Dec. 13, 1955 P. ROUX 2,726,560

METHOD OF PERFORATING METAL INGOTS AND PRESS FOR CARRYING THE METHOD INTO EFFECT

Filed April 17, 1951 2 Sheets-Sheet 1

Fig. 1

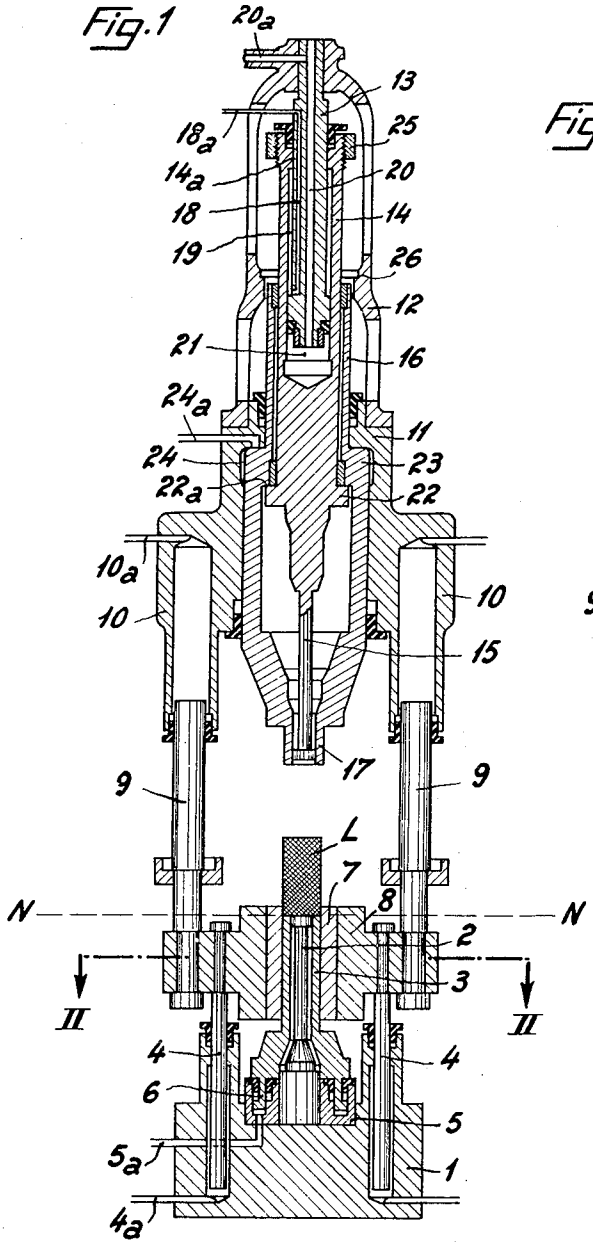


Fig. 2

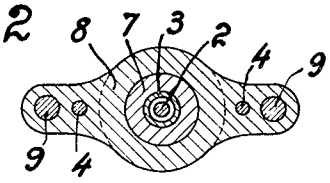
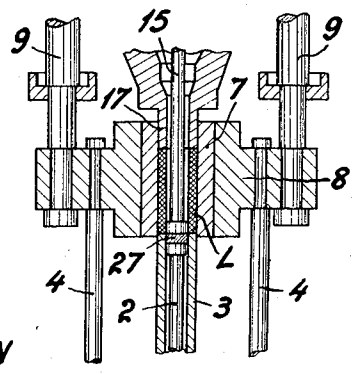


Fig. 5a

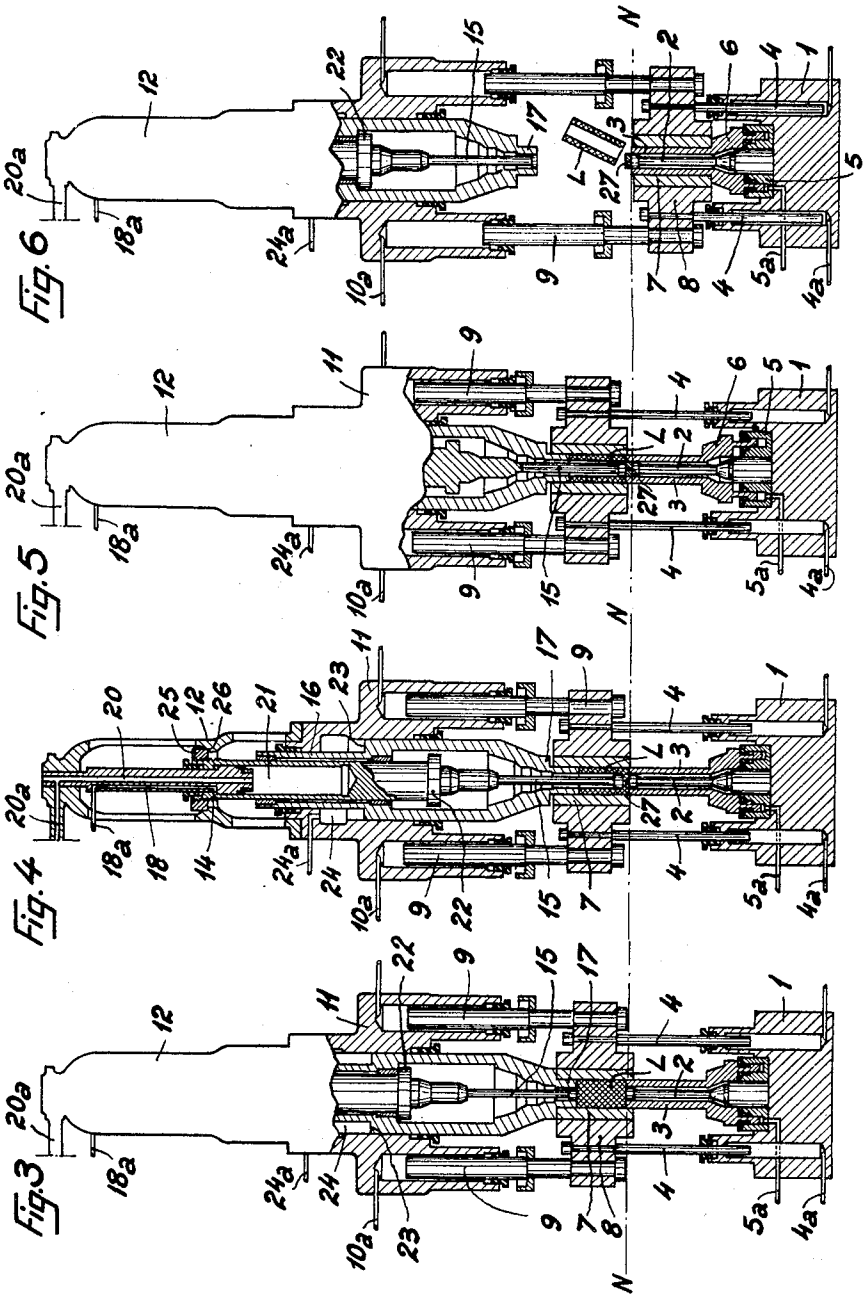


INVENTOR
Pierre Roux
By: Stevens, Davis, Miller & Mosher
ATTORNEYS

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METHOD OF PERFORATING METAL INGOTS AND PRESS FOR CARRYING THE METHOD INTO EFFECT

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INVENTOR
Pierre Roux
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ATTORNEYS

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METHOD OF PERFORATING METAL INGOTS AND PRESS FOR CARRYING THE METHOD INTO EFFECT

Pierre Roux, Paris, France

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Claims priority, application France May 23, 1950
8 Claims. (Cl. 78—9)

In the manufacture of metal tubing by extrusion a necessary preliminary step is to drill through the centre of a cylindrical ingot or blank a hole that is perfectly concentrical with the cylindrical outer surface of the blank. Drilling the blank in the cold by a machining operation is prohibitive owing to the cost of the operation and to the loss of material entailed. It is accordingly desirable to form the hole at high temperature by displacing the metal brought to a plastic or flowing state. This method is advantageous in that it is fast, requires a comparatively low amount of energy and does not incur much loss of metal, but it makes it difficult to obtain a correctly central hole. One way of overcoming this difficulty would be to place the blank, assumed to be perfectly round, into a container slightly larger than it in diameter, in which the blank would be centred by any suitable mechanical means. With the container held stationary, the soft metal would then be caused to flow up along the needle-like punch so that a perfectly centred through hole would be produced. Such a method however would be impracticable because of the rapidly increasing resistance which would be opposed to the downward motion of the punch as the operation proceeds, owing to the increasing difficulty encountered by the displaced metal to flow upwards towards the top of the container, which is its only way of egress.

Aside from this, in order to discharge the last eighth of an inch or so of metal in forming the bottom outlet of the central through hole in the blank, it would be necessary to provide an aperture which would have to be made retractible laterally or vertically. Lastly, the mechanical centring of the blank in the container would, in practice, be difficult to achieve. All the above-listed difficulties are especially hard to overcome when the metal being handled requires to be heated to high temperatures, as is the case with steel and pure copper for example.

It is the general object of this invention to provide an improved drilling press for forming an axial through aperture in a metal ingot or blank.

Another object is to provide a method of forming an axial through aperture in a cylindrical metal blank, and means for carrying out said method, wherein the resulting through aperture will be accurately centred relatively to the cylindrical surface of the blank.

A further object is to provide such method and means whereby a truly round cylindrical blank and a truly centred aperture therein are simultaneously obtained.

A further object is to provide in such a method, an improved step for removing the ultimate small thickness of metal which remains as the drilling operation is approaching completion.

Further objects and advantages of the invention will appear as the description proceeds.

With the said objects in view, the invention comprises the method of forming a central through aperture in a cylindrical metal blank which comprises all or

part of the steps including: Heating the blank to forging temperature; confining the heated blank throughout the lateral surface and one end surface thereof; exerting axial centring pressure on the confined blank to expand the blank radially within the limits of its lateral confinement; relieving said axial centring pressure and exerting drilling pressure on said blank from a central area of its other end surface towards said one end surface thereby causing the metal displaced by said drilling pressure to flow back towards said unconfined other end surface until the friction stresses exerted against the laterally confined surface of the blank no longer permit such flow; thereupon allowing said blank to be slightly axially displaced bodily with its lateral confining means in the axial direction opposite from that in which the drilling pressure is exerted; and suppressing the confinement in a central area of said one end surface to allow a small remaining amount of metal to be expelled therethrough by said drilling pressure.

Apparatus for carrying said method into practice may comprise: Cylindrical container means corresponding in diameter to the outer diameter of the cylindrical blank, and means for imparting parallel axial displacements thereto; end abutment means at one end of said container adapted to receive the drilling reaction thrust and comprising a peripheral abutment section and a central abutment section respectively corresponding in diameter to the outer diameter of the blank and to the diameter of the through aperture to be formed therein, said abutment sections being movable relatively to each other; and a punch and an annular presser head surrounding said punch and movable relatively thereto and both projectable into the container from the other end thereof to compress the blank.

Hydraulic jacks or other suitable actuating means are provided to impart the necessary relative axial displacements to the various above-defined means in carrying out the method of the invention.

The invention will be clearly understood from the ensuing description of an examplary embodiment thereof as illustrated in the accompanying drawings wherein:

Fig. 1 is a vertical section of a drilling press equipped with means according to the invention shown in the position prevailing at the start of a drilling operation;

Fig. 2 is a transverse section of the centring container and lower rammer assembly on line II—II of Fig. 1;

Figs. 3, 4, 5 and 6 are views of the press assembly of Fig. 1 on a reduced scale, in four successive operating conditions or stages thereof; in Fig. 3, the blank has been centred in the centring container by compression thereof between the lower rammer and an upper rammer or presser; in Fig. 4, the drilling punch or needle has been pushed down into the blank almost to complete the drilling operation; in Fig. 5 the drilling operation is completed, with the bottom outlet of the through aperture in the blank completely formed; and in Fig. 6 the centring container has been lowered for removal of the drilled blank.

Fig. 5*a* is a detail view corresponding to a part of Fig. 5, and shows on a slightly larger scale the cooperating parts of the centring container, lower rammer and upper rammer or presser assemblies, and the drilling punch or needle, at the time the bottom outlet is being formed.

As shown in the drawings, a drilling press comprises a fixed lower bed **1** having mounted centrally thereof a fixed upstanding stem or lower punch **2** formed at its top end with an enlarged head equal in diameter to the through hole which is to be formed in the blanks. This lower punch **2** extends through a bore formed in the bottom rammer assembly **3** which is in the form of an annular piston adapted to reciprocate in the cylindrical recess of the centring container presently described. The

bed further supports the cylinders of a pair of hydraulic jack units including the vertical jack-rods 4 connected at their tops to the centring container assembly 7—8 for raising and lowering the said container. The bed further supports an annular cylinder 5 forming part of a central hydraulic jack unit which further includes the annular jack piston 6 rigidly connected with the lower rammer 3 for raising the said lower rammer to an uppermost position in which the rammer lies above the horizontal level N—N of the head of the lower punch 2.

The centring container is of known construction and comprises a central liner 7 and an outer supporting block 8 press-fitted around the liner 7. The block 8 has the jack-rods 4 rigidly coupled with it as already stated and is further rigidly coupled with the lower ends of a further pair of jack-rods 9 projecting down from a pair of jack-cylinders 10 integral with the fixed upper section 11 of the press, this fixed upper press-section being supported from a general press frame which has not been illustrated.

Mounted on the top of the fixed press section 11 is a cage 12 which supports axially thereof a cylindrical rod 13. Slidable about this rod is a recessed cylinder 14 depending from the lower end of which is the drilling needle or upper punch 15, the cylinder 14 having its walls radially spaced from the surface of the cylindrical rod 13 to define a sealed annular chamber 19 therebetween, so that pressure fluid fed into this chamber will act upwards against the annular shoulder 14*a* formed at the top of the cylinder 14 in sealing engagement with the rod 13. The lower end head of the movable drilling punch-needle 15 is equal in diameter to the diameter of the fixed punch 2, and hence equal to the diameter of the through hole to be formed in the blank. Mounted for sliding movement about the cylinder 14 is an annular cylindrical appendage 16 rigidly connected with the top of the upper rammer or presser head 17. The presser head 17 is of generally annular configuration and corresponds in outer diameter to the inner diameter of the liner member 7 of the centring container assembly, so as to be capable of projecting into said liner. The fixed rod 13 is formed with two longitudinal ducts, including a duct 18 connecting with a line 18*a* for delivering pressure fluid from a suitable source of supply into the sealed annular chamber 19 defined between rod 13 and the inner wall of the movable cylinder 14. The other duct 20 formed through the rod 13 connects with a further line 20*a* for delivering pressure fluid into the sealed chamber 21 formed between the lower end of the rod 13 and the lower end of cylinder 14. A radial flange 22 integral with the rod 13 cooperates with an internal shoulder 22*a* of the cylinder or appendage 16 which is integral with the presser 17. The presser 17 further comprises an external shoulder 23 which acts as an annular piston reciprocating in a cylindrical chamber 24 formed in the fixed press section 11 a connection 24*a* being provided to supply pressure fluid into the chamber 24.

It will be understood that each of the various aforementioned connections or lines such as 4*a*, 5*a*, 10*a*, 18*a*, 20*a*, 24*a*, is actually provided with the usual control means, such as three-way valves or the like, whereby each connection may be selectively made to communicate either with a source of pressure liquid such as a hydraulic storage tank or with exhaust.

First assuming that the lines 20*a* and 24*a* are connected with exhaust and that line 18*a* is connected with the supply, it will be seen that the pressure liquid delivered from 18*a* through 18 into annular chamber 19 will act to raise the cylinder 14 together with the upper punch 15 integral with it. Simultaneously the flange 22 raises the cylinder 16 and upper rammer or presser 17, whereupon the components in the upper section of the press assume the relative positions shown in Fig. 1.

If at this time the line 20*a* is allowed to remain connected with the exhaust while the line 18*a* is connected with exhaust and the line 24*a* is connected with the supply, the pressure acting on annular piston 23 drives the cylinder 16 and presser head 17 downwards, and the punch 15 follows this movement owing to the engagement of shoulder 22*a* against flange 24. This downward motion is arrested after the presser head 17 has penetrated into the top of the centring container as the shoulder 17*a* thereof engages the top of said container. If the line 20*a* is now made to communicate with the fluid supply, pressure is supplied to the chamber 21 and causes the punch 15 to move downwards relatively to cylinder 16 and presser head 17.

The above-described arrangement is operated as follows in drilling a hole through a cylindrical metal blank: The movable elements of the assembly are first brought to their initial position shown in Fig. 1. The centering container stands at its lowermost position with its upper aperture slightly above the horizontal level N—N of the top surface of the head of the fixed lower punch 2. Lines 4*a* and 5*a* are connected with exhaust, and so are lines 10*a*, 24*a* and 20*a*, only the connection 18*a* being connected with the supply.

In this condition of the press, the blank or ingot L to be drilled, in the form of a cylinder slightly smaller in diameter than the inner diameter of the centring container liner, pre-heated to a suitable temperature in which the metal is sufficiently plastic or forgeable, is placed on the centring container with its bottom resting on the flat support provided by the flush upper surfaces of the lower rammer 3 and its central fixed punch member 2, within the recess of the container liner 7 as shown in Fig. 1. Pressure liquid is then supplied through the jack connection 4*a* so as to raise the container assembly to the position shown in Fig. 3, whereby the blank which continues to rest upon the lower rammer 3 becomes completely inserted in the container. The line 18*a* is then connected with exhaust and at the same time line 24*a* is connected with the supply to feed pressure into the cylinder 24, while the line 20*a* is allowed to remain in communication with exhaust. As previously explained, the presser head 17 is thus lowered together with the punch 15, thus ensuring that the blank L is fully inserted into the container, in case such insertion was not completely effected previously. Towards the end of its downward stroke, the presser head 17 penetrates into the container liner 7 and together with the upper punch 15 (driven by the engagement of the flange 22 with shoulder 22*a*) experts pressure on the top of blank L. The plastic blank L expands radially and contracts axially (vertically) under the effect of this pressure and is thus applied into close centred engagement against the inner wall of the container (Fig. 3).

With the blank thus perfectly and finally centred, the line 24*a* is exhausted so that the presser head 17 now only bears upon the blank under gravity, and then the line 20*a* is supplied from the pressure source, while the line 18*a* is allowed to remain in communication with exhaust. The pressure which is thus supplied into chamber 21 drives the drilling punch 15 downwards and the punch begins to form a hole in the ingot. At first the metal of the blank as it is displaced by the punch 15 rises upwards and this upward flow of the metal is made possible owing to the fact that the cylinder 24 is exhausted, because the metal can thus force the presser head 17 upwards. Nearing the end of the drilling operation (see Fig. 4), the metal driven down by the punch 15 encounters too much resistance against upward flow and is forced down over the lower rammer assembly, thereby forcing the container assembly upwards by a small amount. This upward movement of the container assembly has been indicated in Fig. 4 where it can be seen that the container assembly has been raised relatively to the reference line N—N above the level occupied by said assembly in Fig. 3. This upward movement of the container assembly (and the presser head 17 with it)

under the stress created by friction between the blank and the inner surface of the container, is assisted by the fact that the jacks 4 remained supplied with pressure from the very start of the operation. A little prior to the completion of the drill in the ingot, the downward motion of the punch 15 is arrested by an adjustable flange 25 threaded on cylinder 14 engaging a stop shoulder 26 of the cage 12. The positions of flange 25 and stop 26 are predetermined so that, at the time they engage, there remains a small thickness or depth of metal 27 (called the "end-plug") in the bottom of the hole in the ingot (see Fig. 4) which remains to be removed in order to open the outlet of the hole. For this purpose, the jacks 4 are allowed to remain under pressure, and the annular jack 5 of the lower rammer 3 is fed with pressure liquid. Under the action of this pressure the lower rammer 3 now for the first time moves upwards, carrying the ingot L upwards with it (see Figs. 5 and 5*a*), and since the lower punch 2 secured to the bed 1 remains stationary, a cavity is created centrally of the lower rammer. The upper punch 15 which remains stationary forces the metal into this cavity. The drilling operation is now completed. The lines 4*a* and 5*a* are connected to exhaust, and the line 10*a* supplying the jacks 10 is supplied with pressure to lower the container assembly. The drilled blank is therefore withdrawn from the container because of its engagement with the lower rammer. At the same time the lines 20*a* and 24*a* are exhausted and line 18*a* supplied to restore the upper rammer or presser 17 to its position of Fig. 1. The drilled blank can then be discharged (Fig. 6) and the end plug 27 removed from the top of lower punch 5.

It is to be understood that the embodiment illustrated and described above is but one out of many, and that numerous alterations may be made and equivalent arrangements substituted therein without exceeding the scope of the invention. Thus, to mention only one modification which will be obvious to those familiar with the art, the relative arrangement of the parts may easily be reversed, the presser head 17 and upper punch or drilling needle 15 being arranged beneath the container assembly, so that the drilling action would be effected upwards rather than downwards, means being provided above the container for removing the end plug 27.

A further obvious modification would consist of providing the lower rammer 3 fixed and its central punch 2 movable downwardly for accomplishing the end-plug extracting step. In such case, the drilling punch 15 instead of being arrested by the stop 26 as in Fig. 4, would proceed on its downward movement to penetrate into the lower rammer 3, while at the same time the lower punch 2 would start and proceed on its downward movement, thus uncovering a central cavity within the rammer into which the drilling punch 15 would force the end-plug.

Many other modifications and variants will occur to the man of the art within the scope of the ensuing claims.

What I claim is:

1. In a press for the manufacture of bottomless tubes, a container with an open-ended cylindrical bore bounded by a continuous wall, said container being movable parallel to the axis of said bore; means for forming a closed bottom for said bore comprising a tubular ejector member having a cylindrical axial passage therethrough and an outer cylindrical surface of same diameter as said bore and coaxial therewith, and a cylindrical ejector member of same diameter as said passage and accommodated therein, said ejector members being movable one relatively to the other parallel to said axis; thrust-bearing abutment means associated with said ejector members for limiting the relative displacement thereof to a relative position and bearing the thrust exerted thereon; operative means connected with one of said members for displacing it relatively to the other from said relative position; operative means connected with said container for displacing it about said ejector members whereby a substantial length of said members is engaged within said bore from one end thereof; a tubular presser member adapted to engage said bore through the other end thereof, said presser member having a cylindrical axial passage therethrough and an outer cylindrical surface of same diameter as said bore and coaxial therewith; a cylindrical punch member of same diameter as said latter-mentioned passage and accommodated therein, said presser and punch member being movable one relatively to the other parallel to said axis; operative means connected with both said presser and punch members for forcefully engaging same into said bore to exert crushing pressure therein; and operative means connected with said punch member for driving it through said bore to a point axially spaced from and in the vicinity of said cylindrical ejector member.

2. A press as claimed in claim 1, where said tubular and cylindrical ejector members respectively end with an annular and a circular planar surface generally perpendicular to said axis, said surfaces being substantially flush one with the other when said ejector members are abutted in said relative position.

3. A press as claimed in claim 2, wherein the relative displacement of said ejector members from said relative position is in a direction such that said annular surface protrudes from said circular surface.

4. A press as claimed in claim 3, wherein the amount of protrusion of said annular surface is at least equal to the distance between said circular surface and said punch member when at said point.

5. A press as claimed in claim 2, wherein said presser and punch members respectively end with an annular and a circular planar surface generally perpendicular to said axis.

6. A press as claimed in claim 5, further comprising abutment means associated with said presser and punch members for limiting relative displacement thereof to a relative position wherein the end surfaces thereof are substantially flush one with the other.

7. A press as claimed in claim 1, wherein said cylindrical ejector member is stationary and said tubular ejector member is movable.

8. A press as claimed in claim 7, comprising an annular piston fast with said tubular ejector member, an annular cylinder accommodating said piston, and means for supplying hydraulic pressure to said cylinder.

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