April 19, 1938. R. J. FRETER 2,114,420

METHOD OF AND APPARATUS FOR MAKING RIVETS AND THE LIKE

Filed May 16, 1936 3 Sheets-Sheet 1

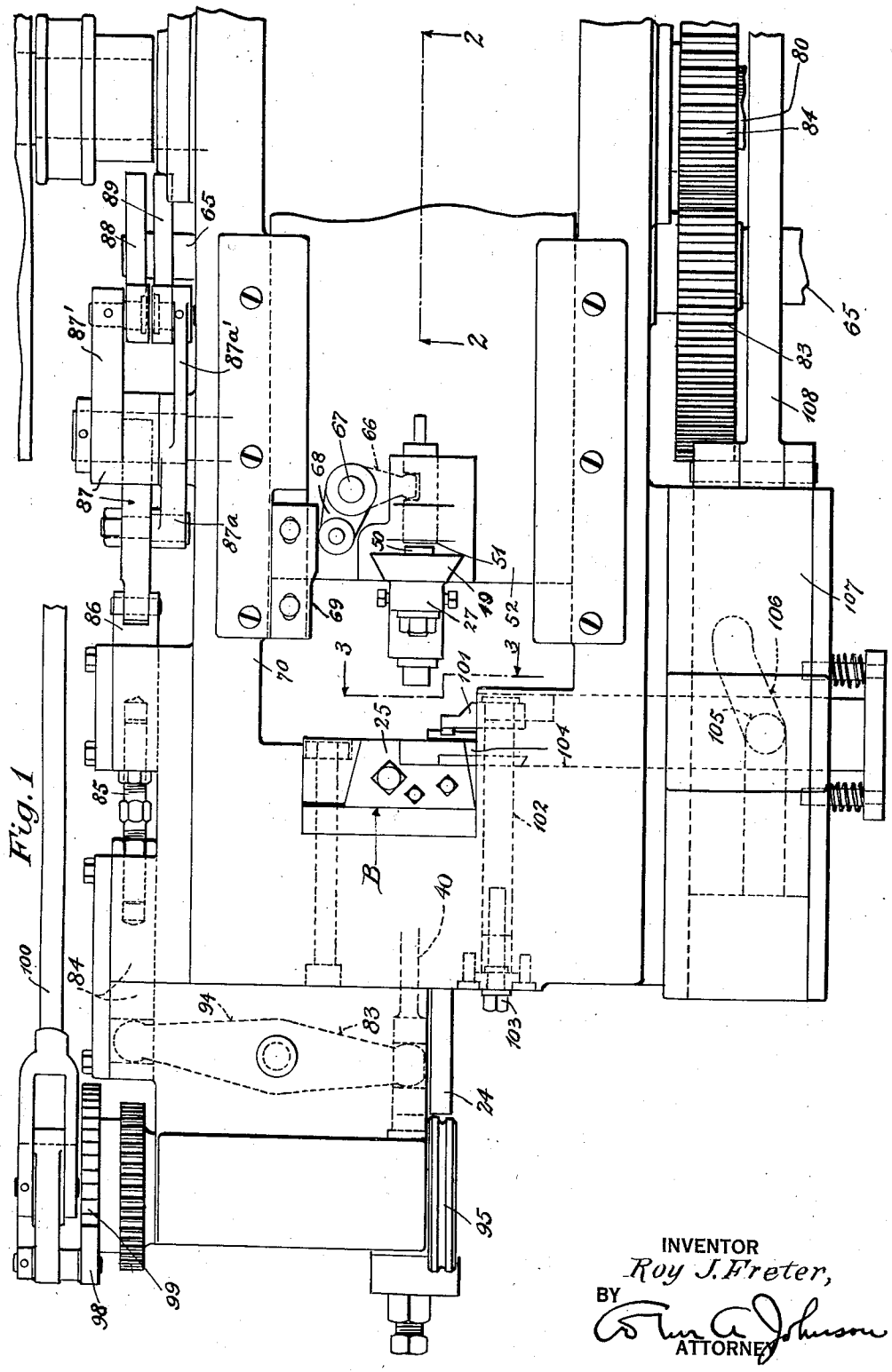

Fig. 1

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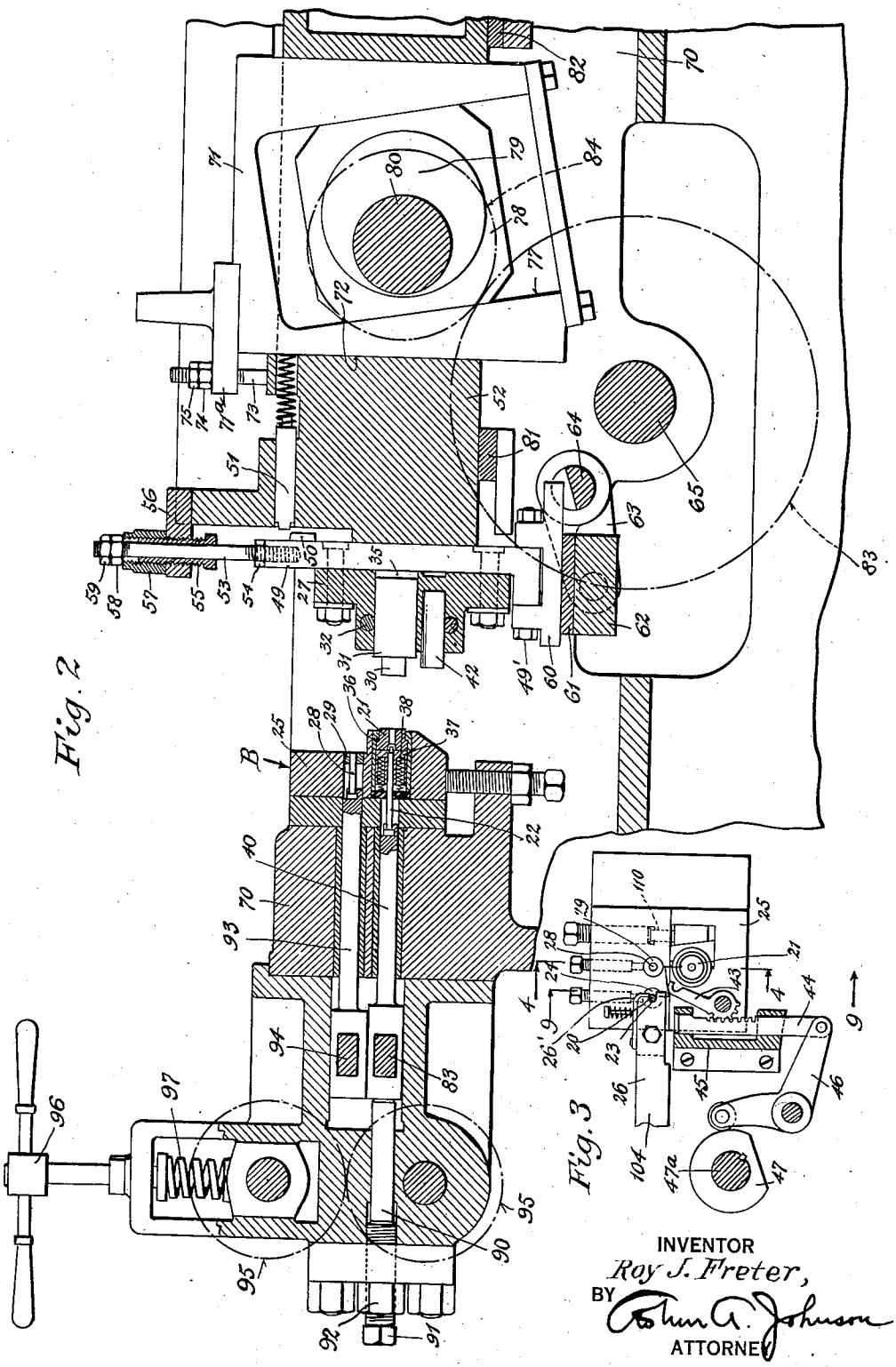

Fig. 2

Fig. 3

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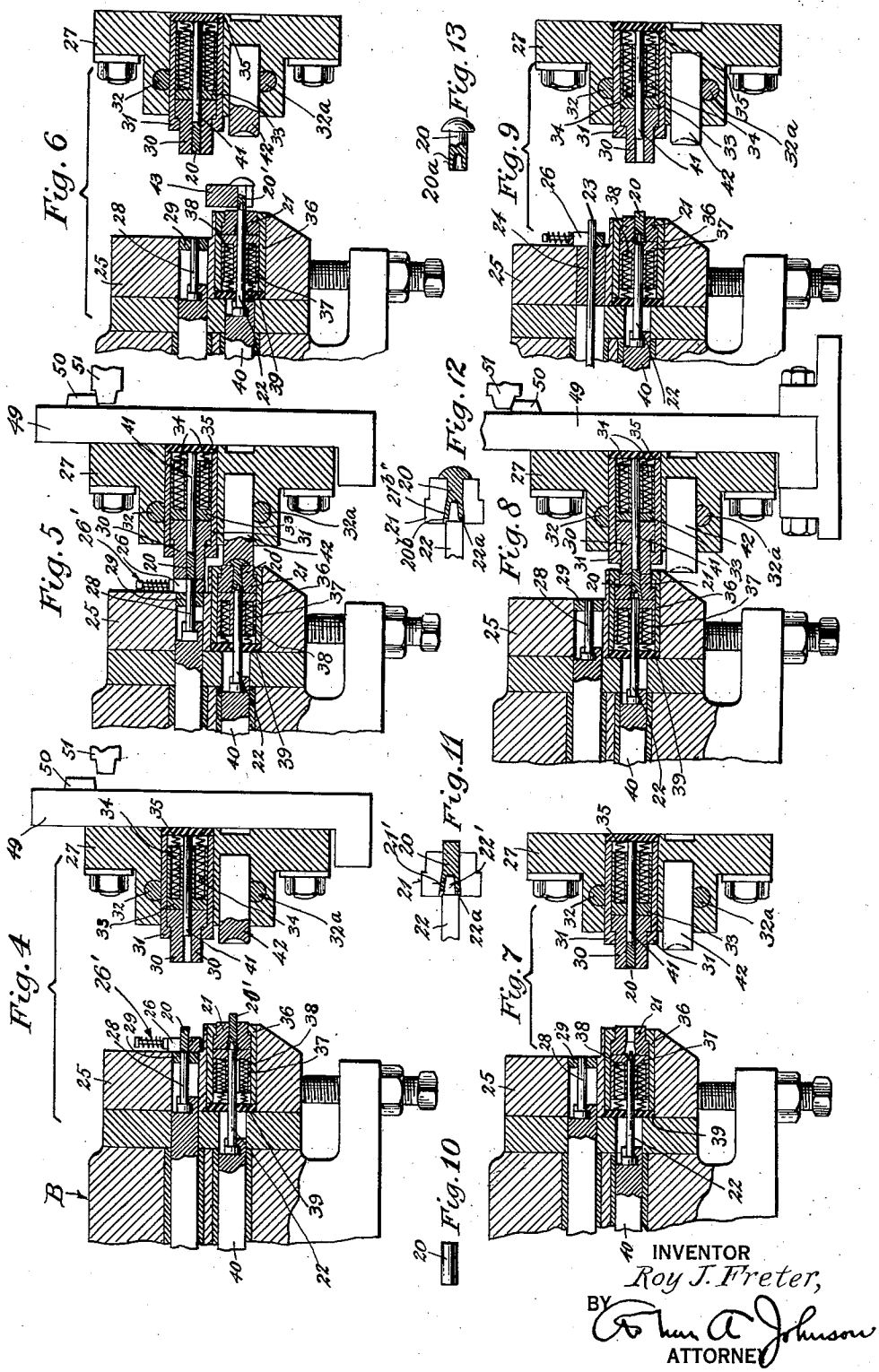

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UNITED STATES PATENT OFFICE

2,114,420

METHOD OF AND APPARATUS FOR MAKING RIVETS AND THE LIKE

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Application May 16, 1936, Serial No. 80,038

18 Claims. (Cl. 10—11)

This invention provides an improved method and mechanism for manufacturing metallic forms from metallic stock, and more particularly to the forming of solid and hollow rivets by extrusion of slugs cut from the stock, and to the forming of such articles, when desired, with an enlarged generally flattened head or shoulder, or both.

It has been the practice heretofore, in machines known as headers which form rivets and the like by metal flow, to cut from a continuous supply of metal stock a portion of said stock to constitute a slug, to carry said slug by means of the cutter into aligning position with a die carried by the die bed, and to have the gate and its head advance upon the slug until a die or punch carried by the head engages the slug, and then to effect withdrawal of the cutter, the head meanwhile continuing in its movement toward the bed carrying the die to cause the slug to enter the die and to be shaped therein. This arrangement has been fairly satisfactory for rivets of substantial length, but has failed when used with rivets of extremely short length because of the impossibility of adjusting the mechanism to handle the correspondingly short slugs.

An object of the present invention is to provide a practicable method for handling extremely short slugs, and an improved machine which is particularly adapted to make both solid and tubular rivets of extremely short length.

In a present preferred embodiment of the invention this is accomplished by providing a novel slug- or blank-handling mechanism including, in addition to a cutting knife which as heretofore is also adapted to carry the cut-off slug or blank to a loading position, a carrying die into which said slug is loaded and which die is later moved to alignment with the forming die then to act as an extension thereof during shaping of the slug in the forming die.

In the handling of rivets of moderately short length, as practiced in prior heading machines, there has often occurred a fouling of the cutting knife which cleaves the stock and carries the cut-off slug into aligned position with the die of the machine. This fouling has been due to said cutter being withdrawn at too late a time to clear the advancing head of the machine; earlier withdrawal of the cutter not being possible because of the shortness of the slug held thereby, as the slug must be engaged by the advancing head before cutter withdrawal.

An object of the present invention is to obviate this fouling of the cutting knife and carrier.

According to a now preferred way of carrying out the present invention, this object is accomplished by loading the slug carried by the cutter into a carrying die as above. This die is movable with the head, but is so formed and is so associated with the head as not to interfere with the required retractive movement of the cutter. Said die is, in accordance with this preference, shaped in such manner that as it approaches the bed it clears the field of operation of the cutter up to a point very close to the bed. This carrying die is, nevertheless, so carried by the head that it receives substantially the entire length of the slug, yet there is no necessity of attempting to time critically a retractive movement for the cutter relative to a partial insertion of the slug in the carrying die. Regardless of the shortness of the slug, safe and certain transfer of the slug to the carrying die is effected on each advancing operation of the head relative to the bed, due to the fact that the carrying die is movable in the head, in a direction opposite to the movement of advance of the head. When the head nears the conclusion of its advancing movement, all the length of the slug, except that part held by the cutter, is received in the carrying die incidental to the movement of such die inwardly of the advancing head. During the last part of the advancing movement of the head, and before retractive movement of the cutter is started, a feeding plunger behind the slug is actuated, sending a part of the slug previously held by the cutter into the carrying die. Then, as the head performs a retractive movement, said plunger is first retracted and the cutter is next retracted. During the retractive movement of the head, yielding means between the carrying die and the head moves said die outwardly of the head to restore the die to its initial position on the head. Consequently, under no circumstances can the cutter be fouled by movement of the head.

Another object is to provide a novel and improved method and apparatus for effecting a flow or displacement of the slug material during formation of the rivet or like article having an annularly continuous or bifurcated tubulure, whereby the rivet shank or an analogous portion of the article fabricated is elongated by what may be termed a drawing or quasi-drawing operation, such operation preferably following and/or simultaneous with a piercing operation.

Various other objects and advantages of the invention will hereinafter be referred to or become apparent from the following detailed description of an exemplifying apparatus as shown in the accompanying drawings, in which:

Fig. 1 shows such apparatus, partially broken away, in top plan.

Fig. 2 is a longitudinal section, taken substantially on the line 2—2 of Fig. 1.

Fig. 3 is a fragmentary transverse vertical section, taken substantially on the line 3—3 of Fig. 1.

Fig. 4 is a vertical section, taken through the fixed bed (B) at the slug (20) where held in loading position, and through the movable head (27) at the carrying die (30),—this view being taken substantially on the line 4—4 of Fig. 3.

Fig. 5 is a similar view, showing the head advanced and the carrying die engaging the cutter (26) but containing the entirety of the slug as the result of operation of the feeding plunger (28).

Fig. 6 is a similar view, showing the head retracted.

Fig. 7 is a similar view, showing the carrying die moved over the head, here vertically downwardly, to align the carrying die with the forming die (21) in the bed.

Fig. 8 is a similar view, showing the two dies brought together to have the carrying die act as an extension of the forming die for shaping of the slug in the latter.

Fig. 9 is a similar view, showing the head again retracted after the operation last-described, and preparatory to moving the carrying die vertically upward to the position of Fig. 4, thereby to align a heading punch (42) with the partially formed rivet now in the forming die so that the next advancing movement of the head will finish the rivet as shown in the lower part of Figs. 5 and 6.

Fig. 10 shows a cut off slug, on an enlarged scale.

Fig. 11 is a similarly enlarged view, but showing the slug being shaped in the forming die by a forming punch (22).

Fig. 12 is a similar view showing the slug further shaped by application of the heading punch.

Fig. 13 is a similar view of the finished rivet.

The apparatus shown is particularly adapted for the formation of small tubular rivets from said metal slugs 20, each slug cut off from rod or wire stock suitably fed. The cut-off slug is worked on while held in a forming die 21 carried by the bed B of the machine, partially to form the rivet as shown in Figs. 8 and 11; the slug being forcibly inserted in the die so that the end of the slug to be made tubular is shaped during such insertion by a forming punch 22. It will be noted that this tubulation of the slug is accompanied by an outward flaring thereof, so that when the rivet is ejected from the die 21 by final advance of the punch 22 through said die, such flared portion of the rivet will be drawn to a smaller diameter with an accompanying lengthening of the rivet shank. Working of the slug as just described is one of the features of the invention as preferably carried out.

In Figs. 3 and 9 there is shown a length of stock 23 movable through the machine in a rightward direction in Fig. 9 through a guiding tube 24 carried by the die bed 25. When the stock 23 is advanced to an extent appropriate to the length of the rivet determined, a cutter 26 severs the thus advanced end portion of the stock to provide a slug 20. This cutter 26 is shown in elevation in Fig. 3, which also shows the semi-circular knife edge of the cutter which is the direct severing agent laid against the stock 23. The severed slug is held to the cutter by a resilient gripper of a type familiar in the art; such gripper seen at 26' in Figs. 3, 4 and 5.

As will also be seen from Fig. 3, movement of the cutter 26 toward the right will effect severance of the stock 23 and also transference of the slug 20 into aligning position, as shown in Fig. 4, with a loading or feeding plunger 28 guided in a ring 29.

Carried by the head 27 is a die 30 the purpose of which is to receive the slug 20 from the cutter 26 while the slug is in the aligning position just-mentioned, to transfer said slug into alignment with the forming die 21, which is carried by the bed B, and also to coact with said forming die during the extruding of the slug; all as shown in Figs. 4 to 9. As seen in Fig. 4, the die 30, which will hereinafter be called the carrying die, is axially aligned with the slug 20 and with the loading pin 28. With the parts as shown in Fig. 4, the head 27 is advanced upon the bed to the position shown in Fig. 5, and during the latter part of said movement the feeding plunger 28 is also advanced to the right so as to force the slug 20 into the carrying die 30, the opening in said die being of a size snugly to receive the slug. It is particularly to be noted that during advance of the head upon the die bed, there is no movement whatever of the cutter 26, even after the carrying die 30 engages the slug. The advance of the feeding plunger 28 pushes the slug 20 entirely out of the cutter 26 and into the carrying die 30, and during the entire slug transferring operation there is no danger of fouling or of injury to any of the moving parts of the slug-carrying mechanism, nor is there any danger of the slug being improperly positioned for work to be done thereon, or of the slug dropping out of the machine.

The carrying die 30 is carried within a sleeve 31 secured in the head 27 by a locking means 32, and said die is longitudinally movable in the sleeve but yieldingly urged to a forward position by pressure transmitted through a cylindrical backing member 33 from expansile coil springs 34 disposed in longitudinally extending recesses annularly spaced around said member and bearing against a fixed plate 35. The carrying die 30 is thus yieldingly positioned in the sleeve 31 in normally projected position so that an external shoulder of the die is in engagement with an internal shoulder at the outer end of sleeve 31. When the head 27 has advanced upon the die bed 25 to full-stroke extent, the carrying die 30 will be in engagement with the cutter 26 and will have been moved inwardly of the sleeve 31 as shown in Fig. 5.

After the slug 20 has been loaded by projection of feeding plunger 28 into the carrying die 30, the head 27 is retracted from the die bed 25 to the position shown in Fig. 6; the carrying die 30 advancing leftwardly to return to its normal position in response to springs 34 following relief of the pressure exerted by the cutter 26. Next the head 27 is moved downwardly from the position shown in Fig. 6, that is, opposite the tube 29 of Fig. 3 to the position shown in Fig. 7, that is, opposite the forming die 21 of Figs. 3 and 7, wherein the carrying die 30 is aligned with said forming die.

The forming die 21 is retractably carried in a sleeve 36 of the bed 25 an external shoulder of the die abutting an internal shoulder at the outer end of the sleeve, and said die is yieldingly held in this position by pressure transmitted through a cylindrical backing member 37 movable in the sleeve by springs 38 disposed in cylindrical recesses annularly spaced around said member and bearing against fixed plate 39 in the die bed.

The forming punch 22 is axially aligned with

the die 21, and normally disposed with its shaped working end at the back of the die. Said punch, passing through an aperture in the plate 39 and through a central bore in the backing member 37, is secured at its inner end to a thrust-rod 40.

After the head 27 has reached the position shown in Fig. 7, it is ready again to perform a full-stroke advance upon the die bed 25.

As the parts are shown in Fig. 8, this operation has been completed; the face of the carrying die 30 now engaging the face of the forming die 21, and the slug 20 has been forced into the latter die and thereby flowed and shaped therein as shown in this view and in Fig. 11. Transfer of the major length of the slug, from the carrying die to the forming die, occurring during the operation just-described, was effected by a driving pin 41 within the die 30 and passing through the backing member 33, said pin held against moving with the die by abutment against the backing plate 35.

It will be noted as shown in Fig. 8, that during the working of the metal of the slug 20 within the die means, the two dies 30 and 21 componental of such means are juxtaposed, although both are in partially retracted positions, with their front faces in intimate contact; the slug being carried by and supported within both dies, and the driving pin 41 being held against lateral bending by the die 30 and the long bore of backing member 33.

After the slug 20 has been formed to shape the rivet shank as in Figs. 8 and 11 or 12, the head 27 of the machine is retracted from the die bed 25, leaving the slug in the die 21. This position of the parts is shown in Fig. 9. (During this retraction of the head 27, stock 23 is given another advance to cut off relation to the cutter 26.)

The slug 20 of Fig. 9 is now in condition to be headed over so as to complete the formation of the rivet. This heading operation is performed after the cutting of a new slug following the operation described in parentheses above, and simultaneously with the loading by feeding plunger 26 (as in Fig. 6) of said new slug into the carrying die 30.

Reverting now to Fig. 5 a slug 20' previously shaped as in Fig. 8 and now within the forming die 21 as in Fig. 9 is now in alignment with a heading punch 42 carried by the head 27, and when the latter again advances upon the die bed 25, as shown by Fig. 6, the slug 20' will be headed-over by said punch.

As, following this operation, the head 27 is again retracted from the die bed 25, the forming punch 22 is forcibly advanced through the forming die 21 to eject the slug therefrom and, during this operation, the rivet is further shaped and by a drawing or quasi-drawing operation, to lengthen the rivet shank at the tubular portion thereof. Such lengthening of the rivet shank is accompanied by a restoration of the tubulure thereof from a conical to a cylindrical shape. It will be noted in this connection that the forming die 21, as most clearly shown in Fig. 11 or 12, has a rearwardly outwardly flaring conical chamber 21', and that the working end of the forming punch, marked 22' in Fig. 11, has a rounded nose and a rearwardly conically expanding body, back to an annular shoulder 22a, the conicity of which body substantially matches that of the chamber 21'. Such a construction, it has been found, results in the final production of a rivet such as shown in Fig. 13, with its final tubulure as at 20a of Fig. 13 considerably elongated relative to its preliminary tubulure as at 20b of Fig. 12, and with the rivet, despite its final heading, also considerably longer than the slug from which it was formed.

Referring to Fig. 8, showing the slug being formed in the die 21, it will be noted that said die is retracted to some extent within the shell 36, against the springs 38 urging said die outwardly. Such retraction of the die is caused by bulging or swelling of the slug against the walls of the die and by movement of the slug as driven by the driving pin 41 against the forming punch 22. Although it is preferable to mount the forming die 21 so that it may thus retract during forming of the slug therein, thereby to prevent undue loading of the driving pin 41, I have found that, when extremely short slugs are handled, it is not necessary that the die 21 be retractable. This is so, because, when working with extremely short slugs, the total friction between such a slug and the walls of the die 21 should not be so great as unduly to load the driving pin 41 and cause excessive compressive stresses therein. In any event, it is now believed preferable thus to mount the die for retractive movement in the bed regardless of the length of the slug, in order to avoid any possibility of placing undesirable stresses on the slug or on the parts acting compressively in regard to the same. In this connection, it should be kept in mind that, even should such stresses be otherwise adequately taken care of, the forming process within the die is facilitated, due to the fact that retractive movement of the die is in the same direction as the flow of the metal of the slug past the nose of the forming punch 22.

After the head 27 has retracted, as shown in Fig. 9, the forming die 21 may or may not remain in retracted position, depending on the amount of friction between the nose 22' (Fig. 11) and the inner walls of the slug. Figs. 5 and 9 show a condition wherein the die 21 has been advanced again to its normal position by the springs 38 overcoming said friction.

In Fig. 6 the finally formed rivet (20') is shown as being carried on the tip of the forming punch 22, now advanced to carry such rivet beyond the forming die 21; and a stripper 43 is in position above the slug and back of the head thereof.

On the next ensuing retraction of the forming punch 22, properly timed, positive ejection of the slug occurs.

This stripper 43 is most clearly shown in Fig. 3; being pivotally mounted on the bed 25 and having a gear-tooth portion engaged by a rack 44 carried in a guide 45 and connected with a bell crank 46 which is actuated by a cam 47. Stripper 43 is brought into position only during the intervals while a finished rivet is being supported on the tip of the forming punch 22 following projection of the latter through the forming die 21; said stripper being returned to the position shown in Fig. 3 directly after the rivet has been stripped from said punch and has fallen or been otherwise conveyed from the vicinity of the die bed, well before the head 27 again advances upon said die.

The above description has been devoted to the making of a tubular rivet, in illustration of the invention, but the shape of the working end of the forming punch 22 will be varied according to the intended shape of the finished article. While as illustrated herein the working end of the punch causes the article to be tubulated, it should

be understood that any shape for the working end of the punch may be employed which performs the function of shaping the inner end of the slug as intended while bearing against that end to cause the metal of the slug to be spread to enlarge the slug laterally at its inner end.

As shown in Figures 1, 4, 5 and 8, the head 27 is carried by a slide 49 which has a lug 50 projecting for engagement by a sliding dog 51 to lock the slide in either upper or lower position during advances of the head. In Fig. 4, which shows the head retracted just after it has been raised to its upper position from its lower position as in Fig. 9, the dog 51 is out of engagement with the lug 50. Just before the head 27 advances toward the position shown in Fig. 5, the dog 51 moves into engagement with the lug 50 so as to wedge the head securely against vertical movement. When the head 27 is in its lower position, and is about to advance upon the die bed 25 for the purpose of forming a slug as shown in Fig. 8, the dog 51 is engaging the upper face of the lug 50 so as to wedge the head likewise securely against vertical movement.

As shown in Figures 1 and 2, the head 27 and slide 49 are carried by a movable gate or carriage 52. A stop means for limiting up and down movements of the carriage includes the following parts: The lower threaded end of a bolt 53 is screwed into the upper end of the slide, there being locked by a nut 54; such bolt at its upper cylindrical portion extending through a bushing 55 screwed into a bracket 56 affixed to the carriage. The bushing 55 is locked in the bracket by a barrel check nut 57. This bushing, which may be adjustably positioned in the bracket 56, acts as a stop to engage the nut 54 to limit the upward movement of the slide 49. The upper threaded end of the bolt 53 is threaded to carry nuts 58 and 59, which are locked against each other, the lower of which nuts serves as an adjustable stop to limit the downward movement of the slide by engagement with the check nut 57.

The slide 49 at its lower end is secured at 49' on a slide shoe 60 on a guide plate 61 of a block 62 carried by an arm 63 mounted on a shaft 64, which shaft is actuated from the cam shaft 65 of the machine through suitable cam-and-follower mechanisms not shown.

Referring to the locking dog 51, this is slidably carried by gate 52, and, with its rearward end spring-urged by the expansile spring shown in Fig. 2, said dog is engaged and actuated by a crank arm 66 carried on a shaft 67, which is, in turn, actuated by a crank 68 engaging a fixed cam surface 69 adjustably mounted on the frame, 70, of the machine. Thus back and forth movements of the gate 52 automatically operate the locking dog 51 to engage and disengage the lug 50 of the slide 49 so as to lock and unlock said slide and the head 27 in either upper or lower position.

Gate 52 is moved back and forth by a Scotch-yoke including a yoke-plate 71 vertically adjustably fixable in a recess 72 by a bracket portion 71*a* positionable by a threaded stud 73 and as thus positioned settable by nuts 74 and 75 on the stud. Riding along the inner walls 77 in this yoke-plate is a block 78 loose on an eccentric 79 carried by a crank shaft 80. Thus gate 52, which rides on guide plates 81 and 82, is reciprocated horizontally by rotation of said crank shaft.

Cam shaft 65 is geared to crank shaft 80 by spur gears 83 and 84 respectively, in such manner that the horizontal reciprocatory movements of the gate 52 are properly timed to the vertical reciprocatory movements of the head 27 and slide 49. The arrangement of the gearing and of the cam and link mechanism for reciprocating slide 49 from cam shaft 65 is such that the successive advances of the gate 52 toward the die bed 25 will be performed with the head 27 and slide 49 raised and lowered alternately.

During each retraction of the head 27 from the die bed 25 after the heading-over of a slug held in the forming die 21 (the head being then in its uppermost position as in Fig. 6), forming punch 22 is, as already explained, forcibly advanced through the die 21 so as to eject the slug therefrom. Referring in this connection to Fig. 2, the thrust-rod 40 secured as aforesaid to the punch 22, is moved by a lever 83 (Figure 1), this last in turn actuated by a slide 84 connected by a stud 85 to another slide 86. Slide 86 is pivoted to a bell crank 87 including an arm 87' actuated by a cam 88 carried by cam shaft 65. These parts, which are conventional, so operate the forming punch 22 that the latter will be advanced only during retraction of the head after the rivet has been headed-over and will be positively retracted directly after the stripper 43 is in the position shown in Fig. 6 so as to effect positive stripping of the rivet from said punch. During the time when the punch 22 is at rest, the thrust-rod 40 is backed up by a screw 90 (Fig. 2), adjustable by turning of the head 91 thereof, and fixed in such adjustment by a lock nut 92.

In a similar manner the feeding plunger 28 is advanced after advance of the head 27 (as in Fig. 5), by a similar thrust-rod 93 (Fig. 2), operated by a lever 94 (Figs. 1 and 2), and by a slide, stud and companion slide corresponding to and lying below the slide 84, stud 85 and slide 86, and actuated by a bell crank 87*a* including an arm 87*a*' engaging a cam 89 on cam shaft 65.

These cams and the associated parts are so arranged that the loading plunger 28 and the forming punch 22 will be automatically advanced and retracted at the proper times during movements of the gate 52 and head 27.

The rod or wire stock 23 is shown as being fed through the guiding tube 24 by the usual wire feed rollers 95, both of which are seen in Fig. 2. As also shown in Fig. 2, said rollers are adjustable for tension by a hand wheel 96 rotatable to vary the compression of an expansile spring 97. The rollers are turned by means of a pawl 98 and a ratchet 99 operated by a link rod 100 driven by a cam (not shown) on the cam shaft 65, all in the conventional manner.

The stock 23 which is being advanced strikes against an adjustable stop 101 mounted on a longitudinally disposed bar 102 carried by the frame 70 of the machine and adjustable by a screw 103, as usual.

Referring to the stripper mechanism as shown in Fig. 3, the cam 47 is carried by a shaft 47*a*, which is operated by gearing (not shown) from the crank shaft 65, and in such manner that the stripper 43 is brought into stripping position after the forming punch 22 is fully advanced as in Fig. 6, and is removed from this position only after said punch has been retracted sufficiently to strip the slug therefrom.

The cutter 26 is mounted on a transverse bar 104, shown in Figs. 1 and 3. This bar carries a pin 105 (Fig. 1) riding in track or guide-way 106 in a cam slide 107 connected by a link 108 with a crank plate (not shown) carried by the

cam shaft 65. By these means the cutter 26 is periodically actuated, to sever a slug from the advanced stock 23 during the time that the head 27 is being retracted from the die bed after the shaping of a preceding slug in the forming die 21, and to carry the severed slug into aligning position (as in Fig. 5) with the feeding plunger 28 during the time that the retracted head is being raised vertically, preparatory to another advance of such head upon the die bed.

Variations and modifications may be made within the scope of this invention, and portions of the improvements may be used without others.

I claim:

1. The method of making formed metal articles which includes inserting a slug of metal into a carrying die, relatively moving said carrying die and a forming die to align the two dies, and compressing the slug endwisely while laterally confined in both dies to shape the slug by allowing flow of the metal thereof longitudinally of the slug.

2. The method of making formed metal articles which includes inserting a slug of metal into a carrying die, relatively moving said carrying die and a forming die to align the two dies, and compressing the slug endwisely while laterally confined in both dies to shape the slug by allowing flow of the metal thereof both longitudinally and laterally of the slug.

3. The method of claim 2, wherein, during such metal flow, the metal is guided to flow in such manner that a longitudinal subdivision of the slug is conically enlarged.

4. The method of claim 2, wherein, during such metal flow, the metal is guided to flow in such manner that a longitudinal subdivision of the slug is conically enlarged, and such enlargement is pierced to tubulate the same.

5. The method of claim 2, wherein, during such metal flow, the metal is guided to flow in such manner that a longitudinal subdivision of the slug is conically enlarged, and such enlargement is pierced to tubulate the same, and wherein the thus shaped slug is subjected to end-wisely applied pressure while guiding the metal of such tubulation to attenuate the latter and reduce its cross-section and thereby elongate the tubulation.

6. The method of claim 2, wherein, during such metal flow, the metal is guided to flow in such manner that a longitudinal subdivision of the slug is conically enlarged and such enlargement is pierced to tubulate the same, wherein thereafter the slug is headed at an end opposite to said tubulation, and wherein thereafter the slug is pulled by way of said head while being confined laterally thereby further to finish said tubulation.

7. The method of making formed metal articles which includes severing an elongate piece of stock to provide a slug, transporting said slug to a point out of alignment with said piece, seizing and confining the slug girthwisely thereof, moving the thus seized and confined slug into alignment with a forming die, partially entering the slug in said die while maintaining said seizure and confinement of the slug relative to a part of the length thereof, and endwisely compressing the slug to shape the same by allowing flow of the metal thereof both longitudinally and laterally of the slug while the slug is subjected over a part of its length to the seizure confinement first-mentioned and over a part of its length to confinement within said die.

8. The method of claim 7, wherein during such metal flow the metal is guided to flow in such manner that a longitudinal subdivision of the slug is pierced and flared.

9. The method of making formed metal articles which includes inserting a slug of metal into a carrying die, aligning the carrying die with a forming die having a mouth of a diameter to fit the slug, driving the slug partially into the forming die and against a forming punch in said forming die, the forward end of said punch and the die chamber being so shaped that the inner end of the slug is hollowed and flared to a larger mean diameter than the diameter of said mouth, withdrawing the carrying die to leave an end of the slug protruding from the forming die, heading-over the protruding end of the slug, and drawing the flared end of the slug to a smaller diameter by thrustwisely moving the slug toward ejection from the forming die.

10. The method of claim 9, wherein the flared end of the slug is further drawn and to finish the same by stripping the slug from the die by pulling on the headed-over end of the slug.

11. In a heading machine, the combination of a carrying die; a slug holder; means for endwisely moving the slug to transfer the same from the holder to the carrying die; a forming die; and means for transferring the slug from the carrying die to the forming die.

12. In a heading machine, the combination of a carrying die; a slug holder; means for endwisely moving the slug to transfer the same from the holder to the carrying die; a forming die; means for transferring a part of the slug from the carrying die to the forming die; and means for forming the slug in the forming die while the slug is contained in both dies.

13. In a multiple-blow heading machine, the combination of a die bed having a longitudinally movable loading pin; a head movable relatively to the bed and having a carrying die; means for moving said head laterally of the bed for aligning the carrying die with the loading pin; means for carrying a slug into alignment with and interposition between said pin and said die; and means for inserting said slug into said die, said means including means for moving the head toward the bed, and means for longitudinally moving said pin toward the carrying die.

14. The invention as defined in claim 13, in which said slug-carrying means includes a cutter for severing the slug from a length of stock.

15. In a multiple-blow heading machine the combination of a die bed; a longitudinally movable loading pin carried by said bed; a forming die also carried by said bed; a head movable relatively to the die bed; a carrying die carried by said head; a heading punch carried by said head, the distance on the head between centers of the carrying die and the heading punch being equal to the distance on the bed between centers of the loading pin and the forming die; and means for moving the head relatively to the bed so that said head will alternately advance upon and retract from said bed and so that incidental to each alternate such reciprocation the head is moved laterally of the bed, whereby during one such reciprocation said pin is aligned with the carrying die and the forming die is aligned with said punch, and during another such reciprocation the two dies are aligned.

16. The method of making formed metal articles which includes inserting a slug of metal into a carrying die, aligning the carrying die with a forming die having a mouth of a diameter

to fit the slug, driving the slug partially into the forming die and against a forming punch in said forming die, the chamber in the forming die being so shaped that the inner end of the slug is flared to a larger mean diameter than the diameter of said mouth, withdrawing the carrying die to leave an end of the slug protruding from the forming die, heading over the protruding end of the slug, and drawing the flared end of the slug to a smaller diameter by thrustwisely moving the slug toward ejection from the forming die.

17. The method of making formed metal articles which includes inserting a slug of metal into a carrying die, relatively moving said carrying die and a forming die to align the two dies, and compressing the slug endwisely while in both dies and while guiding the slug metal to flow in such manner within the forming die that a longitudinal subdivision of the slug is enlarged laterally.

18. The method of making metal articles which includes confining a slug over at least a part of its length in a carrying die, laterally moving the carrying die with the slug therein into alignment with a forming die, moving the slug to drive its inner end into the forming die against the forward end of a forming punch in the die chamber of the forming die while guiding the slug metal adjacent said end of the punch to cause the displacement of the slug metal laterally of the slug thereby to cause the inner end of the slug to be enlarged to a larger diameter than the part of the slug in the carrying die, withdrawing the carrying die to expose an end of the slug protruding from the forming die, heading the protruding end of the slug, and drawing the flared end of the slug to a small diameter by thrustwisely moving the slug toward ejection from the forming die.

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