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Tominaga et al.

[11] **3,832,877**

[45] **Sept. 3, 1974**

[54] **IMPACT HYDRAULIC FORMING EQUIPMENT**

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[22] Filed: **Nov. 19, 1973**

[21] Appl. No.: **417,253**

Related U.S. Application Data

[62] Division of Ser. No. 131,676, April 6, 1971.

[52] **U.S. Cl.** **72/59,** 72/62

[51] **Int. Cl.** **B21d 26/04**

[58] **Field of Search** 72/57, 58, 59, 60, 61, 72/62; 29/421

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Primary Examiner—Richard J. Herbst
Attorney, Agent, or Firm—McGlew and Tuttle

[57] **ABSTRACT**

The apparatus comprises a tubular outer die in which are slidably mounted tubular inner piston dies having work forming inner surfaces corresponding to the desired contour to be imparted, by impact hydraulic pressure, to a tubular work piece inserted into the tubular inner piston dies. An impact hydraulic generator including apressure chamber and a hammer is connected to the apparatus to subject the interior of the tubular work piece and the tubular piston dies to impact hydraulic pressure, a cooperating pair of inner tubular piston dies being engaged with opposite ends of the work piece to shorten the axial length of the work piece as the latter is laterally deformed to the desired shape. The piston dies are so formed that, as opposed dies move toward each other responsive to the impact hydraulic pressure, pressure bleeding ports are opened to control the application of the impact hydraulic pressure to the work piece.

4 Claims, 12 Drawing Figures

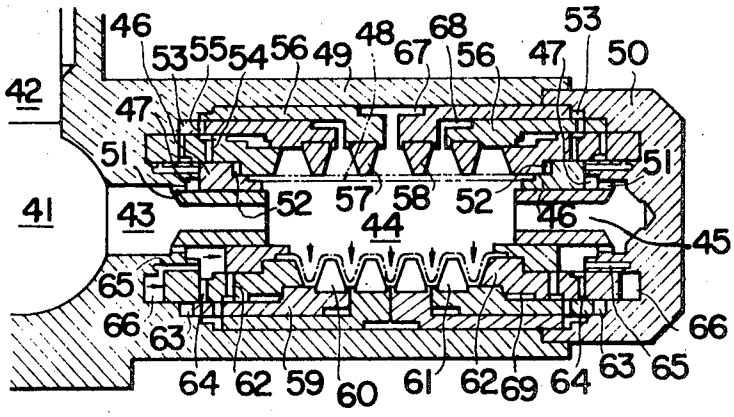


FIG. 1

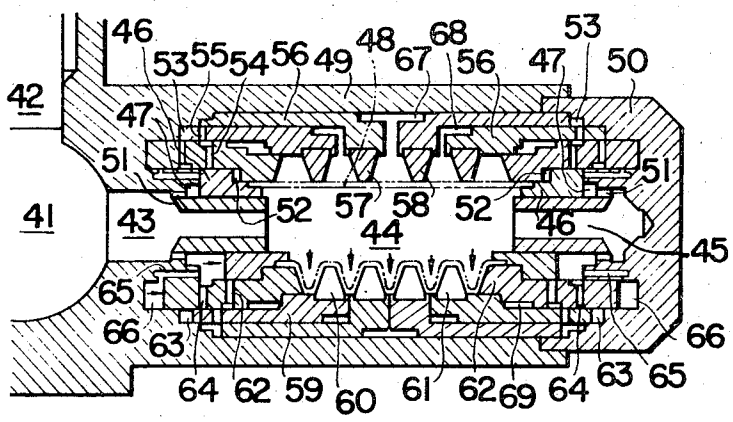


FIG. 2

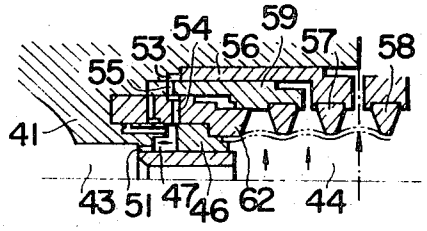


FIG. 3

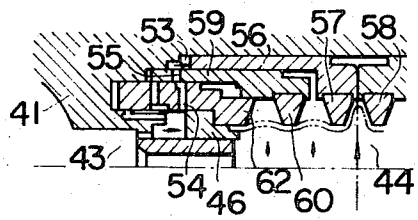


FIG. 4

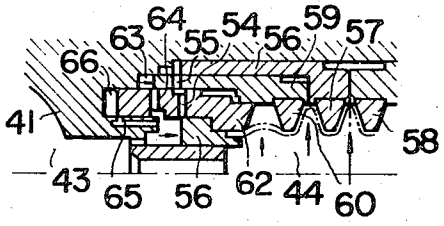


FIG. 5

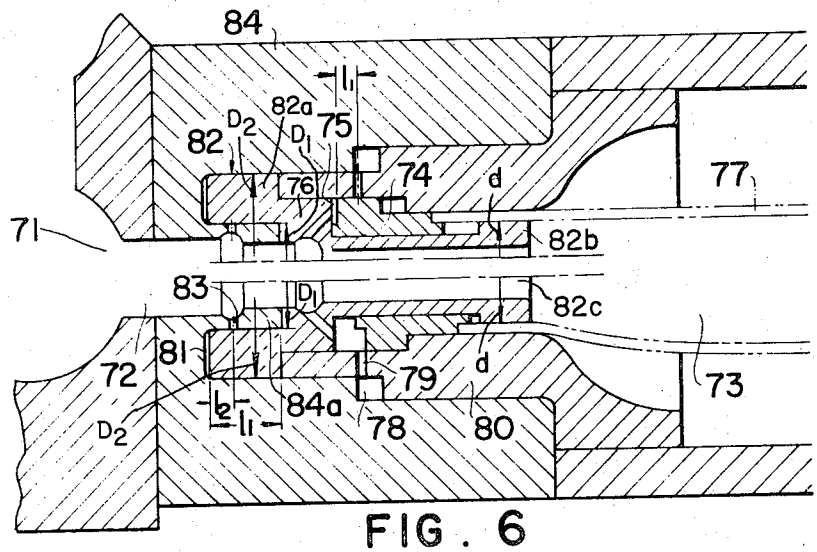


FIG. 6

FIG. 7

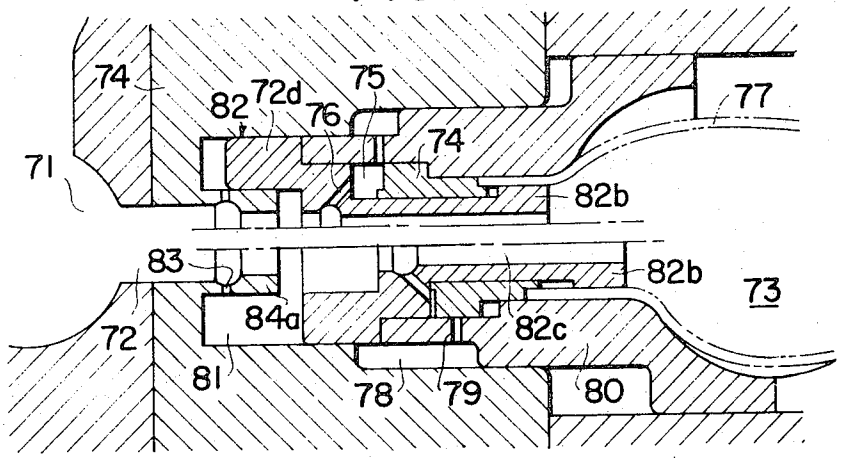


FIG. 8

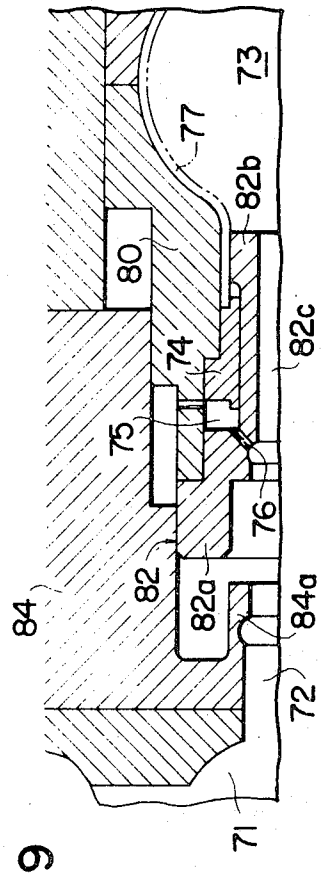

73
77
82b
80
82c
74
75
76
82
82a
84
84a
72
71

FIG. 9

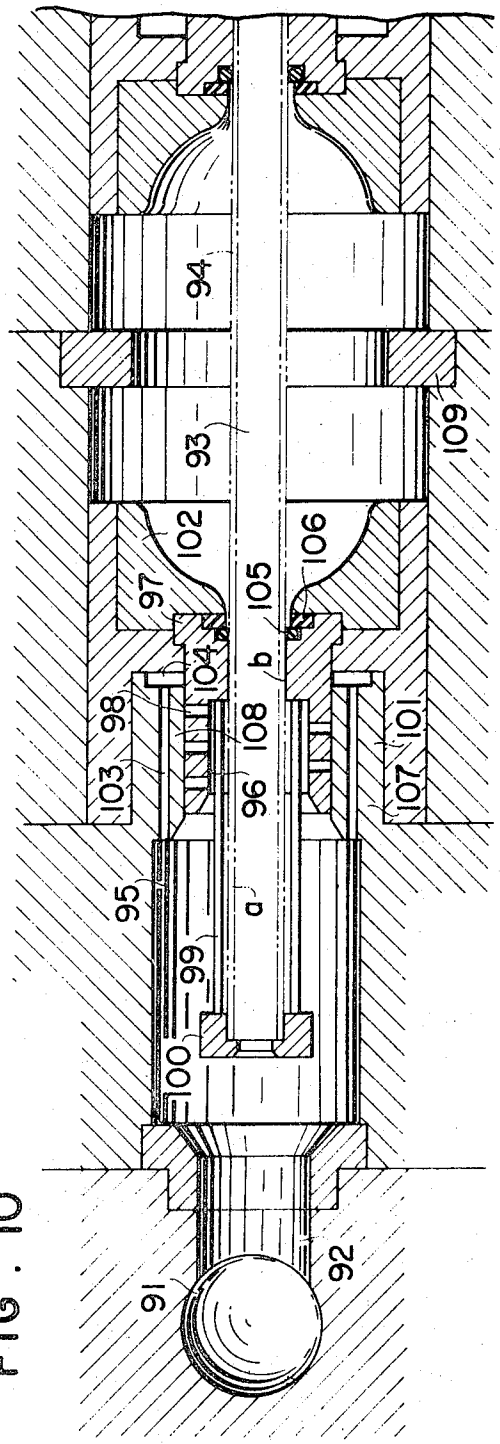

94
93
109
102
106
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105
104
b
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108
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103
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107
95
a
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100
91
92

FIG. 10

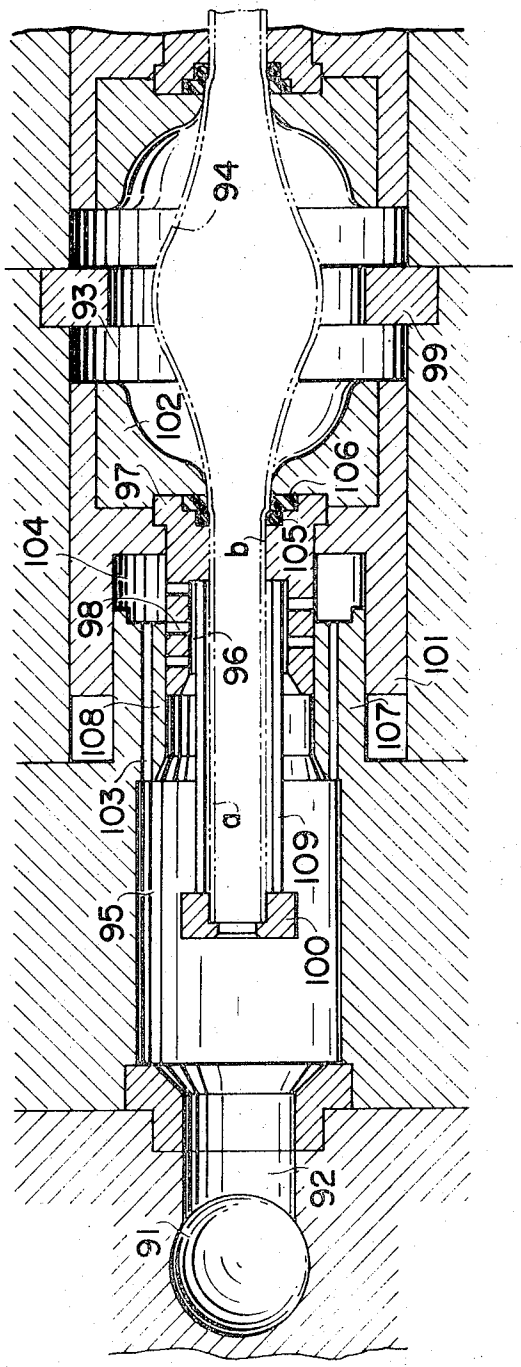

94
93
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FIG. 11

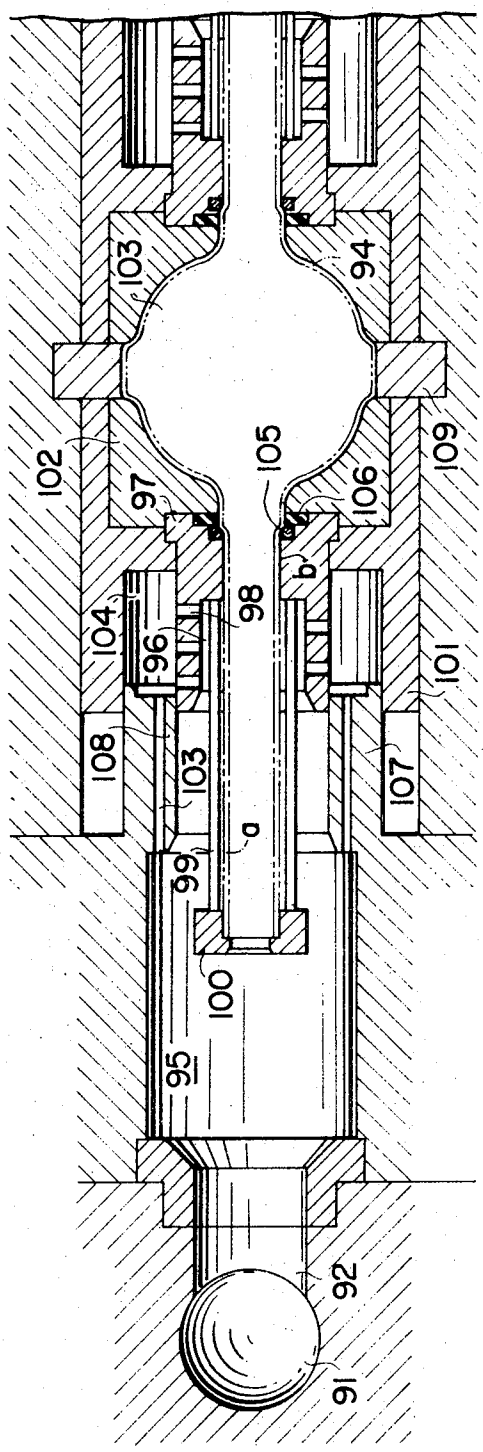

103
94
102
105
109
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106
b'
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101
108
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107
a
99
100
95
92
91

FIG. 12

IMPACT HYDRAULIC FORMING EQUIPMENT

CROSS REFERENCE TO RELATED APPLICATION

This application is a division of application Ser. No. 131,676, filed Apr. 6, 1971, for "Impact Hydraulic Forming Equipment."

FIELD AND BACKGROUND OF THE INVENTION

This invention relates to impact hydraulic pressure forming apparatus in which an impact hydraulic pressure is applied to the interior of a tubular member to deform the same radially into a predetermined shape by engagement of the external surface with forming dies. In forming materials, such as metal or the like, by generating a high hydraulic impact pressure, the high hydraulic impact pressure is applied and the material is bulged laterally only through the application of an internal pressure. In forming a plurality of bulges or the like in a work piece of considerable length, however, the sections of the material are pulled toward each other due to the bulging. In the worst case, this results in thinning or tearing out of the material.

SUMMARY OF THE INVENTION

In accordance with the present invention, tubular inner piston dies are slidably mounted in a tubular outer die connected to a source of impact high hydraulic pressure, and a work piece is inserted into the tubular piston dies. Pressure fluid, such as water, from the impact high hydraulic pressure generator fills the interior of the work piece and is in contact with the tubular piston dies. Opposed tubular piston dies are in operative engagement with the axially opposite ends of the tubular work piece, and the tubular piston dies have die formations on their inner peripheries for providing the desired contact to the tubular work piece. Upon operation of the impact high hydraulic pressure generator, the impact high pressure is applied to the interior of the tubular work piece and to the opposed tubular piston dies so that, as the work piece is bulged laterally or radially into contact with the die formations on tubular piston inner dies, the opposite ends of the work piece are moved toward each other to shorten the effective length of the work piece.

In one embodiment of the invention, two sets of opposed inner piston dies, which are tubular, are arranged within the outer die, with one tubular die of each set being engaged with the associated end of the work piece. The dies of the two sets are progressively brought into action through the medium of pressure bleed ports which are successively uncovered during movement of the two sets of dies toward each other.

In another embodiment of the invention, a forming die piston and a forming die are interconnected to operate as a unit. An annular space between the forming die and the forming die piston receives an axial pressure piston which engages an end of the tubular work piece also received in the annular space. There are two sets of these dies slidably mounted in opposing relation in the outer die.

Upon operation of the impact high hydraulic pressure generator, the impact hydraulic pressure is applied to the interior of the work piece and initially, through ports in the forming die pistons, to the axial pressure pistons to compress the work piece laterally. As the lateral or axial pressure pistons move toward each other and relative to the forming die, they uncover ports admitting the impact hydraulic pressure to be effective on the forming dies, which then move toward each other. The forming dies, moving toward each other, carry the forming die pistons therewith, and the movement of the forming die pistons uncovers additional ports in the outer die which allow the impact hydraulic pressure to be effective on the forming die pistons, the axial pressure dies moving with the forming die pistons and the forming dies so that the work piece is expanded laterally or radially while being compressed axially into a desired form as determined by the inner surfaces of the forming dies.

In a third embodiment of the invention, a pair of opposed forming dies are connected to associated axial pressure pistons for movement as units, and the units are slidable toward each other in a tubular outer die. This embodiment of the invention is particularly designed for the deformation of tubular work pieces having a very large length to diameter ratio and, when the work pieces are disposed in the tubular piston die, the ends of the work pieces project a substantial amount axially outwardly of the tubular piston die. Rods connect a flanged annular collar to each axial pressure die, and these collars engage the respective opposite axial ends of the tubular work piece. Thus, when the interior of the work piece and that portion of the outer die axially beyond the inner dies are filled with hydraulic fluid, such as water, and an impact hydraulic pressure is applied to the water, the pressures on the interior of the tubular work piece and on that portion of the exterior thereof axially beyond the inner dies are equalized. Bleeder passages are provided in the axial pressure piston and are brought successively into communication with axially extending passages in the outer die and subjected to the impact hydraulic pressure. Thereby, control of the movement of the forming dies toward each other is effected.

An object of the invention is to provide an improved equipment or apparatus for shaping tubular work pieces of considerable length by impact high hydraulic pressure.

Another object of the invention is to provide such an apparatus in which plural tubular inner forming dies are axially displaceable in a tubular outer die and are associated with tubular inner piston dies operable to engage the axially opposite end of a tubular work piece, so that the work piece is reduced in length axially while being expanded laterally or radially into contact with the forming dies to impart a desired configuration to the work piece.

A further object of the invention is to provide such an apparatus which is very advantageous in the deformation of tubular work pieces having a very high length to diameter ratio.

Another object of the invention is to provide such an apparatus in which the tubular inner dies have bleeder ports or the like for controlling the movement of the opposing dies toward each other upon application of impact hydraulic pressure to the tubular inner dies.

For an understanding of the principles of the invention, reference is made to the following description of typical embodiments thereof as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1 through 4 are axial sectional views of one embodiment of the apparatus of the invention and illustrating the successive positions of the parts during a forming operation on a tubular member,

FIGS. 2, 3 and 4 illustrating only one half of the apparatus which is symmetrical with respect to a diametric central plane;

FIGS. 5 through 9 are axial sectional views through one half of forming apparatus in accordance with a further embodiment of the invention, the symmetrical other half not being illustrated; and

FIGS. 10 through 12 are axial sectional views through a third embodiment of apparatus in accordance with the invention and again illustrating successive positions of the parts during a forming operation.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIGS. 1 through 4, an impact hydraulic pressure generator is illustrated, in FIG. 1, as including a hydraulic pressure chamber 2 and a hammer 42. In the usual manner of operation of impact hydraulic pressure generators, when chamber 41 is filled with a hydraulic fluid, such as water, and hammer 42 is dropped from a distance toward chamber 41, an impact hydraulic pressure is generated. This impact hydraulic pressure is applied, through a passage 43, to a die inner chamber 44 and also into a passage 45. Through throttling passages or bores, which regulate the pressure, the impact hydraulic pressure is directed into rear chambers 47 associated with piston dies 46 which are engaged with opposite axial ends of a tubular work piece 48. The front chambers 52 associated with piston dies 46 are connected, in a known manner, to atmosphere. The application of the impact hydraulic pressure to the chambers 47 causes piston dies 46 to move toward each other to compress tubular work piece 48 axially. Piston dies 46 will be designated A pistons.

When the impact hydraulic pressure is produced, as by dropping hammer 42 or by dropping a weight on hammer 42 or striking a blow against the upper surface thereof, the impact hydraulic pressure thus is applied to the interior of tubular work piece 48 and to the outer surfaces of the A pistons 46, to compress the work piece 48 axially and to expand it radially so that work piece 48 assumes the configuration shown in FIG. 2. As soon as A pistons 46 have moved toward each other through a predetermined distance, the rear chambers 47 thereof are brought into fluid communication with the rear chambers 53 of B pistons 56 through passages 54 and 55 which will then be in communication with rear chambers 47. The impact hydraulic pressure is thus effective upon B pistons 56 which have inner forming dies 57, 58 at their axially inner ends. Dies 57 and 58 move axially toward each other as a result of the movement of B pistons 56 to engage the material of work piece 48, previously slightly deflected radially into the space between inner forming dies 57 and 58 as shown in FIG. 11. In other words, the bulged out portion of the wall of work piece 48 begins to be embraced by the inner forming dies 57 and 58.

A pair of opposed C pistons 59 have respective inner forming dies 60 and 61 at their axial inner end, and a pair of opposed D pistons 62 have inner forming dies at their axially inner end. The C and D pistons, as well as the A pistons, move axially toward each other by an amount corresponding to the displacement of B pistons 56. The B pistons 56 continue their movement toward each other until they abut each other, as shown in FIG. 3.

As shown in FIG. 4, when the B pistons 56 have abutted each other, rear chambers 47 of A pistons 46 are brought into communication with rear chamber 63 of C pistons 59 through a passage 64 communicating with the passage 54. Thus, C pistons 59 move toward each other in the same manner as B pistons 56 to accomplish the second forming of work piece 48, during which the B pistons 56 no longer move toward each other as they are in abutment.

When the C pistons 59 have completed their movement toward each other, as shown in FIG. 4, passages 65, communicating with rear chambers 47 of A pistons 46, are brought into communication with rear chambers 66 of D pistons 62. The D pistons 62 are thus moved toward each other by the hydraulic impact pressure. These pistons, in cooperation with the inner forming dies 60 and 61 of the C pistons 59 effect the final forming step, as illustrated in the lower half of FIG. 10.

The several sets of opposing pistons are slidably mounted in an outer forming die 49 provided with an end closure 50, and positioning springs are placed in the annular recesses 67, 68 and 69 at the time of assembling the inner tubular dies and the outer tubular die 68. The parts may be readily disassembled to remove the formed work piece 48 by removing the cover 50 and then extracting the inner tubular dies and the work piece from the outer tubular die 49, after which the parts may be reassembled with another work piece in position.

In the embodiment of the invention shown in FIGS. 5 through 9, the hydraulic chamber of the impact hydraulic pressure generator is indicated at 71 as communicating, through an axial passage 72, with a die internal pressure chamber 73. It should be noted that, in this embodiment, the forming dies are symmetrical about a longitudinal center line. FIGS. 5, 7 and 9 represent sections taken above the axis or center line, and FIGS. 6 and 8 are sections taken below the axis or center line, FIGS. 5 through 9 illustrating consecutive stages in the operation of the apparatus.

A forming die piston 82 has a large diameter axially outer portion 82*a* and a small diameter axially inner portion 82*b*. Piston 82 is installed, for sliding movement, in a generally tubular body 84, and the inner diameter D_1 and the outer diameter D_2 of the large diameter portion 82*a* are selected so that they have a close sliding fit with the radially spaced cylindrical supporting surfaces of body 84. The axially inner end of the small diameter portion 82*b* of forming die piston 82 has a diameter *d* such as to fit snugly within a tubular work piece 77.

The two portions of forming die piston 82 define a central water passage 82*c* which is in fluid communication with the hydraulic chamber 71 of the hydraulic impact pressure generator and which is also in communication with the die internal pressure chamber 73, or with the interior of the tubular work piece 77. A forming die 80 (FIG. 6) is connected by bolts or the like, which have not been shown, to the forming die piston

82 so as to form a unit therewith for sliding movement relative to the body 84. The axially outer end of forming die 80 is stepped, in its outer diameter, to have a conforming fit with radially stepped cylindrical inner surfaces of the body 84, and its inner diameter is stepped to conform to the outer peripheral surface of the large diameter portion 82*a* of piston 82 and to conform to the outer diameter of the work piece 77.

A stepped tubular piston 74, for engaging an end of work piece 77, is slidably mounted on the smaller diameter portion 82*b* of piston 82 and has a stepped outer periphery for engaging the stepped inner periphery of the forming die 80. Piston 74 is slidable axially with its axial movement being limited by the larger diameter portion 82 *a* of piston 82 and the enlarged axial inner end of the smaller diameter portion 82*b* of piston 82. A rear chamber 75 defined partly by a recess in the axially outer end of piston 74 and by the axially inner end of the larger diameter portion 82*a* of piston 82 communicates with axial passage 82*c* and thus with passage 72 and generator chamber 71 through a throttling passage 76.

It should be noted that an identical arrangement is provided adjacent the opposite end of the tubular work piece 77 as partially indicated in FIGS. 8 and 9, so as to provide a pair of opposed forming dies 80, a pair of opposed pistons 74 for engaging the respective opposite axial ends of work pieces 77 and a pair of opposed forming die pistons 82. The right hand end (not shown) of the outer die may be closed by a suitable closure such as illustrated, for example, in FIG. 1.

With the described construction, when an impact hydraulic pressure is developed in hydraulic chamber 71, as by dropping a weight upon a hammer associated with this chamber, the impact hydraulic pressure is directed through passage 72 and passage 82*c* into the die internal pressure chamber 73 where the impact pressure is applied to the work piece 77 to deform the latter radially. At the same time, the impact hydraulic pressure, as regulated by throttle passages 76, is applied to rear chamber 75 of the axial pressure pistons 74 engaging the axially opposite ends of the work piece 77. When the impact hydraulic pressure is applied onto the axially opposite ends of the work piece 77 through the pistons 74, the work piece 77 is subjected to both the internal impact hydraulic pressure and the axially directed impact hydraulic pressure, and is deformed as illustrated by the broken lines in FIG. 5. At this point, the forming dies 80 have not moved because pressure has not yet been applied thereto.

As the pistons 74 are moved toward each other by the impact hydraulic pressure in the rear chambers thereof, these rear chambers are brought into communication with chambers 78 at the axially outer ends of forming dies 80 through passages 79 (FIG. 6) provided beforehand in accordance with the conditions required for forming. For example, the operation position can be determined at the distance l_1 shown in FIG. 5. It is only when chambers are subjected to the impact hydraulic pressure that forming dies 80 start to slide axially toward each other, these dies sliding toward the center of the apparatus while forming the work piece 77. Under these conditions, the work piece is bulged radially by the movement of pistons 74 toward each other and by the internal pressure, and thus are deformed to the condition illustrated in FIG. 7.

As forming dies 80 move toward each other, the forming die pistons 82 are likewise moved axially inwardly due to their connection to the forming dies 80 to form units therewith. After a predetermined movement, the axially outer ends of forming die pistons 82 are subjected to the impact hydraulic pressure by virtue of the uncovering of throttling passages 83 so that the impact hydraulic pressure is effective in the rear chambers 81 associated with the forming die pistons 82, the inner peripheries of these forming die pistons sliding on the outer peripheries of tubular projections 84*a* of the body 84. Thus, the forming dies 80 are moved further toward each other by the forming die pistons 82, so that the work piece 77 is deformed to the condition shown in broken lines in FIG. 8. Such deformation is facilitated by the impact hydraulic pressure acting internally of work piece 77. In the last stage of forming the work piece 77 to the desired shape, dies 80 abut each other, but flow pressure is maintained internally of the work piece so as to resist the reaction force.

By way of example, the position of pressure passage 83 is determined by the distance l_2 or l_3, shown in FIG. 6. The distance l_2 represents the distance from the axially outer end surface of forming die piston 82 to the passage 83 formed in the tubular projection 84*a* of body 84. The distance l_3 represents the amount by which forming die piston 82 overlaps tubular projection 84*a*. The relationship of the several distances should be as follows:

$$l_1 \leqq l_2, l_3 < \text{Full stroke.}$$

The operation of the components of the apparatus illustrated in FIGS. 5 through 8 will now be described. If work piece 77 is not introduced sufficiently far into the forming unit, the pressure pistons 74, engaging the axially opposite ends of the work piece, apply pressure thereto until the work piece is introduced by the required mount into the forming apparatus. As no impact hydraulic pressure is applied to forming dies 80 at this time, the forming dies do not move.

If the forming dies 80 begin to slide before the motion of the piston 74 has begun, passages 79 are shut off by piston 74, so that the forming dies 80 stop in that position.

When an impact hydraulic pressure is applied to piston 74 and forming dies 80 under the above condition, pistons 74 tend to move towards the center of the apparatus. By virtue of this movement of pistons 74, forming dies 80 receive the reaction force. Because the chambers 78 at the rear of each forming die 80 is not in free communication with passage 72, the pressure is automatically increased in the chamber due to a slight backward motion of the forming die 80. First the pressure is self-controlled and the pistons 74 are caused to move toward each other. These die and piston motions can be regulated by adjusting the pressure in chamber 78 at the end of each forming die.

When the pistons 74 are moved toward the center of the apparatus, passages 79 are brought into communication with passage 72 and pressure is applied to chamber 78, thus effecting forming of the work piece. When the forming progresses further, forming is effected by the application of the pressure reached at the time when an increase in the pressure exerted by the forming dies is required, due to the reaction force resulting from the internal pressure, and the hydraulic pressure

that is applied to chambers **81** of forming die pistons **82.**

When the forming dies have moved further, the impact hydraulic pressure directed through the passages **83** is converted to a full surface pressure in the final stage in order to overcome the forming internal pressure. Thus, forming dies **80** are brought into abutment with each other. In this case, as shown in FIG. **8,** the pressure required required by the forming die for forming is made higher than the pressure to be applied to work piece **77** by pistons **74.** Thus the forming dies are moved in advance and are brought close together before forming of the work piece **77** is completed.

By further application of hydraulic pressure, the pistons **74** are operated in a condition in which forming dies **80** are very close to each other. Thus, forming is completed by means of the action of the piston **74** and the internal pressure while advancing work piece **77** into the forming unit. The above-described forming operation is carried out without interruption during an extremely short period of time during which the impact hydraulic pressure is applied.

In the embodiment of the invention shown in FIGS. **10, 11** and **12,** the hydraulic pressure chamber of an impact hydraulic pressure generator is indicated at **91** as connected to a passage **92** communicating with the die internal pressure chamber **93.** A tubular work piece is indicated at **94,** and the apparatus has further passages **95** and **96.** A piston **97** is operable to apply pressure to an axial end of the work piece **94.** Only one half of the symmetrical apparatus is shown completely, with the other half being shown only partially.

When an impact hydraulic pressure is produced in hydraulic pressure chamber **91,** it is directed from passage **92** into die internal pressure chamber **93** to apply radial pressure on work piece **94.** Simultaneously, the impact hydraulic pressure is applied to pistons **97** each of which forms a unit with a forming die **102** and engages the back surface thereof. Thereby, forming is effected by the resultant of internal pressure and the pressure directed axially to the opposite ends of the work piece **94.**

The pressure is applied initially to axial pressure application chambers **104** through fixed regulating passages **103** formed in piston guides **107.** In order to conform deforming and control the same during the forming operation, multiple stage radial pressure regulating passages **98** are formed in axial pressure pistons **97** and are brought into communication with the respective axial pressure chambers **104** during axial movement of the pistons **97.** Thereby, forming is done progressively with the control of the axial pressure. In this case, by way of example, the axial pressure regulating aperture **98** in pistons **97** can be provided in a lead arrangement in the outer circumferences of the pistons **97** so that they are continuously related.

Since work piece **94,** to be deformed, is located within dies **102** at the time of mounting the work piece, the work piece should not necessarily be moved within the dies by axial pressure. Therefore, the interior and exterior of section *a* of the work piece, which sections are not to be formed, are both subjected to the hydraulic pressure. This serves to prevent the work piece **94** from buckling and bending under the axial pressure produced by work piece feed box **100** connected by connecting rods **99** to the axial pressure pistons **97.** It will be noted that the feed blocks **100** are generally tubular.

In this way, feed of the work piece **94** is synchronized with forming dies **102** by means of work piece feed blocks **100** and the axial pressure pistons **97.**

Axial pressure pistons **97** and dies **102** are mounted on a sliding forming die guide **101.** An O-ring **105** and a ring **106** serve to prevent water from leaking when water is filled in to the apparatus. At the time of the application of the impact hydraulic pressure, water leakage is prevented by means of the contact portions *b* between pistons **97** and work piece **94** so that work piece **94** is bulged radially outwardly by the internal pressure therein. Piston guides **107** communicate with hydraulic pressure passages **95** and with die guides **108.** A stationary die is indicated at **109** and serves as an abutment for engagement by the axially movable forming dies **102,** as indicated in FIG. **12.**

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. Equipment for forming a tubular member to predetermined shape by impact hydraulic pressure comprising, in combination, a relatively elongated tubular guide; a pair of initially axially spaced annular piston dies slidably mounted in said guide and engaging the axially opposite end of the member to be formed to compress that portion of the member between said piston dies axially responsive to hydraulic pressure applied to axially outer faces of said piston dies, plurality initially axially spaced annular forming dies slidably displaceable in said guide and embracing the member intermediate said piston dies; channel means operatively associated with said guide and connected to the hydraulic chamber of a generator of impact hydraulic pressure, and operable to fill hydraulic fluid into the tubular member and into pressure chambers defined by the axially outer faces of said dies; said channel means, upon impact operation of a generator of impact hydraulic pressure connected thereto, applying a sudden impact hydraulic pressure simultaneously to the interior of the member, to expand the same laterally, to said pressure chambers, to move said dies axially toward each other to compress the member axially, and to all of said dies to move the same axially toward each other to limit lateral expansion of the member to said predetermined shape; and throttling passages in at least some of said dies communicating with said channel means and brought progressively into communication with at least some of said pressure chambers responsive to die movement to control the application of axial pressure to the tubular member in accordance with a lateral deformation of the tubular member by the internal pressure therein.

2. Equipment for forming a tubular member to a prdetermined shape by impact hydraulic pressure, as claimed in claim **1,** in which said piston dies and said forming dies are telescoped with each other within said tubular guide; each forming die comprising a respective piston having a pressure chamber adjacent its axially outer end and a radially inwardly projecting forming die at its axially inner end; said piston dies being initially subjected to the impact hydraulic pressure in said channel means to compress the tubular member axi-

ally; said pressure chambers of said forming dies being successively brought into communication with said channel means, responsive to the initial movement of said piston dies, beginning with the forming dies whose axially inner ends are nearest to the center of said guide and ending with the pressure chambers of those forming dies which are furthest from the center midpoint of said guide.

3. Equipment for forming a tubular member to a predetermined shape by impact hydraulic pressure, as claimed in claim **1**, including a pair of opposed tubular cross-section forming dies having respective pressure chambers at their axially outer ends; a pair of forming die pistons each secured to a respective forming die for movement therewith as a unit and each having a respective pressure chamber at its axially outer end; each forming die piston having a reduced diameter portion extending coaxially into the associated forming die and defining therewith an annular space receiving a respective end of the tubular member to be formed; said annular piston dies each being slidably mounted on the reduced cross-section extension of the associated forming die piston and in sliding engagement with the associating forming die; each piston die being formed with abutment surfaces engageable with mating abutment surfaces on the associated forming die and on the reduced cross-section extension of the associated forming die piston, and having a step formation for engagement with the adjacent end of the tubular member to be formed; each forming die piston being formed with throttle passages extending therethrough and connecting the pressure chamber of the associated annular piston die to said channel means whereby, upon operation of the impact hydraulic pressure generator, the impact hydraulic pressure is applied to the pressure chambers of said annular piston dies to move said annular piston dies toward each other to compress the tubular member axially; the impact hydraulic pressure also being applied to the interior of the tubular member through said tubular forming die pistons; said annular piston dies abutting said forming dies to move said forming dies toward each other together with the associated forming die pistons; each forming die piston having throttling passages therein uncovered by movement of the associated annular piston die to connect the pressure chambers of said forming dies to said channel means for continued movement of said forming dies toward each other responsive to the impact hydraulic pressure; said guide being formed with throttling passages communicating with said channel means and uncovered by movement of said forming die pistons toward each other to establish communication between said channel means and the pressure chambers of said forming die pistons for application of the impact hydraulic pressure to the axially outer ends of said forming die pistons to move said forming dies into abutment with each other to complete deformation of the tubular member.

4. Equipment for forming a tubular member to a predetermined shape by impact hydraulic pressure, as claimed in claim **1**, for forming tubular members having a large magnitude length to diameter ratio, including a pair of forming dies each secured to a respective annular piston die for movement as a unit therewith; each piston die having an axially outwardly projecting tubular extension slidably engaged in a respective guide portion of said die; each guide portion being formed with throttling passages connecting said channel means to the pressure chamber of the associated piston die; the tubular extension of each piston die being formed with a plurality of radial ports therethrough initially closed by the associated guide portion; each piston die having the elongated tubular member extending therethrough in fluid-tight relation and projecting axially upwardly beyond the respective tubular extension; respective annular collars each engageable with a respective axially opposite end of the tubular member within said channel means; and rods connecting each annular collar to the associated piston die; whereby, upon operation of the impact hydraulic pressure generator, the impact hydraulic pressure is initially supplied through the passages in said guide portions to the pressure chambers of the associated piston dies to move said forming dies toward each other, the impact hydraulic pressure also being applied to the interior of the tubular member through said annular collars from said channel means; said radial ports in said piston dies being successively connected to the associated pressure chambers responsive to axial inward movement of the associated piston die to progressively increase the cross-section for application of the impact hydraulic pressure in said channel means through said pressure chambers.

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