

Nov. 29, 1938.

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2,138,199

METHOD OF MAKING METAL FITTINGS AND THE LIKE

Filed Sept. 28, 1935

2 Sheets-Sheet 1

Fig.1. Fig.2. Fig.3. Fig.4.

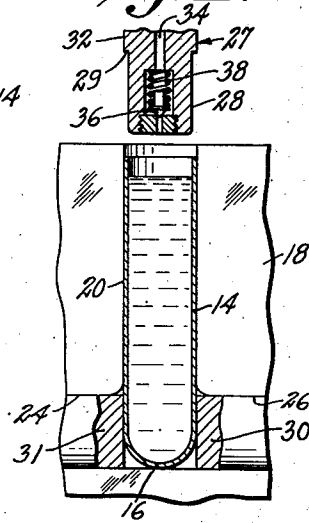
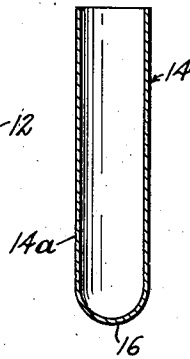
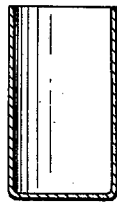
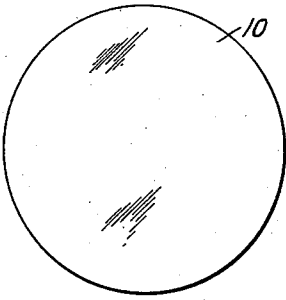


Fig.5. Fig.6.

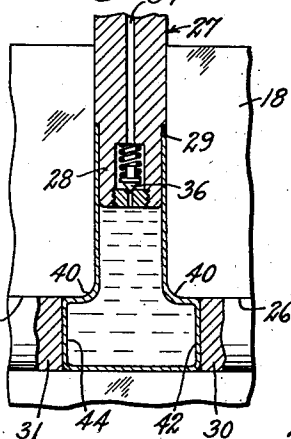
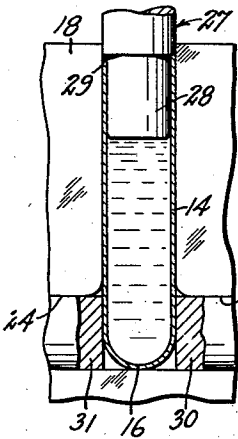


Fig.7.

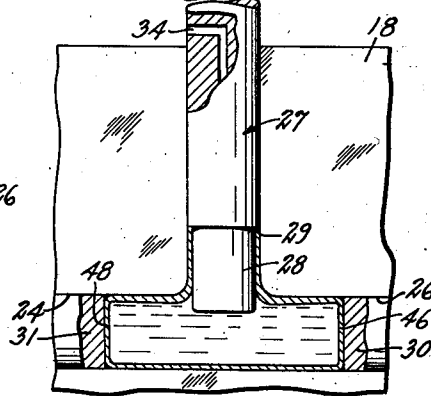


Fig.8.

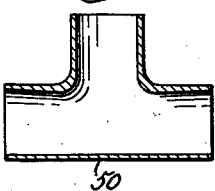


Fig.9.

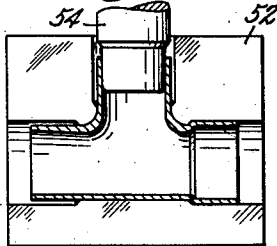
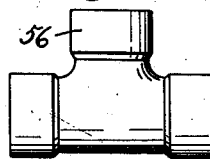


Fig.10.



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2 Sheets-Sheet 2

Fig. 11.

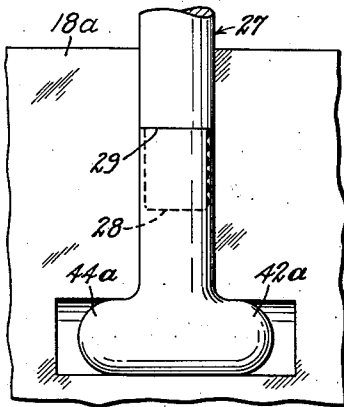


Fig. 13. Fig. 14.

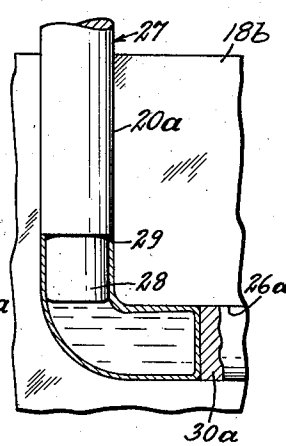
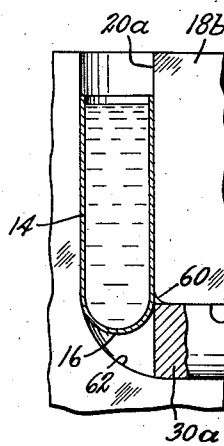


Fig. 12.

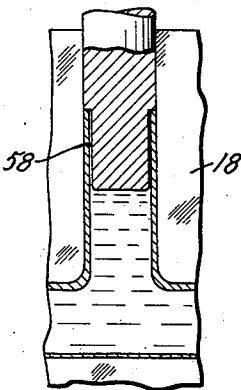


Fig. 15.

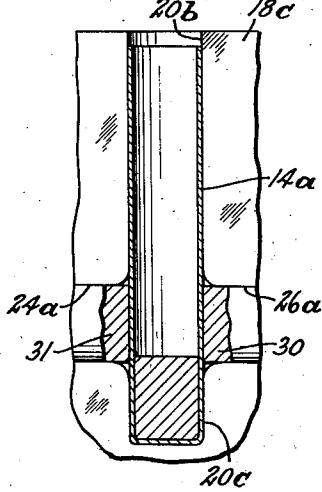


Fig. 16.

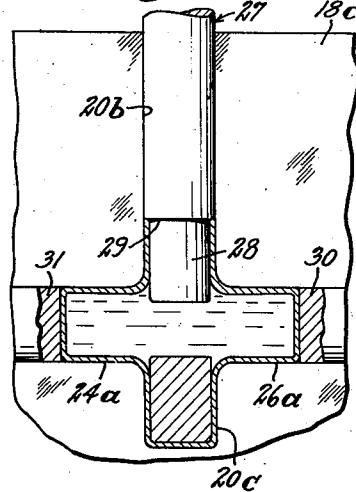


Fig. 17.

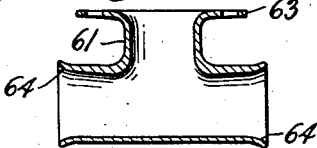
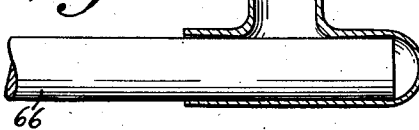


Fig. 18.



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2,138,199

METHOD OF MAKING METAL FITTINGS AND
THE LIKE

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Application September 28, 1935, Serial No. 42,625

8 Claims. (Cl. 113—44)

This application is a continuation in part of my copending application, Serial No. 746,658 filed October 3, 1934.

The present invention relates to metal working, especially to cold-worked metal products and has for its main purpose the manufacture of seamless pipe fittings of copper or other ductile metal. The invention is however applicable to a variety of materials and to the manufacture of other products than pipe fittings.

It has been previously proposed to shape metal for instance to produce bulges on a pipe or the like by means of a plunger acting longitudinally on the pipe and on water contained in the same, the pipe being inserted in a recessed die contacting part of the surface of the pipe and leaving other parts free to bulge out under the pressure. The pipe was subjected to mechanical pressure only towards the end of the pressing operation, the internal liquid pressure however starting earlier so that the pipe would bulge out and its walls be reduced in thickness before applying the mechanical pressure.

It has also been proposed to insert a vessel closed at its one end into a recessed die and to apply simultaneously mechanical pressure and internal liquid pressure to the same during the pressure operation, the internal liquid pressure being then exerted by a separate pressure means such as an accumulator or a pump, whereas the mechanical pressure was applied by means of a plunger.

Such proposals could however hardly be practically used since the liquid pressure at least during a very material portion of the pressing operation was independent of the plunger action. Such independent internal liquid pressure would necessarily tend to thin out the material of the tube or the like or even to burst it.

The present invention refers especially to a method of shaping metal in which a vessel, a tube or the like (the shell) is placed in a guiding member such as a recessed die, a resistive filler such as a liquid or rubber being admitted to the interior of said shell, whereupon the filler and the shell are subjected to pressure, and avoids the disadvantages mentioned by exerting by means of a pressing member such as a plunger a mechanical pressure on the shell and an internal pressure in the filler during the whole or substantially the whole pressing operation, both pressures resulting from the action of the plunger.

A major aim of the invention is the production of such fittings which have highly desirable physical characteristics with respect to mechanical strength and imperviousness to seepage of liquids or gases under high pressure, which have open and smoothly contoured internal passages for free flow of fluid therethrough and which may be cheaply and readily manufactured.

A further aim of the invention is the production of such fittings by cold working of suitable material from sheet stock, and a still further aim of the invention is the production of fittings of the character described, as such, of improved quality. Other and more detailed aims of the invention and the manner in which its various aims are attained may best be understood from a consideration of the following portion of this specification, taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a plan view of a flat sheet metal blank;

Fig. 2 is a section showing the blank partially drawn to desired cup shape;

Fig. 3 is a section showing the blank drawn to the form of a hollow open ended shell;

Fig. 4 is a section showing the shell in die and punch apparatus preparatory to working operations;

Figs. 5 to 7 are sections similar to Fig. 4, showing different stages of operation;

Fig. 8 is a sectional view of a T fitting produced in accordance with the invention;

Fig. 9 is a section showing apparatus for expanding the ends of the fitting shown in Fig. 8;

Fig. 10 is an elevation of a T with expended ends;

Fig. 11 is a section showing a different form of die structure;

Fig. 12 is a section showing a different kind of die punch;

Figs. 13 and 14 are sections of die apparatus for forming elbow fittings;

Figs. 15 and 16 are sections of die apparatus for forming cross fittings;

Fig. 17 is a sectional view of a special fitting made from a fitting of the form shown in Fig. 8; and

Fig. 18 is a sectional view of another form of special fitting.

The fittings that may be produced in accordance with the invention are of such great variety that for obvious reasons the details of manufacture of all of them cannot be dealt with in this specification. For purposes of illustration I will therefore describe the preferred steps of the process and the means for producing a pipe T fitting. From such description the mode of manufacture of fittings of other specific form in accordance with the invention will be apparent to those skilled in the art.

Referring to the drawings, a shell blank of the form shown in Fig. 3 is first formed by known blanking and cupping operations from a suitable sheet 10 (Fig. 1), which is first drawn to a cup such as shown at 12 in Fig. 2 and then to a deep shell 14 as shown in Fig. 3, having a cylindrical portion 14a and a hemispherical bottom portion 16. For purposes of illustration I have indicated the formation of the shell blank as being per-

formed in two operations, but it will be understood that the number of drawing operations required to produce the shell will vary considerably depending upon the character and wall thickness of the metal worked. The metal may obviously and in most instances is annealed between successive drawing operations.

The shell 14 is then placed in sectional external forming dies 18 having mating semi-cylindrical recesses forming a bore 20 of the same diameter as the external diameter of the shell. The depth of the bore 20 is such that when the shell is placed in it, as shown in Fig. 4, the entire shell is within the dies and the portion of the shell adjacent to the open end is externally supported. The dies are provided with two semi-cylindrical recesses transversely intersecting the bottom portion of the bore 20 and forming aligned bore portions 24 and 26 corresponding to the run portion of the T to be formed from the shell. The bore 20 corresponds to the outlet portion of the T.

It will be understood that the dies 18 are of a form adapted to be locked together in a punch press of ordinary known construction and having a reciprocable head for holding a working plunger or punch. Such apparatus being of well-known construction need not be illustrated for an understanding of the present invention.

For deforming the shell in accordance with the present invention a metal punch 27 is provided as shown in Fig. 4, having a pilot portion 28 the diameter of which is preferably substantially that of the internal diameter of the shell, and which may be a plug fit therein. At the end of the pilot portion the punch is provided with a shoulder 29 for contacting the end of the wall of the shell. Above the shoulder 29 the punch portion 32 has a diameter such that it can enter the bore 20. Preferably the diameters of bore 20 and the portion 32 are the same.

For reasons which will hereinafter more fully appear, the punch may be provided with a channel 34 communicating at its lower end with the space below the pilot portion and at its upper end communicating with the atmosphere. This channel is controlled by a check valve 36 opening away from the lower end of the pilot, and spring loaded by means of spring 38. Alternatively, as will also be more fully explained later, the punch may be made with a pilot having a diameter slightly less than that of the internal diameter of the blank.

Referring again to the die structure, the die bores 24 and 26 may be fitted respectively with retractable plugs 30 and 31, which in their inner positions are as shown in Fig. 5, and which in their retracted positions determine the length of the run of the T to be formed in the dies. Such plugs are not essential in all cases and, instead, the ends of the bores 24 and 26 may be determined by the dies themselves as shown in Fig. 11. If retractable plugs are employed, they are advantageously interconnected with the punch so that they retract at suitable speed as the punch descends on its working stroke. Apparatus for effecting this movement is disclosed by my co-pending application Serial No. 746,658 filed October 3, 1934.

Assuming that a punch of the form having the relief channel 34 is employed and that liquid is used as the filler for the shell, the formation of the T from the shell is as follows. The shell is filled with liquid and placed in the dies, the level of liquid being such that an excess quantity over and above that required to effect the deforming

operation is present in the shell. The punch is then moved so that the pilot 28 enters the shell from a position such as that shown in Fig. 4, to a position such as that shown in Fig. 5, with the shoulder 29 in contact with the end wall of the shell. During this portion of the movement, excess liquid in the shell is expelled through passage 34. Continued movement of the punch then exerts mechanical end pressure on the walls of the shell, moving them longitudinally of the bore 20. The liquid in the shell, trapped therein by the spring load on the valve, guides the metal laterally into the bores 24 and 26 and maintains it in contact with the walls thereof, and the pressure of the liquid during this phase of the operation is caused by movement of the same punch which presses against the end of the shell wall. It will be understood that during movement of the punch from the position shown in Fig. 5 to the position shown in Fig. 6, the retractable plugs 30 and 31, if used, retreat at a speed such that free flow of metal into bores 24 and 26 is permitted.

It will be evident that the movement of the punch exerts a very heavy compression stress on the metal of the walls of the blank in the bore 20 and the metal, when flowing into the lateral bores from bore 20, thickness at the point of juncture of the bores under the influence of this compressive stress. This in turn tends to cause the internal volume of the shell to decrease with consequent rise in the pressure of the liquid, and the metal is forced outwardly by the internal pressure, in contact with the dies and without wrinkles. Consequently, the valve 36 must be loaded to enable the proper internal pressure to be maintained. As previously pointed out, the value of the pressure required to be built up in the blank due to the plunger or punch movement will vary with differences in wall thickness and physical characteristics such as ductility of the metal from which the shell is formed.

By deforming the shell by mechanical displacement, aided by an internal filler, the primary function of which is one of guidance of the direction of flow of the metal, I provide a process which is essentially different from hydraulic die forming, since the metal, in accordance with my process, is mechanically fed to the place of deformation and consequently the metal is nowhere subjected to pulling, due to internal pressure, of a nature causing rupture of the blank. This mechanically applied compression to which the material is subjected is regarded as the primary forming force.

Furthermore, the tendency of the metal to compress and thicken in wall section at the juncture of the branches of the fitting, while retaining relative uniformity of section at other places, when deformed in accordance with the present process, is productive of a highly desirable new result, which in turn enables a new article of distinctly superior physical characteristics to be produced. As will be observed from the drawings, the die recesses are curved so that the bores 24 and 26 are joined to the bore 20 along lines curved in the plane of the axes of the bores, as shown at 40. Under the influence of the compressive stress exerted by the punch in the direction of the axis of the bore 20 and the tension stress exerted in the direction of the axis of the transverse bores by internal pressure the metal is caused to flow around these curved surfaces while at the same time thickening in section

somewhat at the place of curvature. This produces a structure which is mechanically strongest at the place where mechanical strength is most needed. At the same time, the variation in the thickness of the wall section is gradual and the desired properties of the thickened wall section are obtained without sacrificing the smoothly rounded interior contour which is highly desirable in order to minimize resistance to flow of fluid through fittings of the character under consideration.

The deformation of the shell to form a T having the desired length of run is ordinarily accomplished in a plurality of operations, the blank being annealed between successive operations. The same or similar dies may be employed for the successive operations, but it will of course be evident that for each succeeding operation either a longer punch or a longer punch stroke must be employed to force the open end of the shell further into the dies. Preferably, from the standpoint of economy of production, the same press set up is used for successive operations, using longer punches for succeeding operations.

For purposes of illustration I have shown a T blank formed in two forming operations as indicated in Figs. 5 to 7 inclusive. In the first operation the punch is moved from the position shown in Fig. 5 to that shown in Fig. 6, the lateral displacement of the branches 42 and 44 forming the run of the T being as shown in Fig. 6. It will be understood that with very soft and ductile metal the relative displacement may be greater than that indicated, without encountering difficulty due to brittleness of metal caused by the cold-working. In order to form the T blank to the desired length of run, the semi-finished blank of the form shown in Fig. 6 is removed from the dies, annealed, again filled with liquid and then replaced in the same or similar dies and deformed to the shape shown in Fig. 7 by a further and longer stroke of the same or similar forming punch. The blank shown in Fig. 7 is then removed and the ends 46 and 48 of the run portion sawed off or otherwise removed to provide a T fitting 50 of the form shown in Fig. 8.

After having been shaped to this form it may be subjected to further desired forming operations, as for example as shown in Fig. 9, where the fitting is placed in suitable dies 52, and the ends of the branches are expanded by punches of the kind shown at 54 to provide a fitting of the so-called "sweat-joint" type, shown in Fig. 10.

While in the preceding description I have indicated the use of retractable plugs in the dies, these plugs are not essential in all cases, and as in the apparatus shown in Fig. 11, the dies may themselves form the ends of the recesses providing for the run of the T. When such apparatus is employed the shell 14 is placed in dies 18a and the same procedure as previously described is carried out. The difference in this instance is that in the operations prior to the last operation the ends of the semi-formed branches 42a and 44a assume roughly hemispherical shape, being brought into flat form in contact with the ends of the die recesses only by the last operation. Obviously, if desired, the deforming operations may end with a blank having such rounded ends but where an open ended finished product is desired, this procedure results in wastage of metal upon removal of the rounded end portions.

When retractable plugs are not employed, I believe that it is only because of the mechanical

feeding of the metal to the place of deformation substantially from the commencement of such operation, that the building up of sufficient internal pressure to rupture the unsupported ends of the branches being formed is prevented. If internal pressure alone were relied upon to deform the metal, particularly in the first operation, the friction between the walls of the blank and those of the bore 20 would result in such resistance to movement as to cause the unsupported metal to be unduly thinned or ruptured.

Thus, in order to achieve practical results, the internal pressure is in accordance with the invention caused by plunger movement, since by having a controlled relationship between the compression exerted on that part of the wall of the shell in the bore 20 by the shoulder of the punch, which is the primary force for causing flow of the metal inwardly of the dies, and the internal fluid pressure, it is possible to prevent wrinkling of the material and also to prevent undue thinning or rupturing of it.

Preferably the quantity of the liquid or other filler employed is also a function of plunger movement. It will be evident that in the apparatus previously described this is the case. Other ways of obtaining this relationship may also be resorted to. For example, the diameter of the pilot may be made so as to provide a slight clearance 58 between it and the wall of the shell, as indicated in Fig. 12, the relief channel being omitted. In the drawing the clearance space 58 has been shown exaggerated in dimension, for clearness. In this case, the clearance space acts as a relief channel for excess liquid until the shoulder of the punch seats. Thereafter the liquid is positively sealed in the shell. The pressure in this instance is also, before and after seating of the shoulder, a function of plunger movement and determined thereby. With different plunger speeds, different initial pressures (or no appreciable initial pressure) may exist at the instant of seating, and after seating the internal pressure will depend on plunger action.

It is not essential that the quantity of fluid be determined by the plunger, for satisfactory results may be obtained by previously filling the shell with a metered quantity of fluid and using a solid and close fitting pilot. For obvious reasons, however, this is a more difficult and less desirable mode of procedure.

The process is not, as previously pointed out, limited to the forming of fittings of T shape. For example, it may be applied to the manufacture of elbows, as illustrated in Figs. 13 and 14.

As shown in these figures, dies 18b are employed which are similar to dies 18, but which have only a single transverse bore 26a, instead of the two bores 24 and 26. This bore intersects the bore 20a and the two bores are joined by curved radius portions 60 and 62. The manner in which the deforming operation or operations are carried out will be obvious from the preceding description with reference to the T fitting. One or more steps may be employed, as determined by the characteristics of the metal employed, and a retractable plug 30a may or may not be used.

For forming crosses, dies 18c such as those shown in Figs. 15 and 16 are employed. In these dies the transverse bores 24b and 26b intersect the bore 20b above the bottom of the latter. The portion 20c of bore 20b below bores 24b and 26b is advantageously formed with a

flat end and with this a flat ended shell 14a is used. Obviously the bore portion may have a hemispherical end for use with a shell of the form of shell 14. In this instance also, for the sake of brevity only the first and final steps are shown.

It will be understood by those skilled in the art that the branches of the fittings, regardless of whether the fittings are of elbow, T, cross or other form may be treated subsequently as desired, as for example, expanded to form sweat-joint pipe fittings and also swaged in known manner to produce so-called reducing fittings wherein different branch openings are of different diameter.

In this connection I wish to further point out that the invention also comprehends the production of special types of fittings for other than pipe use, as for example supporting fittings of various kinds for which the structural characteristics of the products of the present process are particularly advantageous.

By way of example I show in Fig. 17 a support fitting made from a fitting of the kind shown in Fig. 8. In this instance the end of the outlet branch 61 of the T is flanged outwardly by spinning or other known flanging process to provide a flange 63 by means of which the fitting may be attached to any suitable support. The ends of the branches forming the run of the T are flared as at 64, and it will be evident that the resulting fitting provides a guide for rods, cables or the like which is much stronger and lighter than a cast article of the same kind and further has all the advantages of a seamless one piece article. When formed from light alloys such as aluminum, fittings of this character are of material advantage in aircraft construction and the characteristic thickening of the metal at the juncture of the branches provides an advantage which is obvious.

As a further example I have shown in Fig. 18, a bracket type of fitting formed a semi-finished T blank having rounded ends. In this instance the outlet branch is flanged as before, one branch of the run portion is cut off and the remaining branch is left closed. The resulting fitting thus provides a superior support for the end of a rod such as indicated at 66.

In the various embodiments of fittings hereinbefore described I have shown the various branches of the fittings as being of circular cross section but it will be evident that the invention is not limited to this specific shape of section. For convenience I refer to such branches as being tubular in form, but it will be understood that the term "tubular" is not necessarily limited to a circular cross section.

From the preceding description it will be evident that the invention has wide application in numerous fields and that without departing from the spirit or scope of the invention many variations may be made in the specific manner in which the process is carried into effect as well as in the details of the apparatus and the form of the articles produced.

I claim:

1. The method of forming a hollow wrought metal article from a hollow shell by the aid of a recessed die having a bore and a cavity intersecting said bore and having a cooperating punch, said punch having a pilot portion and a seating shoulder; which includes placing in the bore in said die a tubular shell having an open end, introducing an excess quantity of liquid

into the shell, moving the pilot portion of the punch into the shell until said shoulder seats on the end wall of the shell and expelling excess fluid from the shell due to entry of said pilot portion into the shell, until said shoulder seats, positively trapping the remainder of said introduced liquid due to the seating of said shoulder to determine the quantity of liquid in the shell, continuing movement of the punch after said shoulder seats to force the open end of the shell longitudinally of said bore toward said cavity essentially by mechanical end pressure, and guiding the metal of the shell in contact with the walls of said cavity due to the internal liquid pressure induced by such continued movement of the punch.

2. The method of forming a hollow wrought metal article from a hollow shell by the aid of a recessed die having a bore and a cavity intersecting said bore and having a cooperating punch, said punch having a pilot portion and a seating shoulder; which includes placing in the bore in said die a tubular shell having an open end, introducing an excess quantity of liquid into the shell, moving the pilot portion of the punch into the shell until said shoulder seats on the end wall of the shell and expelling excess fluid from the shell with predetermined resistance to flow due to entry of said pilot portion into the shell, until said shoulder seats, positively trapping the remainder of said introduced liquid due to the seating of said shoulder to determine the quantity and initial pressure of liquid in the shell, continuing movement of the punch after said shoulder seats to force the open end of the shell longitudinally of said bore toward said cavity essentially by mechanical end pressure, and guiding the metal of the shell in contact with the walls of said cavity due to the internal liquid pressure induced by such continued movement of the punch.

3. The method of shaping metal by the aid of an external die and a cooperating punch having a pilot portion and a shoulder which includes placing a tubular shell open at one end in a suitable bore in said die, placing an excess quantity of liquid in the shell, moving the pilot portion of the punch into the shell until the shoulder seats on the end wall of the shell and expelling excess liquid past the pilot portion during such movement, whereby to determine the quantity of liquid in the shell, continuing movement of the punch after said shoulder seats to force the open end of the shell longitudinally within the die, and maintaining the liquid contained in the shell at the time the shoulder seats trapped therein to guide the metal in contact with the die due to internal pressure induced by such continued movement of the punch.

4. The method of making a wrought metal T from a tubular shell having an open end and a closed end by the aid of a forming die having a T-shaped recess consisting of an outlet branch and a run branch and having a cooperating punch, said punch having a pilot portion and a shoulder portion; which includes placing the shell in the outlet branch of the recess with the closed end of the shell at the intersection of the outlet branch and the run branch of the recess, introducing a quantity of liquid filler into the shell, moving the pilot portion of the punch into the shell until said shoulder seats on the end wall of the shell and expelling excess liquid from the shell with predetermined resistance to flow due to entry of said pilot portion into the shell,

until said shoulder seats, positively trapping the remainder of such introduced liquid due to the seating of said shoulder to determine the quantity and initial pressure of liquid in the shell, continuing movement of the punch after said shoulder seats to force the open end of the shell toward said run branch essentially by mechanical end pressure and guiding the metal of the shell in contact with the walls of said run branch due to internal liquid pressure induced by the movement of the punch.

5. The improved method of forming a hollow wrought metal article from a hollow shell having an open end by the aid of a die having two tubular bores the axes of which intersect and which bores are connected by a curved surface which consists in placing the shell in one of said bores so that it is externally supported by the die except at the place of intersection of the bores, introducing liquid filler into the shell, moving a punch into abutting contact with the end wall of the open end of the shell, continuing the movement of the punch after contact with the shell to force the shell inwardly of the die essentially by mechanical end pressure and causing the displaced metal to flow laterally past said curved surface into the intersecting bore due to internal pressure of the liquid in the shell induced by movement of the punch, and determining the quantity of liquid trapped in the shell prior to displacement of the shell so that the metal is forced toward said curved surface by the punch at a faster rate than it is moved away from the curved surface by the laterally exerted pressure of the liquid on the unsupported portion of the shell, whereby to cause thickening of the section of the metal at said curved surface.

6. The method of forming a hollow wrought metal article having angularly related tubular branches; by the aid of a punch having a pilot portion and a circumferential shoulder at the end of said pilot portion and a cooperating recessed die having communicating tubular bores of substantially the same diameter and of substantial length relative to their diameters, at least one of said bores having a length several times its diameter and the axes of said bores intersecting with a substantial angle between the bores; which includes placing a tubular shell having a closed end and an open end in said one of said bores with the closed end inwardly of the die and with the wall of the shell wholly supported externally by the wall of the die except at the place of intersection of said bores, introducing liquid filler into said shell, moving said punch inwardly of the die with the pilot portion of the punch within the open end of the shell to seat said shoulder against the end wall of the open end of the shell to effect a liquid tight seal between the end of the shell and said shoulder and to trap the liquid in the shell, and continuing the movement of the punch after such seating to feed the portion of the shell in said one of said bores towards said intersection essentially by mechanical end pressure and to thereby cause the metal of said shell to be bulged laterally in generally tubular form into another of said bores by the internal pressure of the liquid filler resulting from the movement of the punch and the punch-induced movement of the shell in and relative to the die.

7. The method of forming a hollow wrought

metal T; by the aid of a plunger having a pilot portion and a circular shoulder at one end of said pilot portion and a cooperating recessed die having a T-shaped recess consisting of a tubular outlet branch having a length several times its diameter and a tubular run branch of substantially the same diameter as said outlet branch and intersecting the bottom of the outlet branch to provide two tubular recesses of substantial length in relation to their diameter extending laterally from opposite sides of the bottom of said outlet branch; which includes placing a tubular shell having a closed end and an open end in said outlet branch with the closed end of the shell at the intersection of the outlet branch and the run branch and with the shell wholly supported externally by the wall of the die except at the place of intersection of said branches, introducing liquid filler into the shell, moving said punch inwardly of the die with the pilot portion of the punch within the open end of the shell to seat said shoulder against the end wall of the open end of the shell to effect a liquid tight seal between the end of the shell and said shoulder and to trap the liquid in the shell, and continuing the movement of the punch after such seating to feed the portion of the shell in said outlet branch toward said intersection essentially by mechanical end pressure and to thereby cause the metal of said shell to be bulged laterally and simultaneously in opposite directions in tubular form into the opposed portions of said run branch by the internal pressure of the liquid filler resulting from the movement of the punch and the punch-induced movement of the shell in and relative to the die.

8. The method of making a wrought metal T having branches the length of each of which is at least of the order of its diameter from a tubular shell having an open end, a closed end, and a length several times its diameter; by the aid of a punch having a pilot portion and a circular shoulder at one end of the pilot portion and a cooperating recessed die having a T-shaped recess consisting of a tubular outlet branch and a tubular run branch of substantially the same diameter as said outlet branch and intersecting the bottom of the outlet branch to provide two tubular recesses extending laterally from opposite sides of the bottom of said outlet branch; which includes, in one or more operations, placing said shell in said outlet branch with the closed end of the shell at the bottom of the outlet branch and with the shell wholly supported externally by the wall of the die except at the place of intersection of said branches, introducing liquid filler into the shell, trapping the liquid in the shell by subsequent operation of the punch, and moving the major portion of the metal of said shell longitudinally inwardly of said outlet branch and past the place of intersection of said branches into said laterally extending tubular recesses to form the run of the T, the portion of the shell in said outlet branch being forced toward said place of intersection by mechanical end pressure exerted by abutting contact of the shoulder of the punch against the end wall of the open end of the shell and the metal forced to said place of intersection being guided laterally away therefrom in contact with the walls of said recesses by the internal pressure of the trapped liquid filler.

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