

May 9, 1961

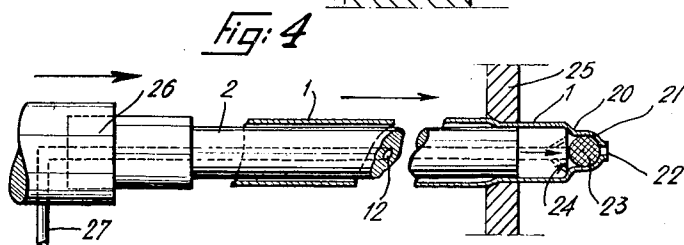
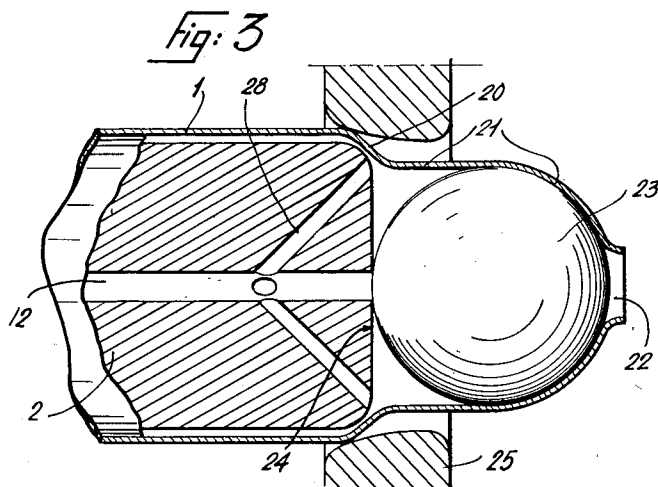
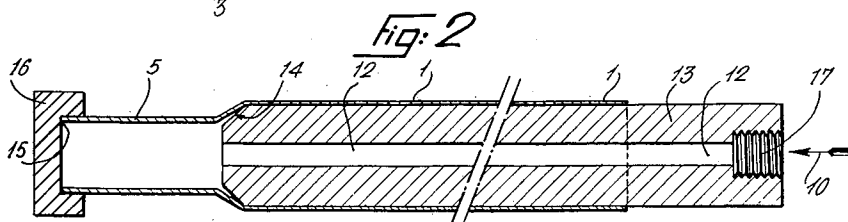
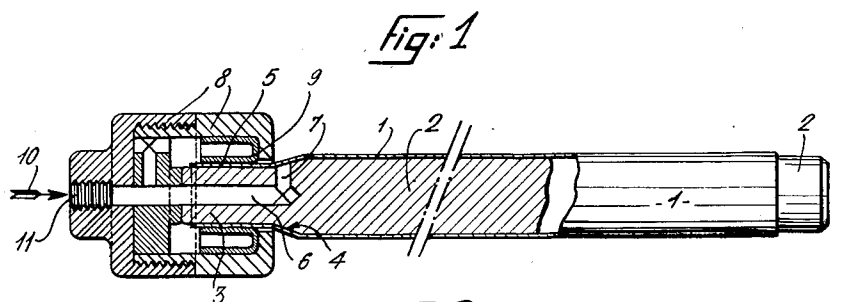
M. PERRET

2,983,366

HYDRAULIC DEVICES FOR REMOVING TUBES DRAWN ON A LONG MANDREL

Filed April 23, 1957

3 Sheets-Sheet 1



Inventor  
 Marcel Perret  
 by *J. Stenning, Davis, Miller & Wade*  
 his attorneys

May 9, 1961

M. PERRET

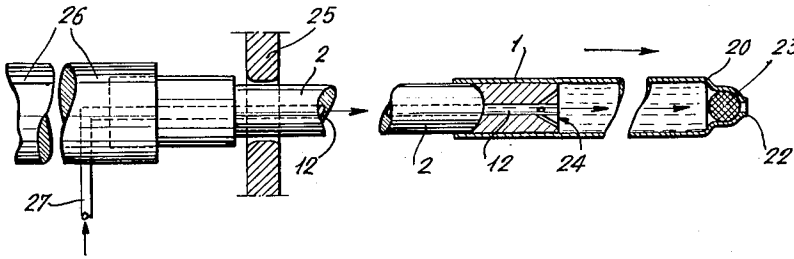
2,983,366

HYDRAULIC DEVICES FOR REMOVING TUBES DRAWN ON A LONG MANDREL

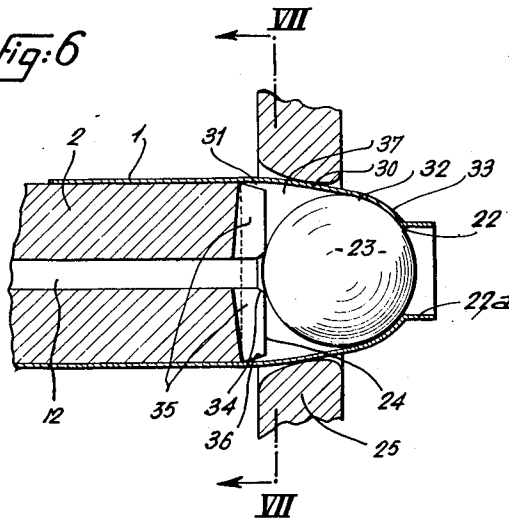
Filed April 23, 1957

3 Sheets-Sheet 2

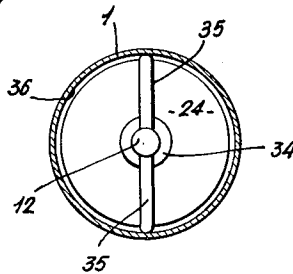
*Fig. 5*



*Fig. 6*



*Fig. 7*



Inventor  
Marcel Perret  
by Stevens, Davis, Miller & Maher  
his attorney

May 9, 1961

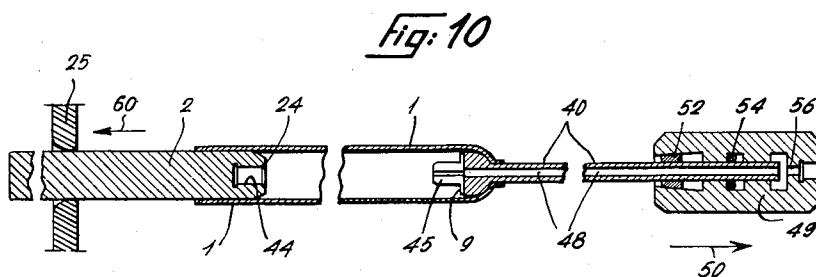
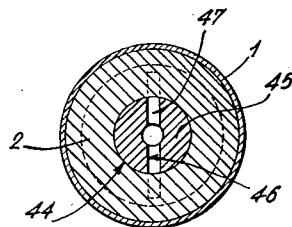
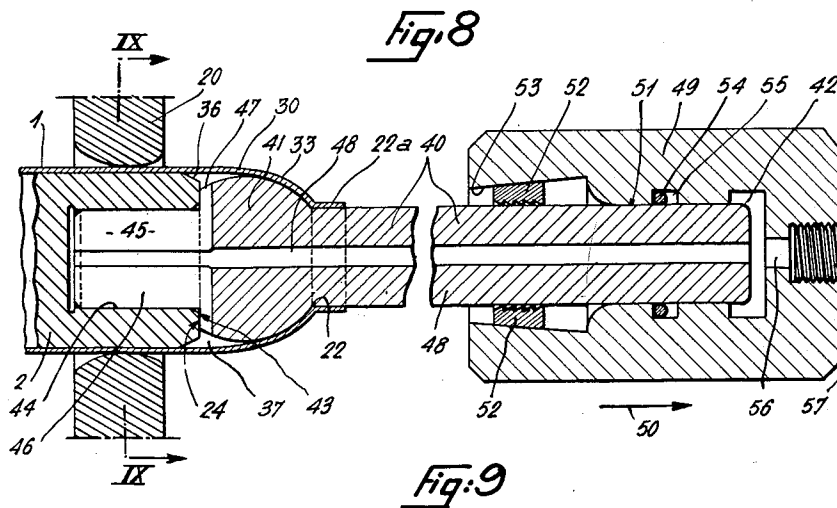
M. PERRET

2,983,366

HYDRAULIC DEVICES FOR REMOVING TUBES DRAWN ON A LONG MANDREL

Filed April 23, 1957

3 Sheets-Sheet 3



Inventor  
 Marcel Perret  
 by Stevens, Davis Miller & Mosher  
 his attorney

1

2,983,366

## HYDRAULIC DEVICES FOR REMOVING TUBES DRAWN ON A LONG MANDREL

Marcel Perret, Saint-Mande, France, assignor to Trefileries  
et Laminoirs de Precision Gilby-Fodor (Societe Anon-  
yme), Rueil-Malmaison, France, a company of France

Filed Apr. 23, 1957, Ser. No. 654,594

Claims priority, application France Apr. 25, 1956

1 Claim. (Cl. 205—7)

It is well known that the drawing of metal tubes with the object of reducing their diameter and wall thickness, or with a view to giving them a section of pre-determined form, is effected by passage through a die, using an internal indeformable mandrel.

Depending on whether this mandrel is fixed or moves with the tube, the drawing processes are respectively termed in the industry "drawing on an oval mandrel" or "drawing on a long mandrel."

The manner of plastic deformation of the metal is different in the two processes, since when drawing over an oval mandrel, internal friction is produced, this being avoided in drawing over a long mandrel by reason of the movement of the mandrel. The result is that, for the same reduction in section, and all other conditions remaining the same, the portion of the tube on the delivery side of the die is subjected during drawing over an oval mandrel to a stress which is substantially greater than that which is encountered in drawing over a long mandrel.

This state of affairs results in limitations in the process of drawing over oval mandrels, amongst others, in the reduction of section per pass, which is smaller than for drawing over long mandrels, and in the case of tubes with thin walls defined by a ratio:

$$K = \frac{\text{external diameter}}{\text{internal diameter}}$$

less than or equal to 1.02, in which tubes the low mechanical strength does not enable them to withstand the higher drawing stresses necessary for drawing over an oval mandrel.

In spite of all this, drawing over oval mandrels is the method most generally adopted for the manufacture of tubes with normal wall thickness, since it gives a high production output, due to the fact that the oval mandrel is automatically disengaged from the interior of the tube at the end of the operation.

The rates of production output are in fact very much lower in the case of drawing over long mandrels, since this process is slowed down by the subsequent operation of removal of the mandrel, which, under the best conditions, requires twice the time needed for the drawing operation proper.

It will be recalled that the operation of removal of the mandrel consists actually in slightly expanding the diameter of the tube by a permanent deformation (the tube having been strongly compressed and remaining closely applied against the mandrel during the previous drawing operation), in order to enable the said mandrel to be extracted later. This operation is usually carried out on machines with rollers of suitable shape which apply to the tube a pressure which produces rolling of the walls, and in consequence a permanent increase in the diameter of the tube, while at the same time the tube-mandrel assembly is driven in rotation so as to detach the tube from its mandrel, in a delivery channel or any appropriate receiving device.

This operation of mechanical removal of the mandrel

2

has a number of drawbacks, amongst which may be mentioned:

(1) The considerable time of operation, to which must be added that required for the extraction of the mandrel;  
(2) The high capital cost of mandrel-extraction machines, and the high cost of grinding their rollers and of maintenance of their feeding and delivery channels;

(3) The limitation of use to round tubes only;

(4) The risk of causing scratches or seizures marks on the outer surface, resulting from defects on the rollers and on the positioning wedge, or from whipping of the mandrel during its rotation in the feed and delivery channels;

(5) The increase in the dimensional tolerances obtained during the drawing operation, which defect has little influence on the wall thickness but has a sufficient effect on the external diameter to necessitate in all cases a subsequent gauging pass on the hollow tube;

(6) The destruction of the base coatings which have been deposited on the bare surface of the metal before drawing in order to improve the adherence and the action of the lubricant employed, the disappearance of this coating being liable to result in bad lubrication during any subsequent gauging or drawing pass which is carried out directly after the operation of extraction of the mandrel.

The present invention is applied to machines for drawing tubes on long mandrels, in which the tube is provided in known manner with a tail at one of its extremities and is tightly engaged on the mandrel at the end of the drawing operation.

In accordance with the present invention, there is provided in machines of this type, a mandrel-extraction device comprising in combination means for closing the tubular tail in a fluid-tight manner, thus forming a chamber, the internal space of which is at least in part inside the tail and communicates with the space comprised between the internal cylindrical wall of the tube and the outer wall of the mandrel, and means for introducing a liquid under pressure into the interior of the said chamber.

Two types of mandrel-extraction devices are envisaged in accordance with the present invention.

In a first type, the closure means surround the tail externally, at a zone having a generally cylindrical shape.

In a second type of mandrel-extraction device, the closure means are essentially disposed inside the tail, at a zone in which the section is becoming smaller in the direction of the free extremity of the tail. A closure member placed inside the tail closes its outer orifice. This closure member is of the autoclave type, since the pressure of the fluid introduced inside the chamber closed by the closure member, the inner wall of the tail and the outer face of the mandrel force the closure member against the inner wall of the tail and thereby increase the sealing effect.

In both types, the fluid may be led inside the chamber by means of a conduit which passes either through the mandrel or through the closure means.

The extraction of the mandrel is effected by means of a diametral elastic swelling of the drawn tube subjected to the action of the fluid under pressure, which swelling becomes progressively propagated from the initial chamber, the fluid under pressure being introduced between the mandrel and the tube in such manner that the tube no longer grips the mandrel and becomes separated from it in a spontaneous manner so that either the mandrel may be ejected from the interior of the tube or the tube may be ejected with respect to the mandrel. The relative movement is similar to that of a piston with respect to its cylinder.

Experience has shown that the minimum pressure of the fluid which produces the initial elastic radial deforma-

tion of the tube can be given to a first approximation by the following formula:

$$P=50E\left(1-\frac{1}{K^2}\right)$$

in which:

- P=the minimum pressure necessary for the elastic expansion of the tube, expressed in kgs./sq. cm.;
- E=the elastic limit of the material drawn, determined under pure tension and expressed in kgs./sq. mm.;
- K=the ratio of the external diameter to the internal diameter.

By way of example, and without any implied limitation, the application of Formula 1 to tubes having an elastic limit of 80 kgs./sq. mm. after drawing gives the following values of pressure:

Dimensions of the drawn tube in mm.

| Internal diam. | External diam. | Wall | K     | P, kgs./sq. cm. |
|----------------|----------------|------|-------|-----------------|
| 102            | 106            | 2    | 1.039 | 290             |
| 102            | 104            | 1    | 1.020 | 150             |
| 102            | 102.8          | 0.4  | 1.008 | 60              |
| 50             | 52             | 1    | 1.040 | 300             |
| 50             | 50.8           | 0.4  | 1.015 | 120             |
| 50             | 50.4           | 0.2  | 1.008 | 60              |
| 30             | 32             | 1    | 1.065 | 470             |
| 30             | 30.8           | 0.4  | 1.026 | 205             |
| 30             | 30.4           | 0.2  | 1.013 | 100             |
| 30             | 30.3           | 0.15 | 1.010 | 75              |
| 12             | 12.8           | 0.4  | 1.067 | 480             |
| 12             | 12.4           | 0.2  | 1.033 | 250             |
| 12             | 12.2           | 0.1  | 1.016 | 125             |

These examples show that the pressures to be employed become smaller, with a constant thickness, as the diameter increases and, with a constant diameter, as the thickness becomes smaller.

These pressures do not reach excessive values and are within the scope of standard types of pumps or pressure multipliers which can be obtained commercially.

The use of a fluid and chemically neutral oil is preferably recommended so as to facilitate the lubrication of the fluid-tight members and to prevent their corrosion, and also in order to facilitate the relative movement of the tube and the mandrel at the moment of extraction of the latter.

The description which follows below with reference to the accompanying drawings (which are given by way of example only and not in any sense by way of limitation) will make it quite clear how the invention may be carried into effect, the special features which are brought out, either in the drawings or in the text, being understood to form a part of the said invention.

Fig. 1 shows in a very diagrammatic form, a first type of mandrel-extraction device in accordance with the invention.

Fig. 2 shows a further form of embodiment of mandrel-extraction device.

Fig. 3 corresponds to a second type of mandrel-extraction device in accordance with the invention and shows very diagrammatically the pointed end of a tube in position on its mandrel, the orifice of the pointed end being internally closed at the moment of introduction of the tube into the die, the tube being actuated during the drawing operation by the mandrel acting under thrust.

Fig. 4 shows diagrammatically the operation of drawing in action with the device shown in Fig. 3.

Fig. 5 shows the phase of hydraulic mandrel-extraction proper when the drawing operation has been completed and the mandrel is stationary at the end of its travel.

Fig. 6 is a view similar to that of Fig. 3, showing a further form of embodiment of the mandrel-extraction device.

Fig. 7 is a cross-section taken along the line VII—VII of Fig. 6, the die being assumed to be removed.

Fig. 8 is a view corresponding to that of Fig. 6 of a further alternative form of embodiment, in which the tube is actuated during the course of drawing by the closure member of the pointed end, acting by tension.

Fig. 9 is a cross-section along the line IX—IX of Fig. 8, with the die removed.

Fig. 10 is a view similar to that of Fig. 8 but to a smaller scale, and showing the phase of hydraulic mandrel-extraction proper, after the completion of the passage of the tube through the die.

In the form of application of the invention shown in Fig. 1, the tube 1 is closely fitted and strongly pressed on the long mandrel 2 at the end of one drawing pass. The mandrel is extended into the corresponding part of the end of the tube by a cylindrical portion 3 of smaller diameter, coupled by a chamfer 4 to the drawn portion 2.

On this portion 3, the tube is formed in a pointed end 5 having a thickness greater than that of the tube on the mandrel 2 and an external diameter less than that of the said tube. The pointed end 5, by virtue of this thickness, does not adhere to the portion 3 by a compression which would give a permanent deformation, and may be subjected to a local gripping action without remaining clamped on to the said portion. The portion 3 of the mandrel corresponding to the pointed end 5 is pierced with a longitudinal channel 6 which terminates by at least one orifice 7 in the region of coupling 4 of the mandrel, for example.

The tube 1 to be extracted from its mandrel is engaged by its pointed end 5 in a hollow head 8 provided with a self-tightening joint shown diagrammatically in the form of a stamped leather 9 engaged around and gripping the pointed end 5. Oil under pressure 10 is supplied to the head 8 through an orifice 11 and this oil is introduced through the channel 6 and the orifices 7 between the mandrel 2 and the tube 1 which it causes to expand elastically, with the result that, since the tube is no longer closely engaged on the mandrel, the latter is then simultaneously driven out by the action of the pressure on its transverse section, and frees the tube without further operation. When the pressure is removed, the head 8 can be separated without difficulty from the pointed end 5.

In Fig. 2, instead of the mandrel being ejected from the tube by the pressure, the mandrel is held fixed during the operation of extraction and it is the tube which is removed by the pressure of oil.

This solution may be considered as more practical in the case of mandrels of a certain diameter, the weight of which is fairly great.

In this alternative form, the mandrel may be either a thick tube with a uniform bore, this being easily produced with special steels, or it may at least be provided over the whole of its length with a passage 12 for the oil. This passage need not necessarily have a machined surface over the whole of its length, and mandrels of this kind, even of small diameters, can be obtained by compression of tubes or by hollow-drawing of thick tubes of larger diameter, for example.

These mandrels 13 may be simply chambered at 14, which part comes, during drawing, into contact with the inner end of the pointed end 5, which is kept fairly thick so as to withstand, when empty, the grip of the dogs on the drawing machine. During drawing, the pointed end 5 is open at its extremity 15 and, before the hydraulic extraction of the mandrel, it is closed by means of a removable cap 16 of any desired type.

The mandrel 13 is connected, for example by a threaded extremity 17 of the passage 12, with the source of hydraulic pressure. This pressure passes into the interior portion of the tail 5, and acts as before to expand the tube and to move it forwards along the fixed mandrel so that it may be freed.

5

The pointed end may also be closed by bringing its edges together, by flattening, welding, etc.

In the devices shown in Figs. 1 and 2, the drawing of the tube through the die is effected by tractive force applied in known manner to the pointed end and/or to the smaller portion of the mandrel inside the pointed end, the hydraulic extraction from the mandrel being effected during the course of a separate operation following the drawing operation proper.

The separation of the operations of drawing and extraction from the mandrel with these devices is effected because of the impossibility of combining in a single head the gripping members for drawing and the fluid-tight sealing members for the mandrel extraction.

On the other hand, the devices shown in Figs. 3 to 10 enable these two operations to be combined, since in this case, the sealing members which are inside the tubes take part in the drawing action applied to the said tubes during the course of the drawing operation.

The forms of embodiment of such devices differ essentially by the method of working of the mandrels which, apart from their function as internal gauges, may act by thrust to draw the tube (see Figs. 3 to 7) or may, on the other hand, be actuated by the tube (see Figs. 8 to 10).

In Fig. 3, the tube before drawing is shown at 1. In accordance with the invention, the tube is reduced to form an offset 20, by means of a compressing machine, for example. This offset 20 is followed, in this example, by a cylindro-spherical portion 21 which terminates axially in an orifice 22 opening into the exterior and reinforced by a dropped edge.

The depth of the cylindro-spherical housing 21 is slightly less than its diameter, so that, at the moment when the mandrel 2 comes into contact with the offset 20, a sphere 23 of rubber or other similar material is pushed by the end 24 of the mandrel and is forced into contact against the base which carries the orifice 22.

This sphere 23 has substantially the same diameter as the interior of the cavity 21. At this moment, the periphery of the offset 20 is engaged in the die 25, and as a result of its forward movement, the mandrel 2, of which the periphery of the end 24 has come into contact with the interior of the offset 20 drives the tube 1 through the die and effects the drawing operation. The offset 20 is able, due to its shape, to withstand the thrust of the mandrel 2 without being deformed, and to transmit this thrust to the tube 1 during its passage through the die, in accordance with known practice.

The mandrel 2 is fixed on the moving portion 26, a jack for example, of the drawing press, on the bed of which is fixed the die 25, this press being of known type and not being shown in the drawing. This mandrel has a channel 12 passing throughout its length, the channel being coupled externally at 27 to a source of liquid under pressure which is controlled so as to admit the liquid after the tube has been drawn by its complete passage through the die (see Fig. 4).

In addition to the central conduit, it is preferable to provide the mandrel with pierced holes such as 28 which open into the central conduit and end close to the offset 20, without being closed thereby, so as to ensure communication of the passage 12 with the cavity.

The pressure of this liquid forces the sphere still more strongly in the cavity 21 and reinforces its closing action at 22. This pressure can thus act effectively for the hydraulic extraction of the tube 1, which is ejected from the mandrel 2 which is freed from it.

The tube is then emptied of liquid, and the sphere 23 is ejected from it by the simple action of compressed air applied through the orifice 22.

During drawing, and before and after the drawing operation, the mandrel remains always fixed on the drawing press, together with all the devices for supporting it and preventing it from buckling, as the case may re-

6

quire. It is thus protected from any handling operation which might result in risk of damage, and it retains an outer surface with a very high degree of polish, resulting in a perfect finish and facilitating the extraction operation.

A same housing profile for the closure member may be employed for a certain range of diameters of tubes, the maximum radius of the offset 20 being the only varying factor as a result of each drawing, over a whole series of passes. A certain economy is thus obtained with respect to the use of ordinary or special pointed ends which are normally employed. The only manipulation of carrying, moving and introduction of pieces is that of the light tubes and this is much simpler than the handling of heavier mandrels, any damage to which would effectively prevent their further use.

While the spherical form of the closure member would appear to be the most satisfactory, any form of housing could of course be employed for carrying out the invention which is adapted to receive a closure device which can be put automatically in position internally, and with which the hydraulic pressure produces an autoclave type of closure: such as conical, cylindro-conical or prismatic plugs in the case of polygonal tubes, or plugs of any section appropriate to that of the tube, which can be drawn in shapes other than cylindrical shapes of revolution, on mandrels and with dies of corresponding shape.

These plugs will be of elastic and deformable material, of a composition which is firm enough to permit of their guiding and easy delivery by the mandrel. In certain cases, they may be of mixed form, having a metal supporting portion for example and an elastic supporting surface for the autoclave closure. In particular, spherical closure valves may be provided with an inner spherical core of steel, covered with a layer of elastic material.

Tests have shown that the use of a plug made entirely of an indeformable material may have certain advantages, especially, in the case of very thin tubes. In order to ensure the maintenance of the plug in position, the most simple expedient is to cause it to be subjected to the thrust of the mandrel. The presence of an offset on the tube is no longer necessary, and this absence of offset avoids the occurrence of the phenomenon known by the term "cuff," and which consists in an excessive cold-rolling of the thicker zone of the offset. Mandrel-extraction devices with rigid plugs are shown in Figs. 6 and 7.

The pointed end of the tube 1 consists of a body of revolution 30, in this case conical over its whole length between its coupling, without any sharp variation, at 31 with the tube 1 and its parallel coupling portion, at 32 where it is tangential with the spherical zone 33 provided with the orifice 22 at the end, which opens into the reduced tubular portion 22a which extends, with an abrupt change in direction, the orifice 22, the latter being thereby strongly reinforced.

In the spherical zone 32 is housed a ball 23 of very hard and perfectly polished steel, in practice a bearing ball, having the same diameter  $d$  as the spherical zone 33 and being subjected to the thrust of the mandrel 2. The ball 23 is automatically centered in the spherical zone 33 and in a conical seating 34 formed in the outer face 24 of the mandrel 2.

In the face 24, a milled transverse slot 35 opens into the chamfer 36 of the extremity of the mandrel, and allows free access of the liquid under pressure which is brought through the mandrel by the passage 12, into the space 37.

The pressure of this liquid enables the hydraulic extraction of the mandrel to be effected in the known manner. The internal diameter of the tube to be drawn being  $D$ , the diameter  $d$  of the ball 23 will remain always in practice between  $D$ , reduced by the quantity necessary for a pre-determined series of successive drawing oper-

ations, and a minimum which will be greater than 80% of the initial diameter  $D$ , which can be expressed:

$$D > d > 0.8D$$

The operation is quite obvious: the pointed end being introduced into the die 25 (see Fig. 6), the ball 23, pushed into the tube and into the pointed end by the mandrel 2, is powerfully applied against the spherical zone 33 and ensures a perfect closure of the orifice 22 while at the same time the thrust of the mandrel applied to the pointed end in this zone 33, is transmitted to the tube 12 by the coupling portion which works under tension. The tube is thus forced through the die 25 by the mandrel 2 and is drawn.

The progressive compression of the portion 31—32 of the pointed end has the result that, after the first pass consecutive to the formation of said end, there is no sharp variation in thickness due to an increase in thickness, as is the case with the abrupt offsets which serve to support the mandrel in the known methods.

The tangential angle of the tube at the moment of initiation of drawing in the die remains practically constant and small during the successive passes with the same pointed end and the same ball, the die and the mandrel being possibly changed a certain number of times. In addition, the progressive nature of this opening phase is accompanied by a chamfer 36 with a fairly small angle. In this way, all cuff effect is avoided, this effect being the cause of ruptures during the course of the hydraulic mandrel extraction which follows each drawing pass of the tube.

When the liquid under pressure is brought at 12 into the space 37—37 for the purpose of mandrel extraction, the ball 23 which closed the orifice 22 by the pressure which it received from the mandrel and which is maintained after passing through the die, by the adherence of the tube on the mandrel, continues to remain in position during the extraction of the mandrel, in the spherical zone 33 by the autoclave effect due to the pressure of the liquid which carries out this mandrel-extraction operation in the known manner.

When the extraction has been completed, after evacuation of the liquid, the ball 23 is pushed back out of the tube which is to be annealed, and is removed in order that it may be re-introduced for the next pass. This ball detaches itself readily and has no tendency to remain stuck by penetration into the open portion 22a. As a last resort, in the case of a coupling with a very small angle which may cause a certain jamming of the ball, the latter may be easily dislodged in this exceptional case by any known means.

The use of a polished ball enables the latter to move inside the tube when it is introduced and removed without causing the slightest scratch in the tube surface.

This device enables very thin tubes to be drawn with a very small percentage of waste during manufacture, in spite of the difficulties of this type of manufacture. Alternative forms of the pointed end, in the manner of constructing the spherical zone and in the machining of the extremity of the mandrel may, of course, be employed in the present device without departing from the scope of the invention.

The pointed end may be made in the form of an elongated section of a cone, open at its small base and coupled to the tube without any offset.

The spherical zone may be formed by the actual forcible introduction of the indeformable ball itself under the thrust of the mandrel, which makes an impression in the said cone until the resistance becomes equal to the force required for passing the tube through the die on the mandrel which drives it.

The spherical zone formed in this way will not progress forwards to any great extent during the following passes, and in practice, slight variations due to this small progression will not have any effect.

In order to avoid any abnormal local stress applied to the ball by the mandrel, there may be an advantage in replacing the conical opening 34 by a hollow spherical opening having the same radius as that of the ball, the communicating passages 35 between the bore 12 and the space 37 remaining of course unclosed when the ball is pressed into the said spherical opening.

Experience has shown that the use of the device shown in Figs. 3 to 7 has limits in the case of tubes of large lengths or of small diameters, by reason of the difficulties of boring the mandrels and the complex arrangements which must be employed to avoid buckling of the said mandrels during the drawing operation.

It should be observed that in the device shown in Figs. 6 and 7, the tractive effort which produces the drawing of the tube is applied to it by the closure member. The mandrel constitutes on the one hand a mechanical coupling member acting by thrust between the closure member and the driving jack, and on the other hand the hydraulic coupling member between the fluid-tight chamber inside the tail and the source of fluid under pressure. The limitations of use referred to above no longer exist if the closure member is driven by a mechanical coupling member acting under tractive force, the mandrel being then simply driven by the tube by the effect of gripping which results from the drawing action. This mechanical coupling member may further constitute a hydraulic coupling member.

A device of this kind is shown in Figs. 8 to 10. As in the case of Figs. 6 and 7, the tube 1 which is to be drawn is terminated by a hollow open pointed end, constituted in known manner by a generally conical coupling 30 between the tube 1 and a spherical zone 33 opening into a circular orifice 22, extended by a tubular reinforcing portion 22a.

Into this pointed end is passed a traction member 40 terminating in a head 41 which is partly spherical with the same radius as the spherical zone 33. This head is extended through the orifice 22 and passes beyond the tubular portion 22a in the form of the body 40, in this case cylindrical, with the angle of its extremity rounded at 42. The part of the head 41 opposite to the body 40 is in this case limited by a flat face 43, perpendicular to the axis of the body 40 in a transverse plane which, when the head 41 is in position, that is to say in contact with the spherical zone 33 of the pointed end, cuts through the conical coupling portion 30 of the said pointed end.

The flat transverse extremity 24 of the mandrel 2 is in contact with this flat face 43. This transverse extremity is chamfered at 36 over a length and at an angle which then permits its free penetration into the commencement of the coupling portion 30 of the tube 1.

In order to effect a strictly coaxial alignment of the mandrel 2 and the tractive member 40, the face 24 of the mandrel is provided with a cylindrical cavity 44 in which is frictionally engaged a cylindrical extension 45 which is split in two halves by a cut 46 milled along a diametral plane, this cut forming in the face 43 of the head 41 a diametral groove 47 opening into the annular space 24 remaining free between this head 41, the extremity of the mandrel 2 and coupling portion 30 of the hollow pointed end.

The tractive member 40, the head 41 and the cylindrical extension 45 have passing through them from one end to the other a bored axial passage 48 which leads the fluid under pressure into the space 24 for the hydraulic extraction of the mandrel, this fluid being, in general, oil.

The mandrel 2 will be provided with the tractive member 40 fitted into its extremity by its portion 45 forced fully into the housing 44 which will be slightly chamfered at its free extremity together with the part 45 in order to facilitate a tight driving fit, without however necessitating any other operation but driving-in by hand.

The mandrel extended in this manner will be forced into the tube 1 (or conversely will be covered by the tube

which is passed over it) before being mounted on the drawing machine, the pointed end in contact in the die 25 through which it passes, and the rod 40 extending beyond and in front of the said pointed end. The extremity of this rod is gripped and fixed in the moving member which will draw the whole assembly in tension through the said die.

In the example shown, the tractive effort is transmitted to the rod 40 by a hollow sleeve 49 actuated for example by the chain of the draw-bench (not shown) in the same way as a conventional type of drawing dog, in the direction of the arrow 50. For that purpose, the hollow sleeve 49 which receives the rod 40 in a bore 51 having a diameter corresponding to that of the rod 40, is provided with mechanical self-clamping fixing means of known type indicated in this case by jaws in the form of toothed wedges 52 displaceable in a conical housing 53 located close to the rear extremity (in the direction of movement 50) of the sleeve 49.

In front of this mechanical actuating clamp, external fluid-tightness around the rod 40 in the bore 51 is effected by means of a usual kind of toric joint 54, housed in a circular groove 55 of the sleeve 49.

At the front, the sleeve is closed and provided with an axial hole 56 which can be coupled through a threaded portion 57 with a flexible conduit (not shown) provided for the supply, in a manner controlled by known means which are therefore not described, of the oil under pressure which passes into the conduit system 48. The pressure of this oil reinforces the tightness of the joint 54 in known manner by an autoclave effect.

The method of operation will be clear: the rod 40 being actuated by the movement of the sleeve 49 in the direction of the arrow 50, forces the tube 1 through the die 25 by the pressure of the head 41 in the spherical zone 33 of the pointed end. The driven tube passes into the die 25 and is drawn between the die and the mandrel 2 which moves with the head 41.

The gripping action of the tube during its passage through the die fixes the tube on the mandrel, which of course accompanies the tube and the head of the extension piece.

The travel of the liquid, generally oil, which is introduced at a regulated pressure so as to effect a freeing action by elastic expansion (thus very limited) of the tube between the mandrel and the tube, is not instantaneous, and its progress along the whole length of the tube would result in a waste of time, if the operator waited until the tube had passed out of the die before admitting the oil at the extraction pressure into the said tube, between the chamfered end of the mandrel, the head 41 and the tube.

As soon as the tube has been drawn over a fairly short length between the mandrel and the die, the oil under pressure is permitted to pass through the extension member.

The length of extension beyond the die will obviously vary, depending on the tube to be drawn, and its is chosen as a result of experience to be as small as possible; in general, this length will be of the order of a decimeter, independently of the length of the tube to be drawn.

The closure, apart from any tractive effort, is maintained by the autoclave effect of the head forced into the pointed end by the extraction pressure, and as soon as the tube has passed out of the die 25, the forward movement of 49 in the direction 50 can be stopped. When the flow of oil between the mandrel and the elastically expanded tube, reaches the extreme portion of the tube, the mandrel 2 will be rapidly ejected towards the rear, in the direction of the arrow 60, through the die 25.

The rod 40 of the tractive member will be separated from the sleeve 49 by means of release of the jaws 52, these means being known and not being shown, and, the pressure of the oil having fallen and its entry at 56 closed, the joint 54 which ensured the fluid-tight seal no

longer offers any resistance to the return movement of the rod 40 which will be pushed into the tube through the tail, to be removed from the rear without difficulty, and without damaging the tube, in which the extension member rests only on smooth and rounded parts.

In the device described, the closure is effected directly by the spherical portion of polished hard steel, engaged in the corresponding housing in the pointed end.

In fact, if this is useful, and this is especially the case in the drawing of tubes having other than circular sections, for which the enlarged portion which constitutes the head is more difficult to accommodate in a concave corresponding coupling in the pointed end, it may be necessary to utilise an elastic portion lining the head of the tractive member so as to ensure a fluid-tight support of this member. The presence of the tension rod 40 which actuates the head through the tubular portion 22 enables practically all extrusion of the elastic lining portion of the head through the opening of the tail to be prevented, by leaving a fairly small clearance between this rod and its passage into the said tubular portion.

This permits of less accurate machining of the head of the tractive member which constitutes a very advantageous feature, in particular in the case of tubes of small dimensions and for tubes of polygonal sections or other than circular form, and thus enables the method of the present invention to be applied to these sections.

Without departing from the scope of the invention, the temporary fixing of the long mandrel to the head of the extension member may be effected by any means other than that shown, and may not be effected before the placing in position of the mandrel and the extension member.

In this case, a simple magnetic grip may be employed, or even a slight thrust applied to the mandrel so as to maintain it in contact with the head at the beginning of its passage through the die.

The tractive member may be brought into position by the thrust of the mandrel and will center itself at the beginning of the passage through the die. The rod of the tractive member, which is generally cylindrical, may very well be provided with transverse grooves or other means, which do not exceed the corresponding diameter of the outlet opening of the tail, for effecting its actuation by tractive effort.

The injection of oil under pressure could in the same way have its inlet independent of the fixing of the rod of the tractive member on the drawing apparatus, the liquid under pressure being admitted through a lateral special coupling, for example to pass into the rod, or axially in front of the rod-actuating member through which the rod then completely passes and is provided with an instantaneous coupling of known type.

By reason of the hydraulic mandrel-extraction device, the tubes produced are tested at the same time for pressure tightness, and those which do not show any leakage (which would furthermore prevent their automatic removal from the mandrel), when the tube is detached over its whole length by the pressure of the liquid producing the extraction, are tubes which are tested and perfectly sound. This represents a very important step in the progress of this technique.

What I claim is:

In a machine for drawing tubes comprising a die and an elongated mandrel adapted to cooperate with said die for drawing a tube disposed over said mandrel and said tube having a pointed end, the combination of a spherical zone in said pointed end, a closure member located within said tube in simultaneous abutting relation both with the mandrel and said zone and formed to define a clearance space while in said abutting relation between said closure member and mandrel, said closure member having a spherical abutment surface corresponding with said zone, and means for introducing a liquid under pressure into said clearance zone between said mandrel and said member, said closure member being a spherical ball, said

**11**

last named means including a plurality of radial passages provided in said mandrel and a longitudinal bore provided in said mandrel in communication with said radial passages, said radial passages opening into said clearance space, said ball being releaseably secured in said clearance space, said ball being releaseably secured in said tube between the end walls of said tube and the end of said mandrel whereby upon removal of said mandrel said ball can be removed from said tube and may be reused in subsequent drawing operations.

10

**12****References Cited in the file of this patent****UNITED STATES PATENTS**

|           |              |               |
|-----------|--------------|---------------|
| 1,273,163 | Ellis        | July 20, 1918 |
| 2,126,814 | Rest         | Aug. 16, 1938 |
| 2,155,437 | Moore et al. | Apr. 25, 1939 |
| 2,361,026 | Greene       | Oct. 24, 1944 |
| 2,720,691 | Kuniholm     | Oct. 18, 1955 |