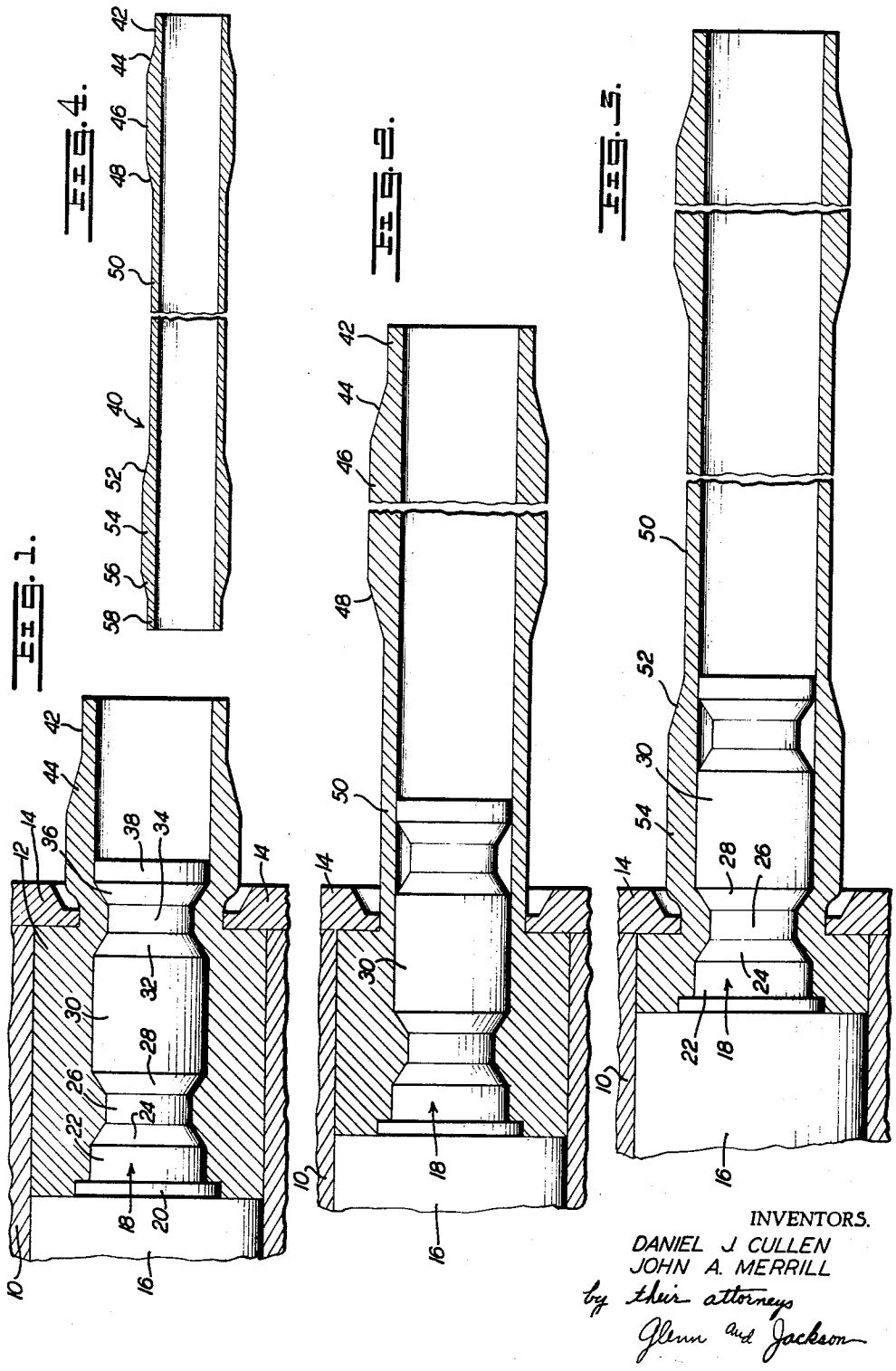
April 6, 1965 D. J. CULLEN ETAL 3,176,494

EXTRUSION PRESS

Filed April 27, 1959 3 Sheets-Sheet 1



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EXTRUSION PRESS

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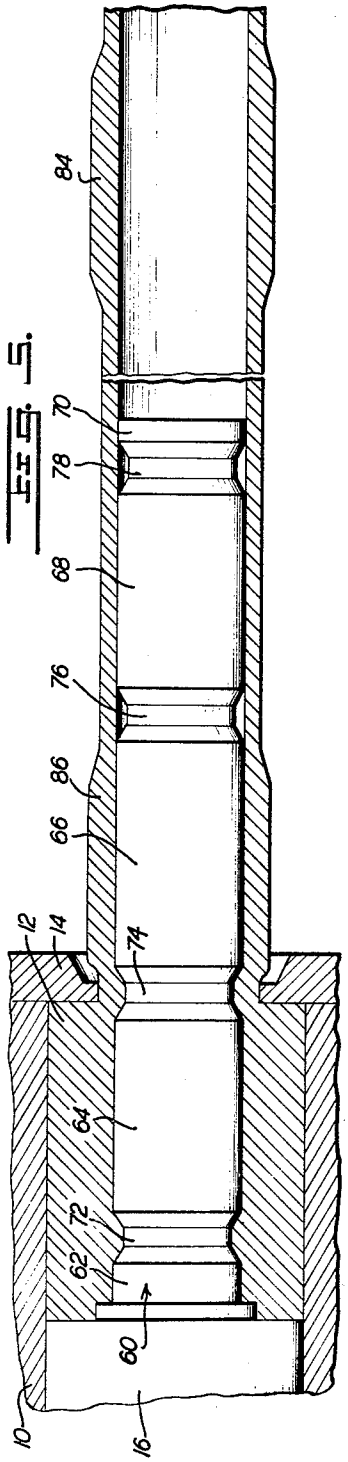


Fig. 5.

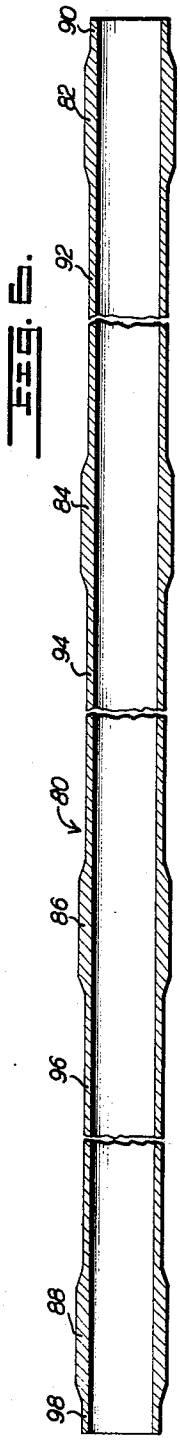


Fig. 6.

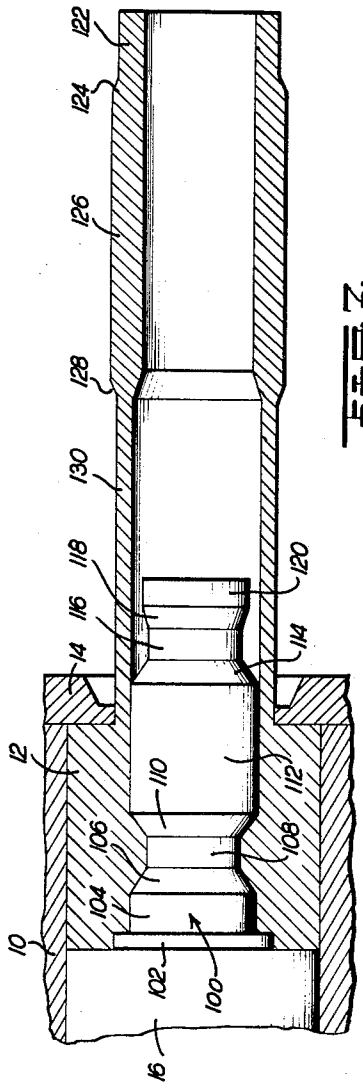


Fig. 7.

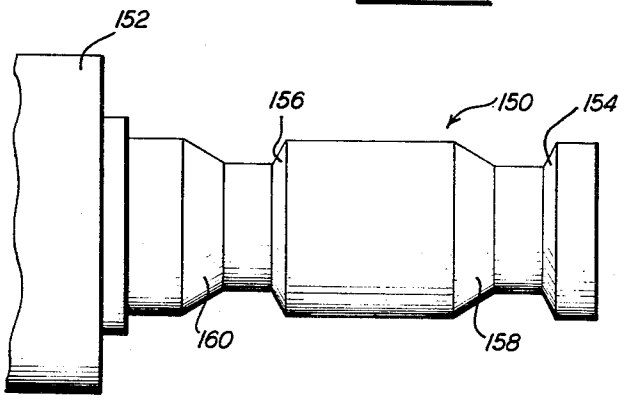
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FIG. 8.



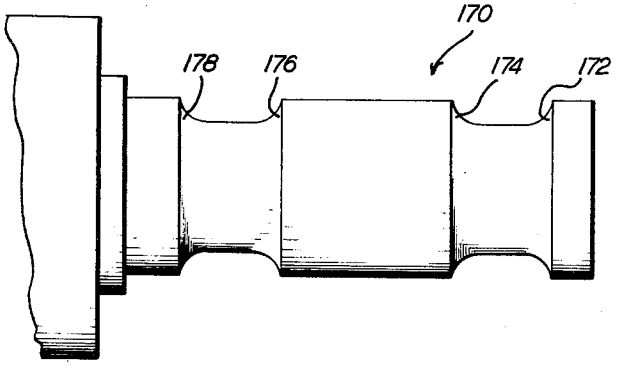


FIG. 9.

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United States Patent Office 3,176,494 Patented Apr. 6, 1965

3,176,494

EXTRUSION PRESS

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Filed Apr. 27, 1959, Ser. No. 809,190
11 Claims. (Cl. 72—260)

This invention relates to an extrusion press for extruding hollow tubes or pipes. More particularly, this invention relates to an extrusion press for extruding tubes of varying wall thickness and varying diameters.

When sections of hollow tube are joined together to form a pipe, the weakest points in the pipe are at the joints between the tubular sections. When the tubular sections have walls sufficiently thick to provide strength at the joints, and the tube walls are of uniform thickness throughout their lengths, then material is wasted at the middle parts of the tubes, where less strength is required.

Prior extrusion presses have been provided for forming hollow tubes of varying wall thicknesses. Some such prior devices have included a mandrel that is tapered to a diminished central portion. Such devices generally have not been able to produce a pipe having a thin middle part and thickened end parts.

This invention provides an extrusion press for forming hollow tubes having thick end walls and a thin middle wall. The tubes thus produced have sufficient strength at their ends for forming strong welded joints. The thin middle part has sufficient strength to stand the stresses encountered in use. Thus, economoy of material is achieved by making the various parts of the tubes have thicknesses and diameters appropriate to their functions in the end use of the tubes.

The hollow tubes formed by the extrusion press of the invention can have a substantially constant internal diameter, in which case the end tube parts are thickened externally and have outer diameters greater than the outer diameter of the thin middle part of the hollow tube. However, by employing modified forms of extrusion presses within the scope of the invention, hollow tubes can be formed having one end thickened externally and the other end thickened both internally and externally, or internally only.

The extrusion press of the invention can also form hollow tubes having thickened parts at spaced positions along their length. The extrusion press can also form hollow tubes having thick parts and thin parts connected by tapered parts, thus avoiding the weakening effect of sharp angles. The tapered parts of the tubes can be made straight where the rate of taper is constant throughout the tapered part. Also, the tapered parts of the hollow tubes can be curved convexly or concavely. The rate of tapering can be varied from high to low rates to produce tubes to meet great varieties of specifications based upon various loading and stress situations to which the tube will be subjected in its end use. A further feature of the invention is that hollow tubes can be produced having tapered parts of equal inclination.

Thus the invention provides an extrusion press having flexibility to produce hollow tubes having appropriate thickened parts, thin parts and tapered parts resulting in economy of material and having sufficient structural strength to meet functional requirements.

For a better understanding of the invention and its other objects, advantages and details, reference is now made to the present preferred embodiments of the invention which are shown, for purposes of illustration only, in the accompanying drawings.

In the drawings:

FIG. 1 is an elevation view, partly in section, of an extrusion press according to the invention at an early point in the extrusion stroke;

FIG. 2 is an elevation view, partly in section, of the extrusion press illustrated in FIG. 1 at an intermediate point in the extrusion stroke;

FIG. 3 is an elevation view, partly in section, of the extrusion press illustrated in FIG. 1 at a later point in the extrusion stroke;

FIG. 4 is a vertical sectional view of an extruded metal tube produced by the extrusion press illustrated in FIGS. 1 to 3;

FIG. 5 is an elevation view, partly in section, of another form of extrusion press according to the invention for producing tubes with four spaced thickened parts;

FIG. 6 is a vertical sectional view of an extruded metal tube produced by the extrusion press illustrated in FIG. 5;

FIG. 7 is an elevation view, partly in section, of another form of extrusion press according to the invention for producing tubes having a thin middle part, one end thickened both internally and externally, and the opposite end thickened externally;

FIG. 8 is an elevation of an alternative embodiment of an extrusion mandrel according to the invention; and,

FIG. 9 is an elevation of another embodiment of an extrusion mandrel according to the invention.

In the present preferred embodiment of the invention illustrated in FIGS. 1 to 4, the extrusion press includes a container 10 having a cylindrical opening extending therethrough. A preheated billet 12 of extrudable metal, such as aluminum, is positioned within the container 10. A die 14 extends across the forward end of the cylindrical opening in container 10. The die has a circular bore formed therein through which the extruded metal passes. The die bore can have other shapes including that of a square, hexagon, octagon, triangle, oval and the like.

To force the billet 12 through the bore in die 14, an extrusion ram 16 is positioned in the rearward end of the cylindrical opening in container 10. Conventional pressure means (not shown) is employed to move the ram 16 from left to right as seen in FIG. 1, thereby forcing the preheated metal billet 12 out through the bore in die 14.

A mandrel generally designated by the numeral 18 is integrally mounted on ram 16 and extends parallel to the axis of the bore of die 14. The mandrel 18 serves to make the extruded metal hollow and, in cooperation with the die 14, determines the thickness and diameter of the extruded metal tube. The mandrel 18 includes a base 20 secured to the ram 16; a large portion 22; a tapered portion 24; a small portion 26; a tapered portion 28; an intermediate large portion 30; a tapered portion 32; a small portion 34; a tapered portion 36; and a terminal large portion 38. The mandrel has a circular cross section. Other shapes can be used such as those of the square, hexagon, octagon, triangle, oval and the like. Referring to FIG. 1, the mandrel portions 22, 26, 30, 34 and 38 are generally cylindrical in shape.

The term "cylindrical" is used herein in its broad geometric sense and includes surfaces traced by any straight line, called generatrix or element, moving parallel to a fixed straight line. The cylindrical surfaces can have various cross sections. Among the cross sections are the circle, square, hexagon, octagon, triangle, oval and the like.

The mandrel 18 has been shown formed integrally with the ram 16 so that both will move at the same speed through the cylindrical opening in container 10. However, the extrusion press of the invention can be constructed so that the mandrel is movable relative to the ram. With this construction, the ram and mandrel can be moved at different speeds for one period of the stroke and at the same speed for another period of the stroke.

The mandrel 18 can have a slight overall diminishing

taper from large portion 22 to terminal large portion 38. This produces a slight taper on the inside of the finished tube to accommodate the cooling and shrinking of the tube as it emerges from the bore of die 14. However, where the specifications of the hollow tube to be formed call for a uniform inner diameter within close tolerances, this overall taper is not used.

Further, by making the tapered mandrel portions curved, either convexly or concavely, the rates of taper on the tube parts can be varied to produce tubes having sufficient strength at the points required by the end use of the tube, but also employing the minimum of material so as to achieve economy.

There will now be described the operation of the extrusion press shown in FIGS. 1 to 3 whereby there is produced the extruded metal tube shown in FIG. 4 and generally indicated by the numeral 40. The extrusion ram 16 is moved by conventional pressure means (not shown) forwardly through the opening in container 10 to force the heated aluminum billet 12 out through the annular aperture between the die 14 and the mandrel 18. At the start of the extrusion stroke, the terminal large mandrel portion 38 is in the bore of die 14. A thin tube part 42 of the tube 40 is thus formed with its thickness determined by the distance between the periphery of terminal large mandrel portion 38 and die 14. The inner diameter of tube part 42 is determined by the diameter of terminal large mandrel portion 38.

As the ram 16 and mandrel 18 move forwardly, the tapered mandrel portion 36 comes within the bore in die 14. At this part of the extrusion stroke, the tapered tube part 44 of the metal tube 40 is formed. The speed of movement of the extruded metal tube is greater than the speed of movement of the mandrel 18. Hence the tapered tube part 44 is moved forwardly along mandrel 18 and is expanded over the terminal large mandrel portion 38. The inner diameter of the tapered tube part 44 is thus determined by the diameter of the terminal large mandrel portion 38.

When the small mandrel portion 34 of the mandrel 18 comes within the bore of die 14, as seen in FIG. 1, a thickened tube part 46 of the metal tube 40 is formed. The thickness of the thickened tube part 46 is substantially determined by the distance between the periphery of small mandrel portion 34 and die 14. The thickened portion 46 is moved along mandrel 18 and expanded over tapered mandrel portion 36 and terminal large mandrel portion 38. There will be some decrease in the thickness of tube part 46 as it expands in diameter. The inner diameter of thickened tube part 46 will be thus determined by the diameter of terminal large mandrel portion 38. When tapered mandrel portion 32 comes within the bore of die 14, a tapered tube part 48 is formed. As with previous parts of the extruded tube, the tapered tube part 48 is expanded over terminal large portion 38 and has its inner diameter determined thereby.

When the intermediate large mandrel portion 30 comes within the bore of die 14, a long thin tube part 50 is formed. The thickness of the thin tube part 50 is determined by the distance between the periphery of intermediate large mandrel portion 30 and die 14. When the tapered mandrel portion 28 comes within the bore of die 14, the tapered tube part 52 is formed and expanded over intermediate large mandrel portion 30.

When the small mandrel portion 26 comes within the bore of die 14, as seen in FIG. 3, the thickened tube part 54 is formed. The thickened tube part 54 is moved along the mandrel 18 and expanded over tapered mandrel portion 28 and intermediate large mandrel portion 30. Thus the inner diameter of the thickened part 54 is determined by the diameter of the intermediate large mandrel portion 30. When the tapered mandrel portion 24 comes within the bore of die 14, the tapered tube part 56 is formed. The tapered part 56 is moved along the mandrel 18 and expanded over tapered mandrel portion 28 and intermediate large mandrel portion 30. The inner diameter of the tapered tube part 56 is thus determined by the diameter of intermediate mandrel portion 30.

When the large mandrel portion 22 comes within the bore of die 14, a thin tube part 58 is formed. The thin tube part 58 has its thickness determined by the distance between the periphery of large mandrel portion 22 and die 14 and its inner diameter determined by the diameter of large mandrel portion 22.

The finished tube 40, shown in FIG. 4, has a long thin middle part 59, thickened parts 46 and 54 at opposite ends, and a substantially constant inner diameter.

As indicated previously, the mandrel 18 can have a slight overall diminishing taper from larger portion 22 to terminal portion 38. This overall taper on the mandrel 18 produces a slight taper on the inside of tube 40. In such cases, while the inner diameter of tube parts 42 and 58 are substantially equal, the inner diameter of tube part 42 is slightly less than the inner diameter of tube part 58 to accommodate the cooling and shrinking of the tube as it emerges from the die 14.

The tube 40 can be employed as such in making pipe. The thickened parts of the tube can be used for welding other fixtures and devices to the tube.

It will thus be seen that the extrusion press of the invention illustrated in FIGS. 1 to 3 produces, in a single extrusion stroke, an extruded metal tube having a substantially constant inner diameter, a long thin middle part, and externally thickened parts at opposite ends. The thick end tube parts provide the strength needed for joints. The thin middle tube part is economical of the aluminum metal but has sufficient strength for the stresses to which it is subject.

In FIG. 5, there is illustrated a further embodiment of the invention wherein like parts of the extrusion press are designated with the same reference numerals as in FIG. 1. The mandrel is of altered form and is generally designated by the numeral 60. The mandrel has five large portions 62, 64, 66, 68, and 70, of substantially equal diameter; four small portions 72, 74, 76, and 78; and connecting tapered portions. By movement of the ram 16 and mandrel 60 from left to right as seen in FIG. 5, the billet 12 is extruded through the bore of die 14 to form the extruded tube generally designated by the numeral 80 in FIG. 6. The tube has four thickened parts 82, 84, 86, and 88; five thin parts 90, 92, 94, 96, and 98; and a substantially constant inner diameter.

Thus, the extrusion press of the invention illustrated in FIG. 5 produces, in a single extrusion stroke, an extruded metal tube having four spaced thickened parts along its length connected by thin parts and a substantially constant inner diameter. The number of thickened parts on the extruded tube can be increased by increasing the number of large and small portions on the mandrel. The thickened parts can be formed wherever heavy loads will be encountered or welded joints will be formed.

A further embodiment of the invention is illustrated in FIG. 7, wherein like parts of the extrusion press are designated with the same reference numerals as in FIG. 1. The mandrel is of altered form and is generally designated by the number 100. The mandrel includes a base 102; a large portion 104; a tapered portion 106; a small portion 108; a tapered portion 110; an intermediate large portion 112; a tapered portion 114; a small portion 116; a tapered portion 118; and a terminal large portion 120. The diameter of terminal large mandrel portion 120 has a magnitude about half-way between the magnitudes of the diameters of the small mandrel portion 116 and intermediate large mandrel portion 112.

The magnitude of the diameter of intermediate large mandrel portion 112 is about half-way between the magnitudes of the diameters of small mandrel portion 116 and the bore of die 14.

The operation of the extrusion press shown in FIG. 7 will now be described. The extrusion ram 16 and man-

drel 100 are moved through container 10 by conventional pressure means (not shown) to force the billet 12 through the annular aperture formed by the bore of die 14 and the mandrel 100. At the start of the extrusion stroke, the terminal mandrel portion 120 is within the bore of die 14. The thin tube part 122 is formed at this time and has its inner diameter determined by the diameter of terminal large mandrel portion 120.

When the tapered mandrel portion 118 comes within the bore of die 14, the tapered tube part 124 is formed. Since the speed of movement of the extruded metal tube is greater than the speed of movement of the mandrel 100, the tapered tube part 124 is moved along the mandrel 100 and expanded over the terminal large mandrel portion 120. Thus the inner diameter of tapered tube part 124 is determined by the diameter of terminal large mandrel portion 120.

When the small mandrel portion 116 comes within the bore of die 14, a thickened tube part 126 is formed having its thickness determined by the distance between the periphery of small mandrel portion 116 and die 14. The thickened tube part 126 is moved along the mandrel 100 and expanded over tapered mandrel portion 118 and terminal large mandrel portion 120. The inner diameter of thickened part 126 is thus determined by the diameter of terminal large mandrel portion 120.

When the tapered mandrel portion 114 comes within the bore of die 14, a tapered tube part 128 is formed. When the intermediate large mandrel portion 112 comes within the bore of die 14, as seen in FIG. 7, a thin tube part 130 is formed having its thickness determined by the distance between the periphery of intermediate large mandrel portion 112 and die 14 and its inner diameter determined by the diameter of intermediate large mandrel portion 112. As seen in FIG. 7, the outer diameter of thin tube part 130 is less than the outer diameter of thickened tube part 126. The inner diameter of thin tube part 130 is greater than the inner diameter of thickened tube part 126. Since the thin tube part 130 is the main or middle part of the tube, the thickened tube part 126 constitutes both an internally and an externally thickened end on the tube.

When the tapered mandrel portion 110 comes within the bore of die 14, a tapered tube part is formed similar to those shown in FIG. 4. Similarly, when small mandrel portion 108 is within the bore of die 14, a thickened tube part is formed. This thickened tube part is expanded over intermediate large mandrel portion 112. Thus, the inner diameter of this thickened tube part is the diameter of the intermediate large mandrel portion 112. This thickened tube part constitutes an externally thickened end on the tube. Tapered mandrel portion 106 and large mandrel portion 104 will produce, respectively, a tapered tube part and a thin tube part similar to those shown in FIG. 1.

Thus the extrusion press of the invention illustrated in FIG. 7 produces, in a single extrusion stroke, an extruded metal tube having a thin middle part, a leading end that is thickened both internally and externally, and a trailing end that is thickened only externally.

In order to obtain an extruded metal tube wherein the tapered parts of the tube are of equal inclination, an extrusion mandrel 150 is employed as illustrated in FIG. 8. The mandrel 150 is secured to a ram 152 and is generally similar to the mandrel 18 except that the tapered mandrel portions 154 and 156 are more steeply or sharply inclined than the tapered mandrel portions 158 and 160. In FIG. 8, a great difference of inclination has been shown to illustrate the principle. But it will be understood that various differences of inclination will be employed depending upon other variables involved in particular extrusions.

When it is desired to produce an extruded metal tube having straight tapered parts, it is necessary to employ a mandrel 170, referring to FIG. 9, wherein the tapered mandrel portions 172, 174, 176 and 178 are slightly curved concavely.

While present preferred embodiments of the invention have been illustrated and described, it will be recognized that the invention may be otherwise variously embodied and practiced within the scope of the following claims.

We claim:

1. The method of making a hollow metal extruded tube having a long thin tubular body and externally thickened walls at opposite ends thereof, by extruding a confined metal charge through an annular orifice between a die of fixed size and a substantially cylindrical mandrel extending through the bore of said die having in alternation, small mandrel portions, and terminal and inner large mandrel portions which are of equal height or diameter, to vary the orifice and control the wall thickness of the extruded product, which comprises extruding the charge through the orifice while advancing the mandrel to form uniform successive thick and thin adjoining parts of the extruded product by varying the internal configuration of the extrusion at the die, and includes the following steps: successively (*a*) enlarging the extrusion orifice to form a uniformly and internally thickened wall, (*b*) gradually reducing the orifice to form a tapered wall of decreasing thickness, (*c*) maintaining the reduced orifice substantially constant to form a long thin tubular body, (*d*) gradually enlarging the extrusion orifice to form a tapered wall of increasing thickness, (*e*) maintaining the enlarged orifice substantially constant to form a second uniformly and internally thickened wall, and progressively freeing the extrusion from confinement by the die, while advancing it relative to the mandrel outwardly of the die and radially expanding the first formed thickened wall over the terminal large mandrel portion and the succeeding thickened wall over an inner large mandrel portion to form a completed hollow extruded tube of uniform internal diameter throughout and having a long thin tubular body and externally thickened walls of substantially uniform thickness at opposite ends thereof, and having an externally thickened tapered wall intermediate each of said uniformly thickened end wall and said tubular body.

2. The method in accordance with claim 1, wherein the steps as recited are repeated to produce a tube having more than two spaced internally thickened wall portions.

3. The method in accordance with claim 1, wherein one of said large mandrel portions is smaller than another, whereby to produce a tube having an externally thickened wall portion and another wall portion spaced therefrom which is both externally and internally thickened.

4. In an extrusion press for extruding a metal tube having a thin part intermediate between thick parts at spaced positions along its length, said press having a container for supporting a metal billet, a die cooperating with the forward end of the container, said die having a bore extending therethrough, an extrusion ram adapted to enter the container at the rearward end thereof to force the billet through the die bore, and a mandrel of varying diameter positioned within said container and extending for movement through said die bore; the improvement which comprises said mandrel having a generally-cylindrical shape with annular grooves spaced along its length, the spacing between adjacent grooves being substantially longer than the length of the grooves as measured parallel to the axis of the mandrel, said grooves being of substantially equal depth, each of said grooves including a substantially-cylindrical mandrel portion having smaller cross section than larger substantially-cylindrical mandrel portions of substantially equal height adjacent thereto, and tapered mandrel portions connecting said larger and smaller mandrel portions, and including means for integrally joining said mandrel and ram to move together during extrusion through the die.

5. Apparatus according to claim 4, in which the tapered mandrel portions are curved concavely to produce a substantially straight tapered part of the extruded tube.

6. Apparatus according to claim 4, in which said mandrel has more than two grooves.

7. Apparatus according to claim 4, in which the forwardmost mandrel groove is spaced from the front end of the mandrel.

8. Apparatus according to claim 4, in which said mandrel has, in sequence from the forward end thereof, a terminal large portion, an inwardly tapered portion, a small portion, an outwardly tapered portion, an intermediate large portion, an inwardly tapered portion, a small portion, an outwardly tapered portion, and a large portion.

9. Apparatus according to claim 8, in which said terminal large portion of said mandrel has a smaller cross section than said intermediate large portion.

10. Apparatus according to claim 8, in which said terminal large portion of said mandrel has a smaller cross

section than said intermediate large portion and a larger cross section than said small portions.

11. Apparatus according to claim 4, in which the forward tapered portions of said grooves are inclined more sharply than the rearwardly tapered portions thereof.

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