Nov. 3, 1931. O. L. SMITH 1,830,722

METHOD AND MACHINE FOR MAKING TUBULAR RIVETS AND THE LIKE

Filed March 16, 1931 5 Sheets-Sheet 1

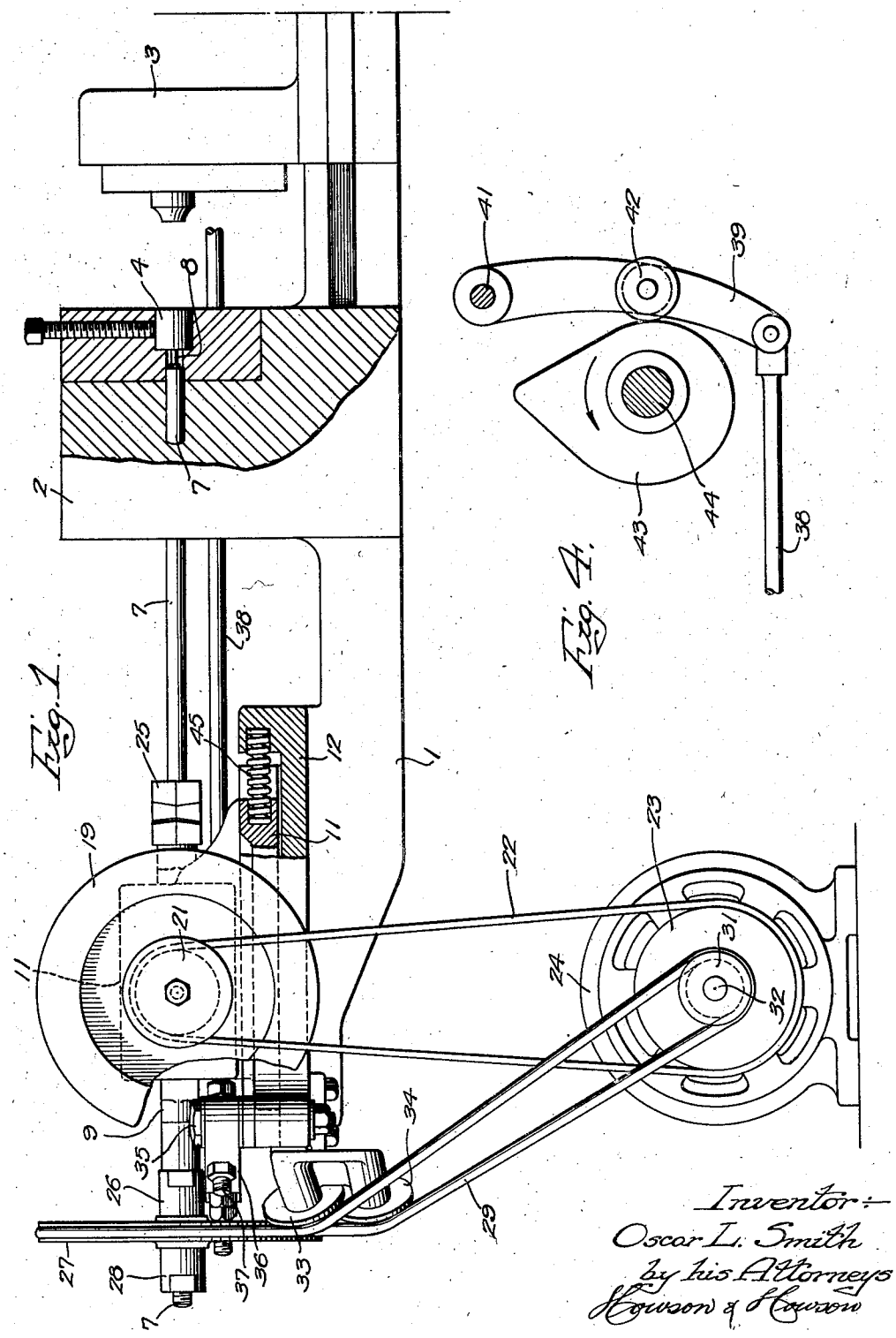


Fig. 1.

Fig. 4.

Inventor:
Oscar L. Smith
by his Attorneys
Howson & Howson

Nov. 3, 1931. O. L. SMITH 1,830,722

METHOD AND MACHINE FOR MAKING TUBULAR RIVETS AND THE LIKE

Filed March 16, 1931 5 Sheets-Sheet 2

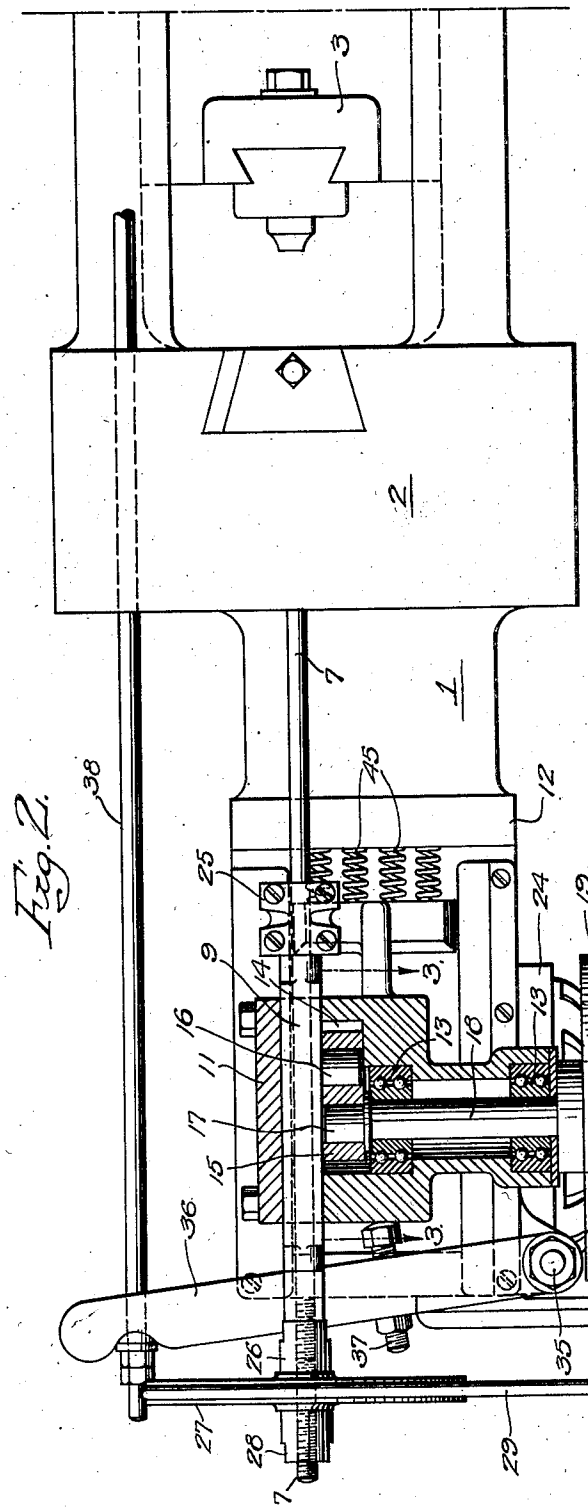


Fig. 2.

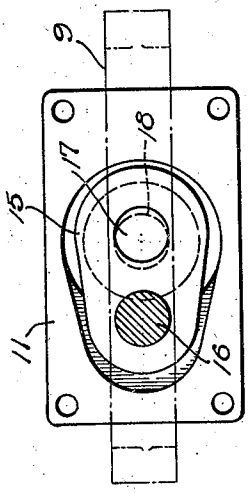


Fig. 3.

Inventor:
Oscar L. Smith
by his Attorneys
Howson & Howson

Nov. 3, 1931. O. L. SMITH 1,830,722

METHOD AND MACHINE FOR MAKING TUBULAR RIVETS AND THE LIKE

Filed March 16, 1931 5 Sheets-Sheet 3

Fig. 5.

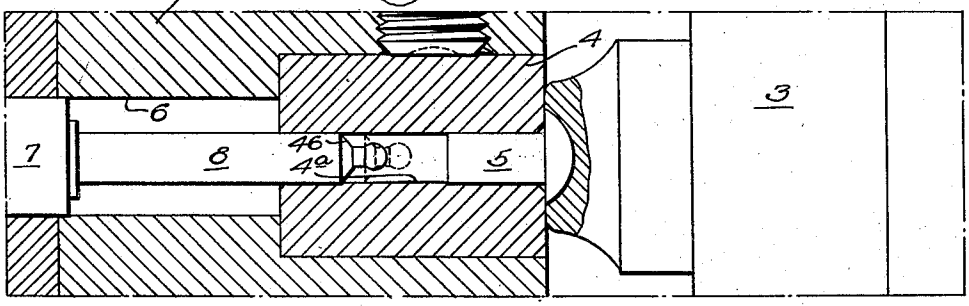


Fig. 6.

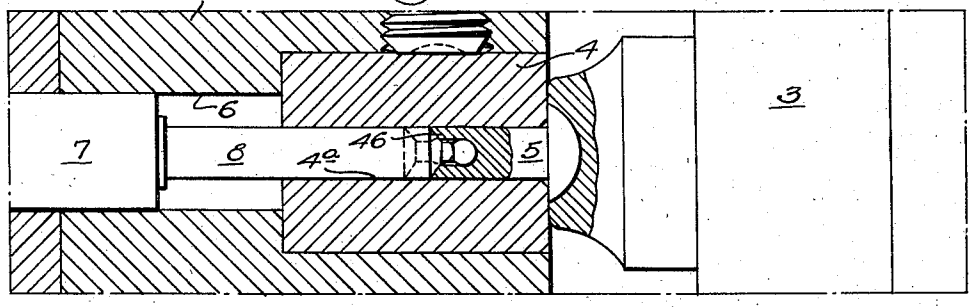


Fig. 7.

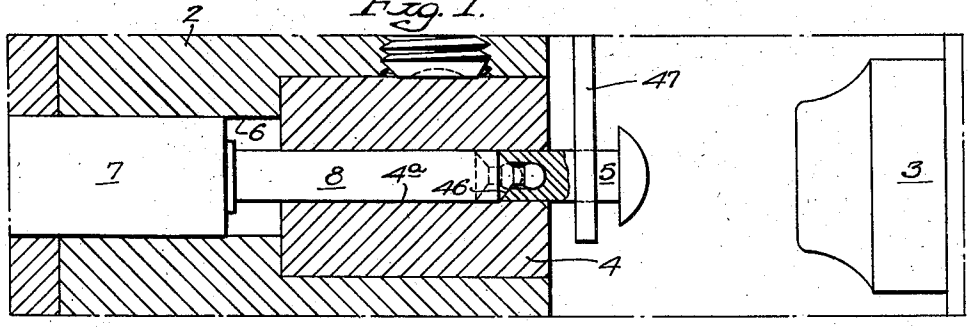
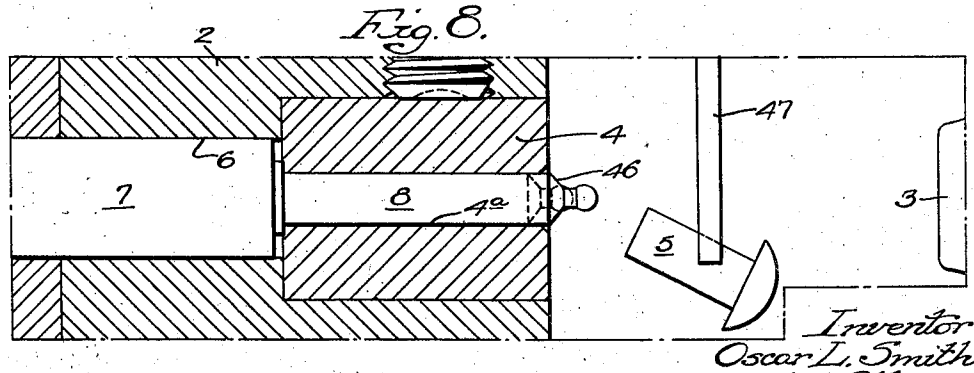


Fig. 8.



Inventor:
Oscar L. Smith
by his Attorneys
Howson & Howson

Nov. 3, 1931. O. L. SMITH 1,830,722

METHOD AND MACHINE FOR MAKING TUBULAR RIVETS AND THE LIKE

Filed March 16, 1931 5 Sheets-Sheet 4

Fig. 9.

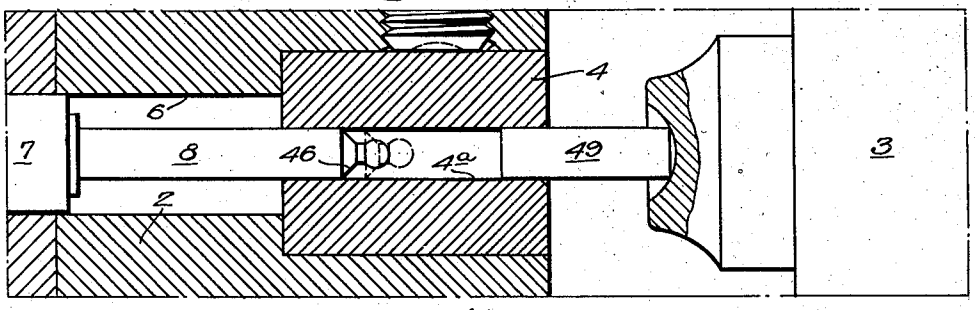


Fig. 10.

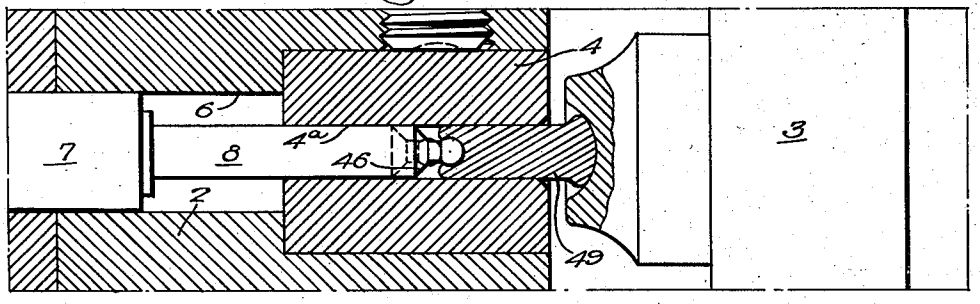
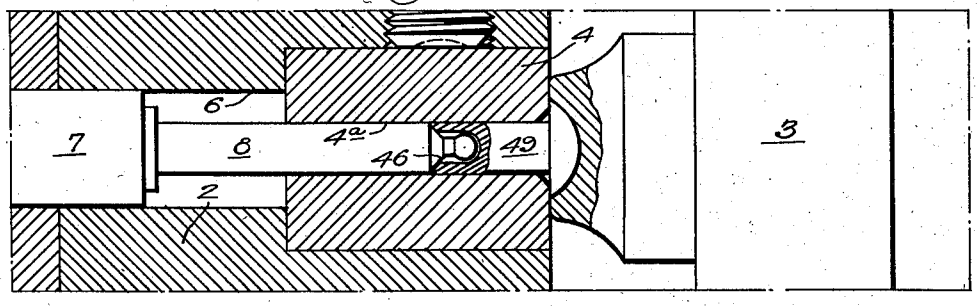


Fig. 11



Inventor:
Oscar L. Smith
by his Attorneys
Howson & Howson

Nov. 3, 1931. O. L. SMITH 1,830,722

METHOD AND MACHINE FOR MAKING TUBULAR RIVETS AND THE LIKE

Filed March 16, 1931 5 Sheets-Sheet 5

Fig. 12.

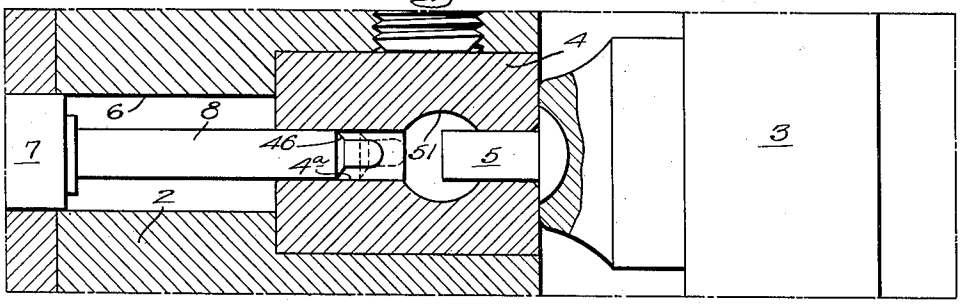


Fig. 13.

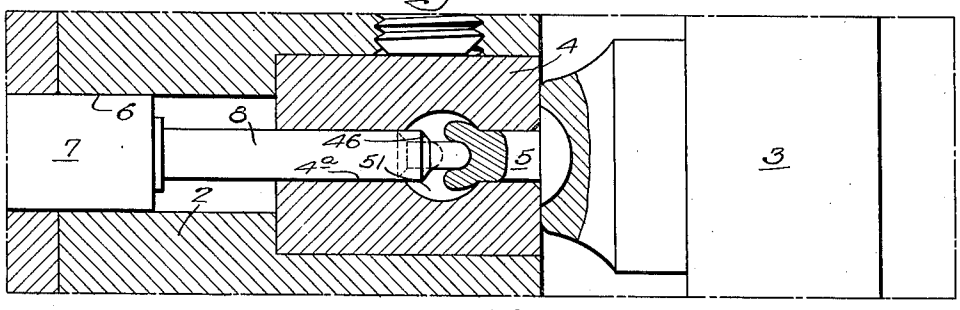


Fig. 14.

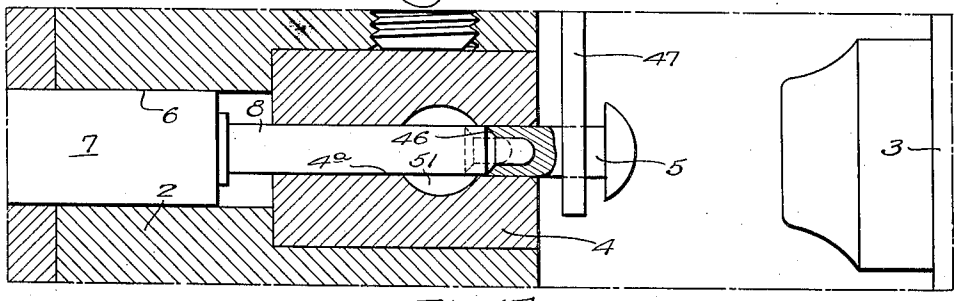
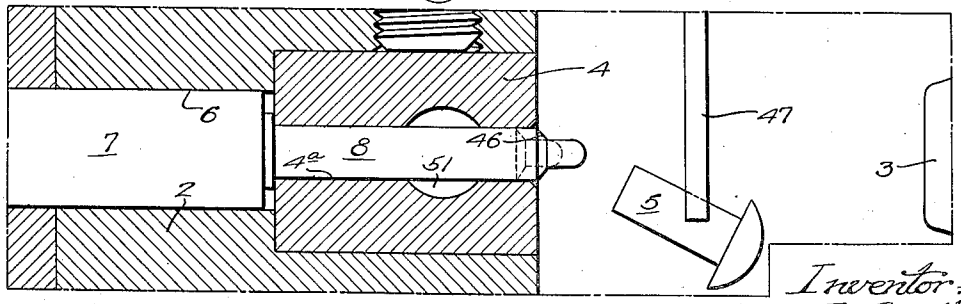


Fig. 15.



Inventor:
Oscar L. Smith
by his Attorneys
Howson & Howson

Patented Nov. 3, 1931 1,830,722

UNITED STATES PATENT OFFICE

OSCAR L. SMITH, OF TOMS RIVER, NEW JERSEY

METHOD AND MACHINE FOR MAKING TUBULAR RIVETS AND THE LIKE

Application filed March 16, 1931. Serial No. 523,109.

This invention relates to an improved method and mechanism for manufacturing hollow or recessed metallic forms by displacement or extrusion of the metallic stock, as distinct from prior methods involving an actual removal of a portion of said stock by a drilling or like operation, and a principal object of the invention is to provide a practicable and efficient method and mechanism of the stated character materially simplifying and facilitating the manufacture of articles of this type.

More particularly the invention has for an object the provision of an improved method and machine for manufacturing tubular-ended rivets, and for the purpose of illustrating the invention I have herein described, and show in the attached drawings, a machine adapted for this function.

In the drawings:

Figure 1 is a side elevation, partial sectional view of the machine;

Fig. 2 is a plan and partial sectional view of the machine;

Fig. 3 is a section on the line 3—3, Fig. 2;

Fig. 4 is a fragmentary side elevation, illustrating a detail of the mechanism;

Figs. 5 to 8, inclusive, are fragmentary sectional views illustrating various steps in the manufacture of the rivet;

Figs. 9 to 11, inclusive, are similar sectional views illustrating a modification of the process; and

Figs. 12 to 15, inclusive, are similar sectional views illustrating a still further modification in the process of manufacture, also within the scope of my invention.

It has been customary, in the manufacture of tubular rivets to form the tubular ends by drilling, an operation complicating and retarding the manufacturing process and adding materially to its cost. By the present invention, I have provided a practicable method whereby the tubular formation may be effected by a displacement of the metal of the rivet blank in an operation analogous to extrusion, and thereby materially facilitate and reduce the cost of manufacturing rivets of this type.

In practicing the invention in accordance with a preferred procedure I employ a die having a cylindrical bore neatly receiving the shank of the rivet blank together with a tool which enters the said bore and is forcibly engaged with the end of the shank, pressure being applied to relatively advance the tool and the said blank and to cause the end portion of the tool, which is somewhat smaller cross sectionally than the die bore, to penetrate the end of the shank. The metal thus displaced by the tool necessarily flows longitudinally of the bore around the penetrating end of the tool to form the tubular end of the finished rivet. During the relative advance movement of the tool and blank, one or both are given a longitudinal reciprocation, of high periodicity and preferably of small throw, effecting a series of rapid impingements which not only materially facilitates the displacement operation by causing an incremental flow of the metal but also relieves a part of the heavy strain to which the tool is subjected and avoids the development of excessive temperatures which would tend jointly to cause rapid deterioration of the tool. This longitudinal relative vibration of the tool and the rivet blank also prevents adhesion of the displaced metal to the tool and simplifies the subsequent stripping operation in which the rivet is separated from the tool. Simultaneously with aforedescribed operations the tool and the rivet blank are preferably relatively oscillated or rotated about their joint longitudinal axis which still further facilitates the displacement operation and permits the use of tools of various favorable shapes other than cylindrical in the formation of a truly cylindrical recess in the tubular end of the rivet.

In the drawings, the reference numeral 1 designates the bed plate of a rivet-forming machine made in accordance with my invention. The machine further comprises a die head 2 relatively fixed on the bed plate, and a head-stock 3 slidably mounted on the bed plate for reciprocation relative to the die head. As illustrated in Fig. 5, the die head 2 is provided with a recess for reception of a die 4, the latter having a cylindrical bore 4*a* formed to receive the correspondingly

formed shank 5 of a rivet blank, and said head is channeled at 6 in alignment with the die aperture, for passage of a shaft 7, having at its end a socket for reception of a suitable working tool 8 which as illustrated enters the inner end of the bore 4*a*. The shaft 7 extends rearwardly through rectangular member 9 which is slidably mounted in a correspondingly formed passage in the superstructure of a carriage 11, this carriage being slidably supported and guided in a recessed portion 12 of the bed plate 1. That portion of the carriage 11 which receives the member 9 is chambered at 14 for reception of a cross-head 15, this cross-head having an opening adapted to receive a cylindrical pin 16 projecting from one side of the rectangular member 9. The cross-head is also provided with a second cylindrical opening for reception of the eccentric cylindrical extension 17 of a shaft 18, the latter being journaled in bearings 13 in the carriage 11 (see Fig. 2) at right angles to the axis of the shaft 7 and of the member 9. The shaft 18 carries a fly-wheel 19 and a pulley 21, which is connected through the medium of a belt 22 to a pulley 23 on the shaft of an electric motor 24. Rotation of the shaft 18 by the motor 24 thus results in a longitudinal reciprocation of the member 9 in its guide. The member 9 is confined between a stop element 25, detachably secured to the shaft 7, and a nut 26 on the projecting threaded end of the shaft 7, whereby reciprocation of the member 9 is transmitted to the said shaft.

A sheave 27 is locked on the shaft between the nut 26 and a second nut 28, this sheave being connected through a belt 29 with a pulley 31 on the motor shaft 32, the said belt extending around idler pulleys 33 and 34 on the bed plate 1. Rotation of the sheave 27 from the motor 24 results in a rotation of the shaft 7, and simultaneously with the rapid reciprocation or longitudinal vibration of the shaft effected as previously set forth through the said shaft 18 and the associated mechanism.

Pivotally secured at 35 to the bed plate 1 is a lever 36, this lever carrying a stud 37, the head of which engages a side of the carriage 11. The outer end of the lever 36 is engaged by a rod 38, which extends longitudinally of the bed plate and is attached at its outer end to a lever 39 pivotally secured at 41 to the bed plate 1 or to a similar relatively fixed part of the machine. The lever 39 carries a roller 42, which is in operative engagement with a cam 43 on a shaft 44. This shaft may also carry a crank mechanism (not shown) for operative connection with the head-stock 3, through the medium of which said head-stock is moved toward and from the die head 2, as hereinafter set forth. Longitudinal movement of the rod 38, by the action of the cam 43, effects an oscillation of the lever 36 and a consequent reciprocation of the carriage 11, springs 45 being provided, confined between the carriage 11 and a portion of the bed plate 1, to maintain continuous engagement between the carriage and the stud 37, and to return the carriage to its original position when the lever 36 is retracted. Reciprocation of the rod 38 occurs simultaneously with the longitudinal vibration and the rotation of the shaft 7, reciprocatory movement of the head-stock 3 being synchronized with the reciprocatory movement of the shaft 7, in the manner previously explained.

In Figs. 5 to 8, inclusive, are illustrated the various steps in the manufacture of a tubular-ended rivet in accordance with my invention. The cylindrical rivet stock, having been headed in a previous operation, is transferred to the die 4 as illustrated in Fig. 5, the head-stock 3 being advanced to retain the rivet securely in the die during subsequent operations. The cam 43 now acts to advance the shaft 7 with the tool 8 into engagement with the inner end of the rivet shank, the said tool being continuously vibrated and simultaneously rotated as previously set forth. The tool, by reason of its forward movement, coupled with the rapid vibration and rotational movement, forces itself into the body of the rivet, the metal displaced by the tool entering the space surrounding the operating end of the tool, as illustrated in Fig. 6. When the metal has solidly engaged the shoulder 46 of the tool, the head-stock 3 is withdrawn and the continued forward movement of the shaft 7 forces the rivet outwardly from the die. In general, the vibratory movement of the tool is sufficient to clear the rivet from the end thereof, although I may provide, in addition, a stripper finger 47 (see Figs. 7 and 8), which functions to insure a separation of the rivet from the end of the tool, as shown in the last-named figure.

In the modified process illustrated in Figs. 9 to 11, the rivet stock 49 is entered in the die into contact with the vibrating and rotating tool 8 by the head-stock 3, which, in a continued advancement following engagement of the stock with the tool, forms the rivet head in the usual manner simultaneously with the formation by the tool 8 and in the manner previously set forth of the recess in the inner end of the rivet. In this instance, the rivet may be ejected from the die and stripped from the tool in the manner previously described.

I have found it desirable to make the advance of the tool during the initial and major portions of the displacing operation relatively rapid, and to feed the tool at a greatly reduced rate during the latter portion of the operation, and in Fig. 4, I have illustrated a cam adapted for this function. In actual operation of my machine in manufac-

turing small rivets, I have found a reciprocation of the tool of three thousand R. P. M. and a rotation of 400 R. P. M. highly satisfactory. An excessively rapid reciprocation is difficult to control mechanically, and too rapid rotation tends to burn the tool or the stock, but within the limits imposed by such considerations, a wide range of speeds varying either way from those specifically mentioned will be found entirely practicable.

In the modification illustrated in Figs. 12 to 15, the die is provided with a cavity 51, which receives the inner end of the rivet blank upon which preferably the head has previously been formed. In this instance, the tool 8 advances as described above into engagement with the inner end of the blank, the effect of the reciprocatory tool action being to upset the end of the shank into the cavity 51, as illustrated in Fig. 13. Subsequently, the head 3 is retracted, to permit a continued advance movement of the tool 8 to force the rivet outwardly from the die. This outward movement causes a drawing of the metal of the upset end portion of the rivet around the working head of the tool, as illustrated in Fig. 14, thus completing the formation of the tubular recess, the finished rivet being ejected in the manner previously described and as illustrated in Fig. 15. The vibratory movement of the tool materially aids the formation of the rivet by this method.

The mechanism described above is extremely rapid in operation and possesses a capacity far exceeding that of the machines of the prior practice. The machine is also substantially free from the disadvantages usually encountered in a rapid displacement of metal by an extruding process, such for example as frequent failure of the tool and inequalities in the product. Although preferring to use the simultaneous reciprocatory and rotary action, as described, the invention may be practiced to advantage with reciprocation alone. While finding a useful application in the manufacture of tubular rivets, the invention in principle may be applied to advantage to the manufacture of many other articles such for example as socketed set-screws, cartridge shells and many other forms of hollow or recessed products. It will also be apparent that mechanism by which the invention may be practiced may vary widely as to form and mode of operation.

I claim:

1. The method which comprises confining a metallic body in a die in engagement with a working tool, and forcibly relatively feeding said tool and body together simultaneously with a rapid relative reciprocation thereof to thereby effect a displacement of the metal of the body by molecular flow around the tool.

2. The method which comprises confining a metallic body in a die in engagement with a working tool, forcibly relatively feeding said tool and body together, and simultaneously relatively reciprocating and rotating said tool and body to effect a displacement of the metal of the body by molecular flow around the tool.

3. The method which comprises relatively feeding a metallic body and a tool toward each other to upset that end of the body engaged by the tool, subsequently drawing the upset portion of said metallic body around the sides of said tool by means of a die relatively moved with respect to the body, and simultaneously with said drawing operation relatively reciprocating said tool and said body.

4. The method which comprises relatively feeding a metallic body and a tool toward each other to upset that end of the body engaged by the tool, subsequently drawing the upset portion of said metallic body around the sides of said tool by means of a die relatively moved with respect to the body, and simultaneously with the drawing operation relatively reciprocating and rotating said tool and body.

5. The method which comprises confining a metallic body in a die with a portion thereof projecting, forcibly relatively feeding a tool and said body together to upset the projecting portion, thereafter relatively moving the die and said tool to cause the latter to force the upset portion of said body into the die to effect a drawing of said upset metal around the sides of the tool, and simultaneously relatively reciprocating said tool and body.

6. The method which comprises confining a metallic body in a die with a portion thereof projecting, forcibly relatively feeding a tool and said body together to upset the projecting portion, thereafter relatively moving the die and said tool to cause the latter to force the upset portion of said body into the die to effect a drawing of said upset metal around the sides of the tool, and simultaneously relatively reciprocating and rotating said tool and body.

7. The method which comprises confining a metallic body in a die in engagement with a working tool, advancing the tool in engagement with the body, and simultaneously effecting a rapid longitudinal reciprocation of the tool to effect a displacement of the metal of the body by molecular flow around the tool.

8. The method which comprises confining a metallic body in a die in engagement with a working tool, advancing the tool in engagement with the body, and simultaneously reciprocating and rotating said tool to effect a displacement of the metal of the body by molecular flow around the tool.

9. The method of forming a tubular rivet,

which comprises inserting the blank shank of said rivet in a cylindrical die opening, inserting in said die opening in engagement with the end of said shank a tool of lesser cross sectional area than the die opening, and forcibly relatively feeding said tool and shank together simultaneously with a rapid relative reciprocation thereof to thereby effect a displacement of the metal of said shank by a progressive incremental flow into and to fill the annular space between the die opening and the path of said tool.

10. The method of forming a tubular rivet, which comprises inserting the blank shank of said rivet in a cylindrical die opening, inserting in said die opening in engagement with the end of said shank a tool of lesser cross sectional area than the die opening, and forcibly relatively feeding said tool and shank together simultaneously with a relative reciprocation and rotation thereof to effect a displacement of the metal of the body by a progressive incremental flow into and to fill the annular space between the die opening and the path of said tool.

11. The method of forming a tubular rivet, which consists in inserting a cylindrical blank in a die with one end projecting, simultaneously engaging the outer projecting end and the inner end of said blank with a heading tool and a forming tool respectively, and feeding said tools toward each other simultaneously with a rapid reciprocation of said forming tool to simultaneously head the rivet and to effect a displacement of the metal of the inner end of said blank by molecular flow around said forming tool.

12. The combination with a die having an opening adapted for reception of a metallic body, of a tool adapted for insertion in said opening to engage an end of said body, means for relatively feeding said body and tool, and means for simultaneously relatively rapidly reciprocating said tool and body to effect a displacement of the metal of the body by molecular flow around the tool.

13. The combination with a die having an opening for reception of a metallic body, of a tool adapted for insertion in said opening into engagement with said body, means for feeding said tool toward the body, and means for simultaneously rapidly reciprocating said tool to effect a predetermined displacement of the metal of said body within the die.

14. The combination with a die having an opening for reception of a metallic body, of a tool adapted for insertion in said opening into engagement with said body, means for feeding said tool toward the body, and means for simultaneously rapidly reciprocating and rotating said tool during the feeding operation.

15. The combination with a die having a cylindrical passage adapted for reception of a correspondingly formed metallic blank, of means movable with respect to the die for confining the blank to said passage at one end of the latter, a tool adapted for insertion into said passage to engage the inner end of said blank, means for relatively feeding said blank and tool together, and means for relatively rapidly reciprocating said tool and blank during the feeding operation to cause the metal of the blank to have a progressive incremental flow into and to fill the annular space between the said cylindrical passage and the path of the tool.

16. The combination with a die having a cylindrical passage therethrough adapted for reception of a correspondingly formed metallic blank, of means for closing one end of said passage to confine the said blank, a tool adapted for insertion in the opposite end of said passage into engagement with said blank, said tool having a working tip of lesser cross sectional size than the said passage, and means for relatively feeding said blank and tool together and for simultaneously relatively reciprocating said tool and blank to effect a displacement of the metal of said blank by a progressive incremental flow into and to fill the annular space between the said cylindrical passage and the path of the tip of the tool.

17. The combination with a die having an opening adapted for reception of a metallic body, of a tool adapted for insertion in said opening and having a working tip of lesser cross sectional area than said opening, means for forcibly advancing said tool against the said body while confined in said opening, and means for rapidly reciprocating said tool during the feeding operation simultaneously with the advancing operation to cause the metal of the body to have a progressive incremental flow into and to fill the annular space between the die opening and the path of the tip of the tool.

18. The combination with a die having an opening adapted for reception of a metallic body, of a tool adapted for insertion in said opening and having a working tip of lesser cross sectional area than said opening, means for forcibly advancing said tool against the said body while confined in said opening, and means for rapidly reciprocating and rotating said tool simultaneously with the advancing operation to cause the metal of the body to have a progressive incremental flow into and to fill the annular space between the die opening and the path of the tip of the tool.

19. The combination with a die having a cylindrical passage therethrough adapted for reception of a correspondingly formed metallic blank, of a heading tool for engagement with a projecting end of said blank, a penetrating tool adapted for insertion in said die passage into engagement with the inner end of said blank, means for feeding the said tools simultaneously against the opposite ends of said blank, and means for rapidly re-

ciprocating said penetrating tool simultaneously with said feeding operations to cause the metal of the blank to have a progressive incremental flow into and to fill the annular space between the said cylindrical passage and the path of the penetrating tool.

20. The combination with a die having a cylindrical passage therethrough adapted for reception of a correspondingly formed metallic blank, of a heading tool for engagement with a projecting end of said blank, a penetrating tool adapted for insertion in said die passage into engagement with the inner end of said blank, means for feeding the said tools simultaneously against the opposite ends of said blank, and means for rapidly reciprocating and rotating said penetrating tool simultaneously with the feeding operations to cause the metal of the blank to have a progressive incremental flow into and to fill the annular space between the said cylindrical passage and the path of the penetrating tool.

21. The combination with a die having a cylindrical passage formed with an intermediate enlargement, said die being adapted to receive in one end a blank rivet having the end of its shank projecting into the enlarged portion of said passage, of a tool adapted for insertion into the opposite end of said passage in engagement with the end of said shank, means for feeding the tool against the blank to upset the inner end portion of said blank and to subsequently force the blank outwardly from said die passage, means for rapidly reciprocating said tool simultaneously with the feeding operations, and means for confining the blank in the die during the upsetting operation.

22. The method which comprises confining a metallic body in a die in engagement with a working tool, and forcibly relatively feeding said tool and the confined body together, simultaneously with a rapid relative reciprocation thereof, thereby to effect a displacement of the metal of the body by a progressive incremental flow into and to fill the annular space between the die wall and the path of the tool.

23. The method which comprises confining a metallic body in a die in engagement with a working tool, forcibly relatively feeding said tool and the confined body together and simultaneously relatively reciprocating and rotating said tool and body to effect a displacement of the metal of the body by a progressive incremental flow into and to fill the annular space between the die wall and the path of the tool.

24. The method which comprises confining a metallic body in a die in engagement with a working tool, advancing the tool in engagement with the confined body, and simultaneously effecting a rapid longitudinal reciprocation of the tool to effect a displacement of the metal of the body by a progressive incremental flow into and to fill the annular space between the die wall and the path of the tool.

25. The method which comprises confining a metallic body in a die in engagement with a working tool, advancing the tool in engagement with the confined body, and simultaneously reciprocating and rotating said tool to effect a displacement of the metal of the body by a progressive incremental flow into and to fill the annular space between the die wall and the path of the tool.

26. The combination with a die having an opening adapted for reception of a metallic body, of a tool adapted for insertion in said opening to engage an end of said body, means for relatively feeding said body confined in said opening and said tool, and means for simultaneously relatively rapidly reciprocating said tool and confined body to effect a displacement of the metal of the body by a progressive incremental flow into and to fill the annular space between the die wall and the path of the tool.

27. The combination with a die having an opening for reception of a metallic body, of a tool adapted for insertion in said opening into engagement with said body confined by said opening, means for feeding said tool toward the body, and means for simultaneously rapidly reciprocating said tool to effect a displacement of the metal of the body by a progressive incremental flow into and to fill the annular space between the die wall and the path of the tool.

28. The combination with a die having an opening for reception of a metallic body, of a tool adapted for insertion in said opening into engagement with said body confined by said opening, means for feeding said tool toward the body, and means for simultaneously rapidly reciprocating and rotating said tool during the feeding operation to effect a displacement of the metal of the body by a progressive incremental flow into and to fill the annular space between the die wall and the path of the tool.

OSCAR L. SMITH.