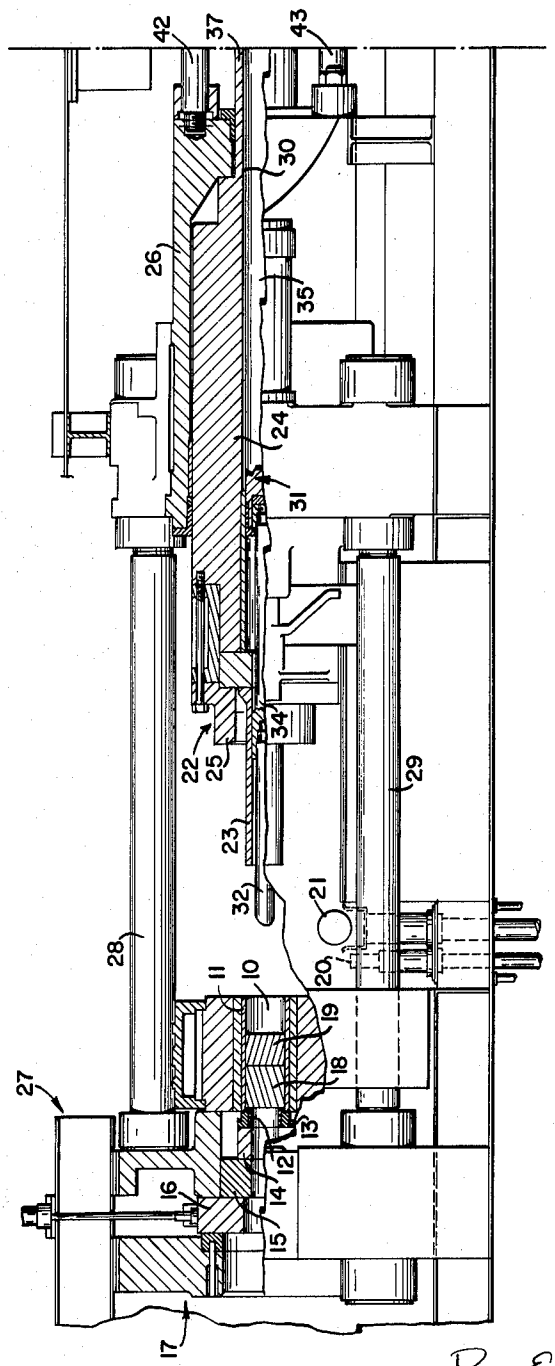
July 12, 1966 G. F. FLANAGAN 3,260,095

METHOD AND APPARATUS FOR EXTRUDING TUBES FROM SOLID BILLETS

Original Filed Dec. 11, 1961 2 Sheets-Sheet 1

FIG. 1A



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FIG. 1B

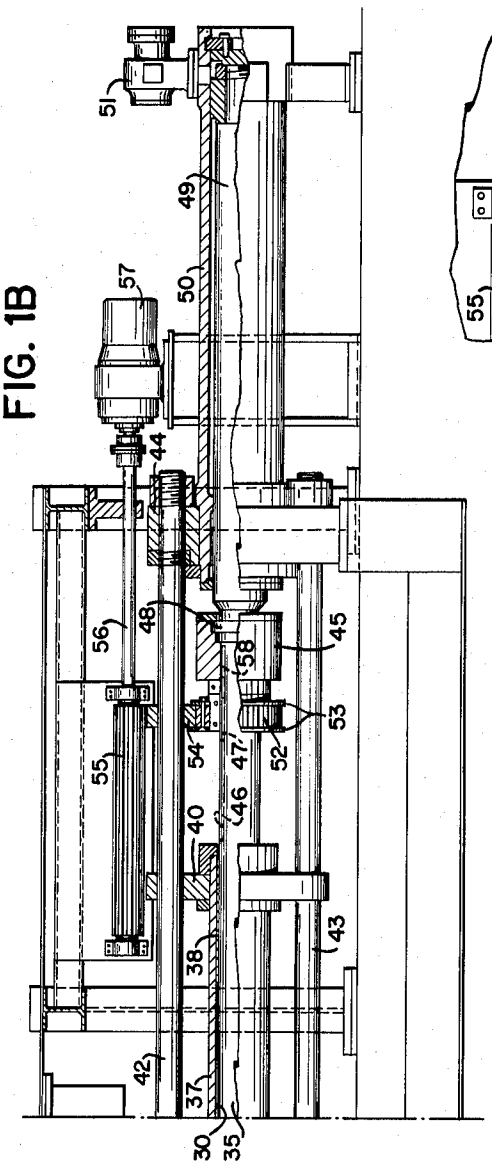


FIG. 2

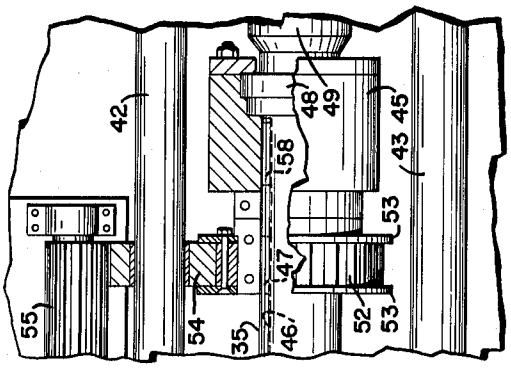
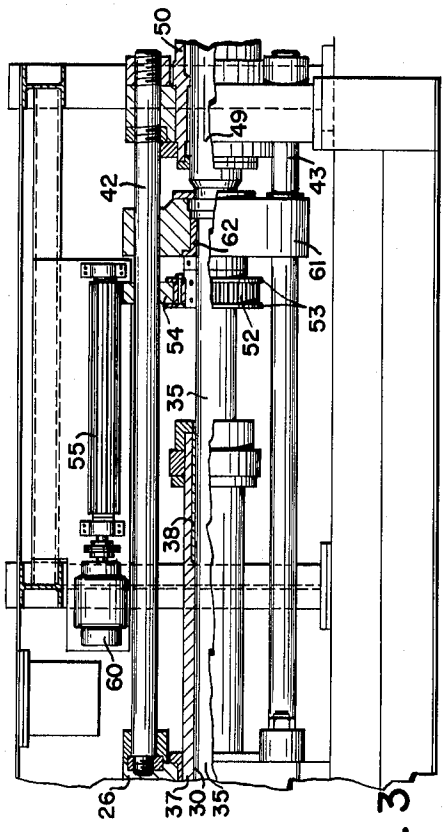


FIG. 3



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United States Patent Office 3,260,095 Patented July 12, 1966

3,260,095

METHOD AND APPARATUS FOR EXTRUDING TUBES FROM SOLID BILLETS

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Continuation of application Ser. No. 158,373, Dec. 11, 1961. This application Dec. 4, 1964, Ser. No. 418,945
4 Claims. (Cl. 72—265)

This is a continuation of my earlier filed application, Serial No. 158,373, filed December 11, 1961, now abandoned.

This invention relates to the extrusion of tubes from solid billets and more particularly to the method and apparatus for extruding tubing wherein a piercing mandrel is rotated continuously during piercing and extrusion operations.

In the extrusion of tubing from solid billets wherein the billet is upset, pierced, and then extruded, the mandrel which is used for both piercing the billet and to determine the inside diameter during the extrusion operation, is subject to extreme frictional forces which cause excessive wear on the surface of the mandrel. Moreover, it is often difficult to maintain effective control over the mandrel during the piercing operation. Ordinarily the bore pierced in the solid billet is not truly concentric. Also, when the mandrel wanders during the piercing operation and is subsequently extended out of the billet to its position within the die, it is seldom concentrically positioned relative to the die. When this happens the resultant tube is not extruded with walls of uniform thickness.

It is a purpose of this invention to eliminate the abovementioned problems by providing apparatus which is capable of extending the useful life of a mandrel used in this dual capacity and at the same time to extrude tubes having greater uniformity of wall thickness. I have found that by providing apparatus which is capable of rotating the mandrel during the piercing operation and continuously during the extrusion operation, the useful life of the mandrel is appreciably increased and the concentricity of the bore pierced in the solid billet is improved, and the subsequently extruded tube has a surprising degree of uniformity in the thickness of its walls.

The apparatus of the invention is comprised of a billet chamber and has a die positioned at one end thereof. An extrusion ram is mounted adjacent the opposite end of the billet chamber and has first drive means connected thereto for moving the ram axially into and out of the billet chamber. A rotatable piercing mandrel is slidably mounted on the extrusion ram and is extensible therefrom. The piercing mandrel has second drive means associated with the piercing mandrel assembly for axially extending and rotating the mandrel assembly out of the ram and axially into the billet chamber and die. Rotating means are connected to the mandrel for rotating the assembly independently of said second drive means.

With the new apparatus the mandrel performs the dual function of piercing the billet as well as determining the inside diameter of the extended tube. Moreover by providing means for rotating the mandrel continuously and independently of any drive means, apparatus is provided which can extrude tubing of uniform wall thickness.

The invention also contemplates an improvement in the method of extruding tubes from a solid billet wherein the billet is upset, pierced, and extruded through a die. The improvement comprises longitudinally piercing the billet with a rotating mandrel to form a bore therein, positioning the mandrel within the die and continuously rotating the mandrel throughout the extrusion operation, whereby a tube of substantially uniform wall thickness is formed.

A preferred embodiment of the invention is described hereinbelow with reference to the drawings wherein:

FIG. 1A is a side elevation partly in section showing the extrusion chamber, piercing mandrel and extrusion ram and drive means for the extrusion ram of the extrusion apparatus;

FIG. 1B is a continuation of the extrusion apparatus of FIG. 1A and is a side elevation partly in section showing the means for rotating and driving the piercing mandrel of the extrusion apparatus;

FIG. 2 is an enlarged section of the mandrel rotating means of FIG. 1B; and

FIG. 3 is a fragmentary side elevation partly in section substantially similar to FIG. 1B but showing an alternate means for rotating the piercing mandrel of the extrusion apparatus.

Referring initially to FIG. 1A and FIG. 1B one embodiment of the extrusion apparatus is shown. The extrusion apparatus is generally of the type adapted to extrude a tube from a solid billet. As shown in section in FIG. 1A, a billet chamber **10** is defined in the usual manner by a container lining **11**. Mounted at one end of the billet container **10** is a die **12**. The die **12**, which will determine the outside diameter of the extruded tube, is held in place by a die retainer **13** which substantially surrounds the outer circumference of the die. The retainer **13** and the die **12** are abutted by back-up piece **14** which in turn is held in position by die block **15**, a lock plate **16**, and ultimately by platen assembly **17** in the conventional manner.

As shown, deposited in the billet chamber **10** is a billet **18** and abutting the billet **18** in the billet chamber, such that the billet **18** substantially abuts against the die, is a dummy block **19**. The billet **18** and the dummy block **19** are loaded in the chamber **10** by a conventional dummy block loader **20** and billet loader **21** shown positioned below the billet container.

Longitudinally spaced from the billet container **10** but mounted adjacent thereto is an extrusion ram assembly **22**. The extrusion ram assembly consists essentially of an extrusion ram **23** which has a smaller diameter than the diameter of the billet chamber **10** and a main ram **24** to which the extrusion ram is secured by means of a retaining ring assembly **25**. The main ram **24**, which has a stepped external diameter, is mounted in a hydraulic cylinder **26** and is adapted to be hydraulically driven such that the extrusion ram **23** can be moved axially into and out of the container **10**. The hydraulic cylinder **26** is maintained in its proper longitudinal position relative to the extrusion station **27** by means of conventional tie rods **28** and **29** which extend longitudinally and substantially parallel to the longitudinal axis of the apparatus.

Extending axially through the extrusion ram **23** and the main ram **24** is an axial bore **30**. Mounted in the axial bore **30** and rotatable and slidable therein is a piercing mandrel assembly **31**. The piercing mandrel assemly **31** is comprised of a piercing mandrel **32** which has a mandrel head of substantially circular cross section and which is adapted to be extended out of the extrusion ram **23** and axially into and out of the billet container and die. The piercing mandrel **32** has its end remote from the end which is adapted to extend out of the extursion ram **23** mounted in a mandrel holder **34**. The mandrel holder **34** is slidable within the axial bore of the extrusion ram **23** and in turn is mounted in a piercing stem **35** which is slidable and rotatable within the axial bore of the main ram **24**. An elongated tail portion **37** formed by a reduction in diameter of the main ram **24** extends out of the hydraulic cylinder **26** in a direction away from the billet container **10** and substantially circumscribes an appreciable length of the piercing stem **35**. The endmost portion of the tail portion

37 has a bearing 38 mounted in its inner wall, thereby permitting the tail portion to be slidable longitudinally on the piercing stem 35. In this embodiment the endmost portion of the tail portion 37 is also secured to a bracket assembly 40 which serves to guide the elongated main ram 24 and provide support for the longitudinally extending piercing stem 35. The bracket 40 is slidable on a set of longitudinal tie rods 42 and 43 which extend substantially parallel to the axis of the apparatus and are secured at one end to the hydraulic cylinder 26 and at the opposite end to a vertical support 44 spaced longitudinally from the cylinder at the rear end of the apparatus.

The piercing stem 35 has its end remote from the piercing mandrel holder 34 mounted in a moving platen 45. A longitudinal keyway 46 is formed in this end portion of the piercing stem 35 from substantially the point where the bracket 40 overlies the piercing stem to the end thereof and a drive gear 52 is keyed to the piercing stem in nonrotatable relation being slidable longitudinally along the key portion. The internal portion of the gear 52 has a key 47 formed to fit in the keyway as indicated in FIG. 2. Also securely mounted in the moving platen 45 is the head portion 48 of a piercing ram 49. The piercing ram 49 is mounted in a hydraulic cylinder 50 and is adapted to be driven by hydraulic pressure fed through the pump 51 so that it can be driven outwardly from the hydraulic cylinder 50 and thereby longitudinally displace the piercing stem 35 such that the piercing mandrel 32 will be axially moved into the billet chamber 10 and within the die 12.

In accordance with the invention means are also provided for continuously rotating the piercing mandrel 32 during the piercing and extrusion operations independent of the second hydraulic cylinder assembly 50 used for driving the piercing mandrel longitudinally. To provide this rotatable movement a driven gear 52 is keyed to the piercing stem 35 in nonrotatable relationship but slidable longitudinally along the keyed portion thereof. As best shown in FIG. 2, the driven gear 52 has flange plates 53 attached to the sides thereof which are of a larger diameter than the gear and therefore extend radially therefrom on both sides of the gear teeth. This driven gear 52 meshes with an idler gear 54 which is rotatable and slidable about the tie rod 42. The idler wheel 54 in meshing with the driven gear has a marginal peripheral portion beyond which the flanges 53 extend. The idler gear 54 in turn meshes with an elongated drive gear 55. The drive gear 55 is driven by a splined shaft 56 which is powered by a drive motor 57.

As previously noted the endmost portion of the piercing stem 35 has keyways 46 formed therein. The moving platen 45 has a key portion 58 formed on its inner surface to fit into the keyway 46 and is thereby mounted on the end of the piercing stem 35 and coupled in rotatable relationship therewith. Moreover, the piercing ramhead 48 is secured by the retaining ring 59 to the moving platen 45. Hence, when the circular gear 52 is rotated such that it rotates the piercing stem 35, the moving platen 45 will similarly be rotated as will the piercing ram 49. By rotating the piercing ram 49 considerable savings in horsepower is realized.

In FIG. 3 an alternative means of rotating the piercing stem 35 and, of course, ultimately rotating the piercing mandrel 32 is shown. Here a similar driven gear 52 is driven by a drive gear 55 through the intermediate idler gear 54. The drive gear is powered by a suitable motor 60. Here the movable platen 61 is slidably mounted on the tie rods 42 and 43 and is thus secured in nonrotatable relationship. Moreover, the endmost portion of the piercing stem 35 is no longer keyed to the moving platen 61 but rather is rotatable therein; specifically it is rotatable within the bearing 62. As a result of this arrangement the piercing ram 49 simply abuts the end of the piercing stem 35 and is in nonrotatable

relationship therewith. Although this provides a satisfactory manner in which the piercing stem 35 can be rotated and the stem also longitudinally driven by the hydraulic cylinder assembly 50, some friction is produced at the abutment between the piercing ram 49 and the end of the piercing stem 35 thereby requiring more horsepower than in the first embodiment, and as a result, is somewhat less desirable than the first embodiment described above.

In operation the billet container 10 is loaded with a solid billet 18 and the dummy block 19. The extrusion ram 23 is then driven forward by the hydraulic cylinder assembly 26 so that it contacts the dummy block and displaces the dummy block against the billet to the extent that the billet is upset. Then the hydraulic cylinder assembly 50 is activated and the motor 57 is similarly activated such that the piercing mandrel 32 is rotated and simultaneously displaced axially toward the billet chamber 10. As the piercing ram 49 is displaced out of the hydraulic cylinder 50 the piercing stem 35 is in turn longitudinally displaced. Accordingly, the driven gear 52 and the idler gear 54 are also displaced longitudinally with the intermediate gear 54 siding along the drive gear 55 but being simultaneously driven thereby. The piercing mandrel 32 is thereby inserted through the dummy block 19 and pierces a substantially concentric bore in the solid billet 18. The piercing mandrel 32 is then brought to a position substantially concentric within the die 12 and is held in that position and continuously rotated. The extrusion ram 23 is then brought forward against the dummy block 19 and exerts sufficient pressure to extrude the metal of the billet 18 around the rotating piercing mandrel 32 and between the die 12, thereby extruding a tube having substantially uniform wall thickness.

I claim:

1. Apparatus for extruding tubes from solid billets comprising:

(a) a billet chamber,

(b) a die positioned at one end of said billet chamber,

(c) an extrusion ram mounted adjacent the opposite end of said billet chamber, said ram having an axial bore extending completely therethrough,

(d) first hydraulic drive means connected to said extrusion ram for moving said ram axially into and out of said billet chamber,

(e) a rotatable piercing mandrel slidable within the bore in said extrusion ram and extensible therefrom and having a mandrel head of substantially circular cross section,

(f) a piercing mandrel stem connected to one end of said mandrel and extensible therefrom away from the billet chamber,

(g) second hydraulic drive means operatively connected to the end of said piercing mandrel stem opposite to the end on which the mandrel is mounted, said second drive means adapted to slide said mandrel in the bore of said ram axially into said billet chamber and said die,

(h) gear means mounted on said piercing mandrel stem for rotating the stem and mandrel independent of said second drive means, and

(i) a second elongated drive gear means connected to said first gear, whereby said first gear is slidable relative to said second gear and said stem and mandrel are continuously rotated thereby independent of said second drive means during the piercing and extruding operation.

2. Apparatus according to claim 1 wherein said second hydraulic drive means includes a piercing ram which is connected to the end of the piercing mandrel stem in rotatable relationship therewith.

3. Apparatus according to claim 1 wherein said second hydraulic drive means includes a piercing ram which

is in abutting relationship with the end of the piercing mandrel stem.

4. In a method of extruding tubes from a solid billet wherein the billet is pierced and extruded through a die, the improvement in combination therewith comprising:

(a) first longitudinally piercing the billet with a rotating mandrel to form an axial bore therein,

(b) continuing to rotate the mandrel within the pierced billet after piercing and advancing it in the same longitudinal direction to position it within the die,

(c) thereafter extruding the pierced billet through said die by ramming it in the same longitudinal direction as the billet was pierced, and

(d) continuously rotating the mandrel through the extrusion operation whereby a tube of substantially uniform wall thickness is formed.

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