shear station **33** and an intermediate transfer station **34*d***. Stock **32** is fed through the bore **34*c*** by the usual feed rollers until it engages a stock gauge **34*h***. The stock gauge **34*h*** is adjusted so that the proper length of stock for the blank **35** extends beyond the shear plane at the face of the shear station **33**. The shear arm is then moved until the bore **34*c*** is aligned with a knockout **34*e*** at the intermediate transfer station **34*d***. A transfer arm **34*f*** provided with fingers **34*g*** oscillates from the position illustrated in FIGURE 2 wherein the fingers **34*g*** are aligned with the transfer station **34*d*** to a position in which the fingers are aligned with the die **12**.

In operation the stock **32** feeds through the bore **34*c*** at the shear station **33**. The shear arm **34*a*** then moves to the transfer station **34*d*** thereby shearing the blank **35** from the stock and moving the blank to the transfer station **34*d***. The movement of the transfer arm **34*f*** is

timed so that both the fingers **34*g*** and bore **34*c*** are aligned with the transfer station **34*d*** at the same time and the knockout **34*e*** pushes the blank out of the bore **34*c*** until it is supported only by the fingers **34*g***. The transfer arm then carries the blank gripped in the fingers to the die **12**. For a detailed description of the structure and operation of the shear and transfer **34**, reference should be made to the co-pending application of Robert G. Friedman, Serial No. 770,805, filed October 30, 1958, and now U.S. Patent No. 3,116,499 issued January 7, 1964.

Reference should now be made to FIGURES 2 and 3 for a clear understanding of the blank working operation during the first working stroke. FIGURE 2 illustrates the position of the elements as the first tool holder **18** approaches the die immediately before the first blank working operation. The die **12** is mounted in a die holder **36** which is in turn supported in an insert sleeve **37** in the die breast **11** for limited axial sliding movement relative to the insert **37**. A key **38** projects into an axially extending keyway **39** in the die holder **36** which limits the maximum forward movement of the die holder **36** to position illustrated in FIGURE 2. A backup sleeve **41** is mounted in the insert **37** behind the die holder **36** and engages the backup plate **42** of the die breast **11** to limit rearward movement of the die holder **36**.

The die **12** is formed with a bore **43** extending therethrough and an end face **44** at its forward end. A combination knockout tool and punch **46** projects into the rearward end of bore **43** of the die **12** and is formed with a reduced diameter punching section **47** adapted to cooperate with the bore **43** to form the tubular extruded portion of the shank during the first operation. The punch **46** is guided at its forward end in the bore **43** immediately adjacent to the punch section **47**. The rearward end of the punch **46** is formed with a head **48** which slides in a bore **49** formed in a tubular guide **51**.

The forward end of the guide **51** slides in a bore **52** in the die holder **36** and is formed with an inwardly extending shoulder **53** engaging and supporting the midsection of the punch **46**. Therefore, the maximum unsupported length of the punch **46** is equal to the spacing between the head **48** and the shoulder **53**. This intermediate support of the punch is used since the punch has a diameter no larger than the bore and a length sufficient to eject the finished rivet completely out of the die. The punch **46** is freely movable relative to the guide **51** in a forward direction until the head **48** engages the shoulder **53** to limit further relative movement.

The rearward end of the guide **51** is formed with a radial flange **54** extending into sliding engagement with a bore **56** formed in the backup plate **42**. A spring **57** extends between the rearward end of the die holder **36** and the flange **54** and resiliently urges the die holder **36** and die **12** to its forward limit of movement and also urges the guide **51** toward its rearward extreme position illustrated wherein the shoulder **54** engages the forward face of a bearing member **58** in the frame **10**. The rearward end of the punch **46** is engaged by an operating pin **59** which abuts at its other end against a drive member **61**. The drive member **61** is operated by linkages driven by cam means on the halfspeed shaft **27** in a manner described below.

A tool **62** mounted in the first stroke tool holder **18** is formed with a bore **63** slightly larger than the stock adapted to receive one end of the blank **35**. The inner end face **66** of the bore **63** is rounded so that the end of the slug **64** will be crowned and smoothed during the first stroke operation to insure that a polished head will be formed on the final rivet. An air vent **67** which has been enlarged for purposes of illustration extends back from the bore **63** to an axial bore **68** formed in the tool **62**. The tool **62** seats at its rearward end against backup plates **69** and **71** and is secured and positioned by a locking mechanism **72**.

As the header slide 13 moves forward to the position of FIGURE 2, the engagement between the outer end of the blank 35 and the rounded end 66 on the tool 62 moves the blank 35 into the bore 43 to the position illustrated. In order to provide confinement of the blank during the entire blank working operation, the elements are proportioned so that the forward end of the tool 62 engages the end face 44 of the die 12 before any working of the blank occurs.

As the header slide 13 moves forward from the position of FIGURE 2 to the forward extreme position of FIGURE 3, the engagement between the tool 62 and the die 12 causes the die holder 36 to move rearward against the action of the spring 57 while the punch 46 remains stationary.

The engagement of the inner end of the blank 35 with the end of the punch 46 produces a resisting force to inward movement of the blank causing the blank to swell into tight engagement with the wall of the bore 43. Therefore, the inward movement of the die 12 assists, by virtue of this engagement, in moving the blank 35 over the punching section 47 to produce the necessary extrusion. When the proper amount of extrusion has occurred, the inner end of the blank engages the shoulder 45 on the punch 46 preventing further extrusion and insuring that the tubular skirt 73 will have the exact length required. When the stock engages the shoulder 45 before the tool 62 reaches its forward extreme position, the increased pressure of reaction produced by the engagement with the inner end of the blank and the shoulder 45 causes the blank to slide relative to the die 12 and the end of the blank contained within the tool 62 upsets slightly within the bore 63, even though the die 12 continues to move with the tool.

Any variations in the mass of the blank 35 caused by variations in diameter or variations in sheared length, therefore, merely cause slight variations in the amount of upsetting occuring in the bore 63 but do not change either the shank diameter or the shank length which must be rigidly maintained to meet the specification requirements of high-grade rivets. The outer end of the blank is rounded by the end face 66 on the tool 62 during the working stroke to insure that the sheared ends will be smooth and a polished head will be produced. When the header slide 13 reaches its forward extreme position, the die holder 36 engages the backup sleeve and the spring 57 is partially compressed. At the completion of the first stroke, the blank is worked to form the intermediate blank 64 of FIGURE 8.

While the header slide 13 is in the forward extreme position as shown in FIGURE 3, a clamping rod 74 is cammed inwardly into engagement with the die holder 36 to retain the die in the rearward position of FIGURE 3. The forward end 76 of the rod 74 is inclined at an angle of approximately 5° and the die holder 36 is formed with a mating clamping surface 77 to assure proper locking action. The mechanism for operating the clamping rod 74 is described in detail below.

As the header slide 13 moves back from the die breast 11 after the completion of the first working stroke, the drive member 61 moves forward a predetermined distance to position the intermediate blank 64 so that the exact shank length required for the finished rivet is contained within the die 12 and the material required to form the head extends beyond the face of the die 12. While this occurs, the clamping rod 74 holds the die 12 on its rearward most position. At the completion of the forward movement of the drive member 61 and the punch 46, the blank 64 is in the position illustrated in FIGURE 4.

Mounted in the second tool holder 19 is a heading tool 81 having a recess 82 with the shape of the finished head. FIGURE 4 illustrates the position of the elements when the header slide 13 is approaching the forward most position of its second working stroke immediately before the

head is upset on the rivet. During the second working stroke, the die 12 and tool 46 are fixed against relative movement providing friction which in addition to the extrusion nose and shoulder 45 prevent further extrusion of the blank 64 during the upsetting operation. During the second working stroke, the end of the blank is upset to form the head 83, thus finishing the rivet 85. Any variation in mass of the initial blank 35 appears as a slight variation in the diameter of the head 83. Since this is the maximum diameter of the rivet the dimensional variation is minimized. The mechanism for moving the drive member 61 and in turn the punch 46 is adjustable so that the correct length of stock remains within the die 12 to provide the exact required shank length. This adjustment feature, which is discussed in detail below, permits ease of adjustment for die wear and the like so that properly formed uniform quality rivets are manufactured.

By providing adjustment of the drive for the member 61, it is also possible to manufacture rivets of different lengths with the same tooling. In such case the position of the punch 46 is adjusted so that blanks of different lengths can be accommodated. As an example, if longer rivets are to be manufactured, the punch 46 is adjusted rearwardly for both of the positions of FIGURES 2 and 4 to accommodate the additional shank length. If it is desired to form rivets having the same shank diameter but a different head shape or size, it is merely necessary to remove the upsetting tool 81 and substitute a different tool having the desired shape head cavity or recess 82 and readjust the machine. In such case the length of the blank is changed to provide the proper mass of stock and the punch 46 is adjusted in both its rearward position and forward position to properly form the rivet.

At the completion of the second working stroke, the header slide 13 moves away from the die breast 11 and the drive member 61 moves forward to perform the knockout operation of ejecting the completed rivet 85 from the die 12. At the same time the clamping rod 74 releases to permit the die holder 36 to slide to its forward position. It should be noted that the head 48 on the punch 46 engages the shoulder 53 before it reaches the fully ejected position of FIGURE 6. Therefore, the tubular guide 51 moves with the punch 46 during the later portion of the ejection operation compressing the spring 57. As soon as the punch 46 has moved the rivet 83 to its ejected position, a stripper 84 moves up and engages the underside of the head 83. After this occurs, the drive member 61 retracts and the spring 57 withdraws the punch 46 from the rivet 85 and back into the die 12. The fact that the spring 57 does not carry the punch 46 all the way back to the position of FIGURE 3 does not present any difficulties since the engagement of the punch with the next blank 35 will push the punch back until it is properly seated. The spring 57, therefore, performs the dual function of urging the die holder 36 to its forward position and withdrawing the punch 46 from the finished rivet at the completion of the cycle.

FIGURES 10 and 11 illustrate the mechanism for operating a clamping rod 74 used to lock the die 12 in its rearward position. The clamping rod 74 is pressed inwardly against the die holder 36 when the header slide 13 reaches its forward extreme position at the completion of the first blank working operation and operates to hold the die holder 36 and in turn the die 12 in its rearward position until the completion of the second working stroke. To accomplish this operation, a cam 131 is mounted on the halfspeed shaft 27 so that it rotates through one revolution each time the main crankshaft rotates through two revolutions. Therefore, the clamping mechanism operates through a cycle timed with a complete cycle of the operation of the machine. A cam follower 132 is mounted on a follower arm 133 pivoted on the frame 10 for rotation about the axis of a pivot pin 134. When a lobe 136 on the cam 131 moves under the cam follower 132, the lever 133 rotates to a die clamping position. The follower arm **133** is resiliently pressed in a direction causing the cam follower **132** to engage the cam **131** by a spring **137** so continuous engagement is provided between the follower and cam.

The follower arm **133** is formed with a projection **138** which engages one end of a push rod **139** journaled on the frame for reciprocating movement. The other end of the push rod **139** is engaged by an adjusting screw **141** threaded into a rocker arm **142**. The rocker arm **142** is pivoted on a pivot pin **143** for oscillating movement under the influence of the reciprocating movement of the push rod **139**. The clamping rod **74** extends into engagement with the rocker arm **142** and a spring **144** resiliently urges the clamping member **74** toward its retracted position.

Rotation of the cam lobe **136** under the cam follower **132** causes the cam follower arm **133** to rotate in a clockwise direction, as viewed in FIGURE 10. This in turn pushes the push rod **139** to the right turning the rocker arm **142** and causing the clamping member **74** to move into the clamping operative position. The die holder **36** and the die **12** are therefore retained in the rearward position so long as the lobe **136** remains under the cam follower **132**. When the lobe **136** moves past the cam follower **132**, the mechanism returns to the unclamped position with the clamping member **74** moving back under the influence of the spring **144**. Since the die **12** should be held in the rearward position from the instant the first working stroke is complete until the completion of the second working stroke, the lobe **136** extends around the cam **131** through an angle of substantially 180°. Because the clamping mechanism operates to positively move the clamping members **74** into engagement with the die holder **36**, it is necessary to provide the adjustment screw **141** to properly set the linkage so that proper clamping pressures will be produced without overstressing any of the elements.

In order to properly position the punch **46** for the various phases of the operating cycle, a mechanism illustrated in FIGURES 12 and 13 is used. As described above, the punch **46** is in its rearwardmost position during the first working stroke when the blank is extruded over the punch section **47**. During the time between the completion of the first working stroke and the commencement of the second working stroke, the punch **46** is moved forward so that the shank length is correct and the proper mass of material projects beyond the end of the die. The punch **46** is held in this intermediate forward position during the second working stroke at which time the head is formed on the blank. After the completion of the second working stroke, the punch is again moved forward until the finished rivet is ejected from the die **12**. The punch **46** therefore must be accurately located in three different positions during three different phases of operation. In the illustrated embodiment the mechanism for positioning the punch can be adjusted so that each of the positions of the punch can be independently determined.

The rearward end of the drive member **61** engages the upper end of a knockout lever **151** pivoted at **152** on the frame **10**. The rearward side of the knockout lever **151** opposite the drive member **61** engages an adjustable screw member **153**. The forward end of the screw member **153** is supported in a bushing **154** and the rearward end is supported in a bushing **156**. The screw **153** is provided with a threaded section **157** which is threaded through a wedge block **158**. The wedge block **158** is slotted on one side so that clamp bolts **159** can be tightend to securely lock the screw **153** relative to the wedge block **158** when the elements are properly adjusted. To change the adjustment, it is merely necessary to loosen the clamp bolts **159** and rotate the screw to the required adjusted position after which the bolts **159** are retightened.

A wedge **161** is mounted on the machine frame for limited movement normal to the axis of the screw **153** and is formed with an inclined wedging surface **162** engaged by a complemental surface on the wedge block **158**. When the wedge **161** is in the lowermost position illustrated in FIGURE 12, the engagement between the wedging surface **162** and the wedge block **158** determines the rearwardmost position of the wedge block. This in turn determines the position of the screw **153** and is the position of the wedge **161** during the first working stroke of the header slide **13**. Since the position of the screw **153** determines the position of the knockout lever **151** and in turn the drive member **61**, adjustment of the screw **153** relative to the wedge block **158** provides the adjustment of the position of the punch **46** during the first working stroke.

In order to move the punch **46** forward between the first and second working strokes, a cam drive for the wedge **161** is provided. This drive incorporates separate adjustments so that the position of the punch during the second working stroke can independently be adjusted. A cam **163** is mounted on the halfspeed shaft **27**. A rocker shaft **164** is pivoted on the machine frame and supports arm **166** on which a cam follower **167** is journaled. The cam follower **167** engages the cam **163** so that rotation of the cam **163** produces an oscillating movement of the rocker shaft **164**. The rearward end of the rocker shaft **164** is provided with a flange or face plate **168** on which a second cam **169** is mounted.

Referring now to FIGURE 13, the second cam **169** is provided with a dwell portion **171** of uniform radius and a lift portion or projection **172** having a camming surface of increasing radius. A lever **173** is pivoted at **174** on the machine frame **10** and is provided with a cam follower **176** engaging the second cam **169**. A cross pin **177** engages the lower end of a push rod **178**, the upper end of which engages the lower end of the wedge **161**. A spring assembly **179** engages the upper end of the wedge **161** and presses it downwardly resiliently maintaining the wedge **161** in engagement with the upper end of the push rod **178**.

When the rocker shaft **164** is rotated by the cam **163** in a clockwise direction, as viewed in FIGURE 13 to positions where the follower **176** engages the lift portion **172**, the lever **173** is caused to rotate in a clockwise direction. This operates to raise the push rod **178** and in turn the wedge **161** through a distance which is determined by the maximum position of engagement between the follower **176** and the lift portion **172**. This causes upward movement of the wedge **161** and through the engagement of the inclined wedging surface **162** with the wedge block **158** causes the wedge block to move to the right, as viewed in FIGURE 12, advancing the screw **153** and in turn the punch **46**. The amount the punch **46** is advanced during this operation is determined by the amount of upward movement of the wedge **161**.

To provide adjustment of the operated position of the wedge **161** and thereby adjustment of the amount of forward movement of the punch during this phase of the operation, the position of the second cam **169** is adjusted by the mechanism illustrated in FIGURE 13. A stud **181** is threaded into the flange **168** and projects through an elongated slot **182** in the cam **169**. A nut **183** threaded on the stud **181** is tightened to clamp the cam **169** in position. An adjusting screw **184** is threaded laterally into the cam **169** until its end engages the stud **181** and is provided with a lock nut **186**. To change the position of the cam **169** relative to the flange **168**, it is merely necessary to loosen the nuts **183** and **186** and thread the adjusting screw **184** in the direction required to permit the cam **169** to move to the desired adjusted position. When the cam **169** is in the desired position with the end of the screw **184** engaging the stud **181**, the nuts **183** and **186** are tightened locking the cam **169** relative to the flange **168**. The load transmitted by the cam **169** tends to urge the cam **169** in a counterclockwise direction relative to the shoulder **168**, however, movement in this direction is positively prevented by the engagement between the end of the screw 184 and the stud 181.

The amount of movement of the rocker shaft 164 and in turn the cam 169 is predetermined by the cam 163. This amount of oscillating movement, however, produces movement of the wedge 161 determined by how far the roller 176 moves up along the lift portion 172 of the cam 169. Therefore, if the cam 169 is adjusted relative to the shoulder 168 in a counterclockwise direction from that illustrated in FIGURE 13, the terminal position of the cam 169 produced by clockwise rotation of the rocker shaft 164 will not produce as much upward movement of the lift portion 172 and as a result, the follower 176 will move along the dwell portion 171 of the cam 169 for a longer portion of the oscillating movement. In this way the movement of the wedge 161 can be adjusted from zero to approximately an inch in the machine illustrated. This in turn permits adjustment of the displacement of the wedge block 158 from zero to 13/64 of an inch.

The punch 46 must be maintained in its forward intermediate position during the second working stroke of the header slide 13. Therefore, the cam 163 is formed with a dwell portion which moves past the follower 167 while the second working stroke is taking place. This causes the rocker shaft 164 to remain stationary in its operated position and therefore hold the wedge 161 stationary during the second working stroke. The cam 163 is therefore formed with two dwell portions 187 and 188. The dwell portion 187 has the maximum radius so the rocker shaft remains in an extreme of clockwise rotation while the dwell portion 187 passes the follower 167. The dwell portion 188 has a minimum radius and the follower 167 therefore remains stationary in its extreme of counterclockwise rotation during the period when the dwell 188 passes under the follower 167. The cam 163 is designed and timed so that the dwell 188 is engaged by the follower 167 during the first working stroke of the header slide and the dwell 187 is engaged by the follower 167 during the second working stroke of the header slide.

To operate the knockout lever 151 after the second working stroke, a cam 191 is mounted on a pivot 192. The cam 191 is actuated by a connecting rod 193 which is driven from a suitable cam mounted on the cross shaft 23 which rotates at one half crankshaft speed. The cam 191 therefore oscillates through a complete cycle as the crankshaft moves the header slide through two working strokes. To provide adjustment of the position of the cam 191, the connection with the rod 193 includes a lock bolt 201 and an adjustable bearing block 202. An adjustment nut 203 is threaded on the bearing block 202 and is held against the end of the rod 193 when a lock nut 204 is tightened on the lock bolt 201. A spring 206 holds a second bearing block 207 against a pin 208 carried by the cam 191, and in turn holds the pin 208 against the bearing block 202. The cam 191 engages an adjustment lever 194 pivoted on the lower end of the knockout lever 151. A bolt 196 determines the position of the lever 194 relative to the knockout lever 151 and therefore determines the amount of clockwise rotation of the knockout lever 151 produced by the cam 191. During the two working strokes of the header slide, the cam 191 remains spaced from the lever 194. At the completion of the second working stroke the cam 191 engages the lever 194 and produces clockwise rotation of the knockout lever 151 which causes the upper end thereof to move away from the screw 153 and move the drive member 61 forward to eject the finished rivet from the die. Here again, the extent of movement of the punch 46 produced by the knockout lever 151 is independently adjustable by means of the screw 196, the bearing block 202, and the nuts 203 and 204.

During the set up of the machine, the screw 153 is adjusted with the wedge 161 in its maximum downward position so that the punch 46 is properly located in the die 12 for the first working stroke of the header slide 13. The cam 169 then adjusted so that it will produce the required amount of upward movement of the wedge 161 to properly position the punch 46 for the second working stroke. Finally the knockout operation is adjusted by adjusting the position of the cam 191 and the position of the lever 194.

Since each position of adjustment is independent of the other, the machine incorporating this invention can be used to manufacture a variety of rivet sizes, and tool and die wear can be compensated for permitting longer use of these elements.

Referring to FIGURES 14 and 15, the stripper 84 includes a slide 211 guided for reciprocation on a bracket 211*a* from a retracted position of FIGURE 14, to a forward position of FIGURE 15 adjacent to the die 12 and driven by a linkage and cam (not shown) on the half-speed shaft 27. An arm 212 is carried by the slide 211 and is provided with opposed stripper blocks 212*a* which loosely embrace the shank of the rivet and engage the under side of the head 83 when the punch 46 is retracted. A spring-loaded finger 212*b* pivoted on the slide 211 is maintained in the open position by a latch 213 until the block 212*a* are adjacent to the rivet. The latch is tripped by a stop 214 during the last portion of the forward movement to allow the finger 212*b* to snap down to confine the rivet in the arm 212 as illustrated in FIGURE 15. The stripper assembly 84 remains in position in front of the die 12 until the punch is withdrawn from the finished rivet and is then carried back to the retracted position of FIGURE 14 moving the rivet clear of the die. A cam wheel 215 engages a camming surface 216 on the finger 212*b* which opens the finger against the action of its spring releasing the rivet and allowing the latch to snap back into the latched condition under the influence of the spring.

A lubrication nozzle 217 is located immediately adjacent the die and is adjusted to lubricate the end of the punch during its withdrawal from the finished rivet. Therefore, the stripper assembly 84 is proportioned to maintain the skirt of the rivet forward of the die 12 during the stripping operation to allow the lubricant to wet the extrusion portion of the punch.

Referring to FIGURE 16, the lubricant pump includes a cylinder 218 connected to a lubricant reservoir 219 and a piston 221 extending thereinto. The piston 221 is operated against the action of a spring within the cylinder by a cam actuated linkage including a cam 224 mounted on the halfspeed shaft 27 and a cam follower arm 226 pivoted on the frame and at 227. The cam is proportioned to stroke the pump depressing the piston 221 as the punch is withdrawn from the finished rivet so that lubricant is pumped through a pipe 228 to the nozzle 217 in timed relationship to the operation of the machine. Suitable screens and check valves (not shown) complete the structure. A rod 229 is connected to a handle for manual control of the lubricating pump when desired. This structure insures that the punch is lubricated during each cycle of operation to prevent excess wear or punch breakage.

Referring to FIGURE 17, a modified form of tools and dies are used when a tapered hole rivet is produced. Similar reference numerals are used to indicate similar parts with a prime (′) added to indicate that reference is made to this second form. The die 12′ is made in two parts 12*a*′ and 12*b*′. The die 12*b*′ is formed with a bore 43′ extending to a flared mouth 43*a*′ at its rearward end. The die 12*a*′ is formed with an opposed flaring mouth 43*b*′ extending from the mouth 43*a*′ to a radial shoulder 45′. Thus the die assembly 12′ includes a bore 43′ of shank diameter and a rearward end cavity tapering outward from shank diameter to a maximum cross section and then tapering inward again to the shoulder 45′ having a diameter substantially equal to the diameter of the bore 43'. The punch 46' is formed with a tapered nose 47'.

The tool 62' is formed with a recess 63' having a volume substantially equal to the volume of the finished head of the rivet and shaped to provide an initial upset of the head. The shape of the die cavity formed by the two mouths 43*a'* and 43*b'* is substantially the same shape the end of a blank would assume if it were unconfined and pressed over the tapered nose 47' of the punch 46'. Therefore, the two mouths 43*a'* and 43*b'* are completely filled when the blank is pressed back over the nose to the position of FIGURE 17. This insures uniformity of shank length in the finished rivet.

As the tool 62' approaches the die 12' the die is held forward by the spring. The blank moves into the bore 43' until it engages the punch 46'. This engagement with the end of the punch 46' provides sufficient resistance to further movement of the blank to cause it to swell into tight engagment with the wall of the bore 43'. The friction produced by such engagement also resists movement of the blank relative to the dies 12' so the initial upset within the recess 63' occurs during the first portion of the working stroke until the end face of the tool 62' engages the end face 44' of the die 12'. Continued forward movement of the tool 62' moves the die 12' back along the punch 46' until the position of FIGURE 12 is reached. This final portion of the first working stroke causes the inner end of the blank to upset over the tapered nose 47' filling the mouths 43*a'* and 43*b'*. The friction between the bore 43' and the blank during this phase assist in causing the blank to be carried back with the die 12'. Therefore, no upsetting occurs in the recess 63' during the final phase of working. The clamp 74' then locks the die in its rearward position during the second working stroke.

Since the blank moves into the die 12' relatively freely until it engages the end of the punch 46', a predetermined volume of blank material is located within the die 12' so the dimension of the shank of the final blank is accurately maintained and any variation in blank volume occurs as variation in the upset in the recess 63'. During the second stroke a finished head is formed by a tool similar to the tool 81 of the first embodiment. After the head is upset on the second stroke, the punch 46' is pushed forward until it extends beyond the face of the die 12*b'* and the finished rivet is stripped therefrom. During the forward movement of the punch, the flared portion of the blank within the mouths 43*a'* and 43*b'* is drawn down to shank diameter by movement through the bore 43'.

This die shape defined by the mouths 43*a'* and 43*b'* is the shape a blank would upset to if it were unconfined and pushed over a tapered punch. Therefore, a minimum pressure is required to press the blank onto the tapered nose 47' and the die is filled at the completion of the first working stroke. The upsetting during the second working stroke cannot produce any additional movement of the portion of stock within the dies 12' so uniformity of shank length is again achieved with any variation which may occur appearing in the head diameter.

Although preferred embodiments of this invention are illustrated, it is to be understood that various modifications and rearrangements of parts may be resorted to without departing from the scope of the invention as defined in the following claims.

What is claimed is:

1. A double blow header comprising a frame, a die breast on said frame, a die slidably mounted in said breast for movement between a forward and a rearward position, spring means urging said die toward said forward position, a slide reciprocable in said frame, a pair of tools on said slide each operable to engage and work a blank in said die on alternate forward strokes of said slide, one tool operating to move said die to said rearward position during its working stroke, and clamp means operable when said one tool is in its forward position to lock said die in said rearward position against movement relative to said breast and continue to lock said die in said rearward position during the forward stroke of the other of said tools.

2. A double blow header comprising a frame, a die slidably mounted in said frame for movement between a forward and a rearward position, support means engaged by said die when it is in said rearward position operating to support said die against movement under the influence of upsetting loads, a slide reciprocable in said frame, first and second tools carried by said slide each operable to engage a blank in said die on alternate forward strokes of said slide, a punch movable in said frame having an end positioned in said die, power means operable in timed relationship to said slide to position said punch relative to said die, said first tool pressing said die and the rearward end of a blank contained therein along said punch moving the forward end of the blank over said punch to a predetermined position and moving said die to its rearward position, clamp means operating to lock said die in said rearward position when said first tool moves back from said die, said power means advancing said punch with said die locked by said clamp means to project the rearward end of said blank out of said die to a second predetermined position, and said second tool operating to upset the projecting rearward end of said blank forming the head while said clamp means retain said die in said rearward position.

3. A double blow header comprising a frame, a die on said frame, a slide reciprocable in said frame through a cycle including two successive working strokes on a blank in said die, a tool in said die, a halfspeed cam shaft rotated through one revolution during each of said cycles, a rocker shaft, cam means connected between said cam shaft and rocker shaft oscillating said rocker shaft through a predetermined arc, an adjustable cam mounted on said rocker shaft for oscillation therewith formed with a dwell portion and a lift portion, a lever pivoted on said frame having a follower engaging said dwell and lift portions on said adjustable cam producing oscillations of said lever which have a magnitude determined by the adjusted position of said adjustable cam relative to said rocker shaft, adjustment means permitting movement of said adjustable cam relative to said rocker shaft to change the magnitude of oscillations of said lever, a wedge connected for reciprocation by said lever, a wedge block engaging said wedge movable normal to the direction of reciprocation of said wedge, and means operably connecting said wedge block and tool determining the position of said tool and said die in response to movement of said wedge block, said last named means including a screw threaded through said wedge block permitting adjustment of the position of said tool relative to said wedge block.

4. A double blow header comprising a frame, a die assembly on said frame slidable between forward and rearward positions, a slide reciprocable on said frame, first and second tools on said slide operable to sequentially engage and work a blank in said die assembly, said first tool being formed with an end face engageable with said die assembly to move the latter to said rearward position, said die assembly being formed with a bore of uniform radius extending rearwardly from the face thereof, a first portion of increasing radius rearwardly of said bore and a second portion of decreasing radius extending rearwardly from said first portion, a punch having a tapered nose extending into said die assembly and positioned within said first and second portions when said die assembly is in said rearward position, said first tool including a recess shaped to upset a portion of a blank projecting beyond the face of said die assembly before the end face of said tool engages said die assembly, said first and second portions being

proportioned to define a cavity having a shape similar to the shape of the end of an unconfined blank pressed over said nose, said first tool pressing said die assembly to said rearward position and a blank contained therein over said nose until said blank completely fills said first and second portions, means operable to maintain said die assembly in said rearward position during the working stroke of said second tool, said second tool upsetting a finished head on said blank while said die assembly remains in said rearward position, and means operable to push said tool and said blank out of said die assembly through said bore.

5. A method of forming rivets comprising positioning a cylindrical blank in a die providing lateral confinement of at least part of said blank, holding said die and blank against relative movement while producing relative movement between said blank and a punch causing said punch to pierce one end of said blank and form a tubular end thereon having a predetermined length, allowing a limited amount of upsetting of the other end of said black to compensate for variations in the volume of blanks, and thereafter holding said blank against movement relative to both said punch and die and upsetting the other end of said blank to form a head.

6. A method of forming rivets comprising positioning a cylindrical blank in a die providing lateral confinement of at least part of said blank, holding said die and blank against relative movement while producing relative movement between said blank and a punch causing said punch to pierce one end of said blank and form a tubular end thereon having a predetermined length, allowing a limited amount of upsetting of the other end of said black to compensate for variations in the volume of said blanks, producing movement of both said punch and said blank relative to said die causing the other end of said blank to project from said die an amount providing sufficient material to form a head on such other end, and thereafter holding said blank against movement relative to both said punch and die while upsetting said other end of said blank to form a head thereon.

7. A method of forming rivets comprising positioning a cylindrical blank in a die providing lateral confinement of at least part of said blank, moving said blank and die as a unit against a punch causing said punch to pierce one end of said blank and form a tubular end thereon, the material of said stock of said tubular end being radially displaced by said piercing with the radial displacement completely filling an enlarged section of said die adjacent thereto, allowing a limited amount of upsetting of the other end of said blank to compensate for variations in the volume of said blanks, and thereafter holding said blank against movement relative to both said punch and die while upsetting the other end of said blank to form a head thereon, and thereafter moving both said blank and said punch relative to said die ejecting the blank from said die and reducing the diameter of said tubular end to a diameter substantially equal to the initial diameter of said blank.

8. A method of forming rivets comprising positioning a cylindrical blank in a die providing lateral confinement of at least part of said blank, holding said die and blank against relative movement while producing relative movement between said blank and a punch causing said punch to pierce one end of said blank and form a tubular end thereon having a predetermined length, allowing a limited amount of upsetting of the other end of the blank to compensate for variations in the volume of blanks, thereafter holding said blank against movement relative to both said punch and die and upsetting the other end of said blank to form a head thereon, and thereafter moving said punch and blank relative to said die ejecting said blank from said die.

9. A method of forming rivets comprising positioning a cyclindrical blank in a die with a portion at one end of said blank projecting out of said die, said die providing lateral confinement of at least a part of said blank, positioning a tool against said die operating to hold said blank against movement relative to both said tool and die and producing relative movement between the other end of said blank and a punch causing said punch to pierce said other end of said blank and form a tubular end thereon having a predetermined length, allowing a limited amount of upsetting of the other end of said blank to compensate for variations in the volume of said blanks, and thereafter holding said blank against movement relative to both said punch and said die preventing further piercing of said punch while upsetting the other end of said blank to form a head.

10. A double blow header comprising a frame, a die breast on said frame, a die slidably mounted in said breast for movement between a forward and a rearward position, spring means urging said die toward said forward position, a slide reciprocable in said frame, a pair of tools on said slide each operable to engage and work a blank in said die on alternate forward strokes of said slide, one tool operating to move said die to said rearward position during its working stroke, means preventing rearward movement of said die byeond said rearward position, and clamping means including a locking element mounted for lateral movement in said frame engaging said die intermediate its ends and maintaining said die in its rearward position during the forward stroke of the other of said tools.

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ANDREW R. JUHASZ, *Primary Examiner.*