(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 623 408 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number : **94103040.5**

(22) Date of filing : **01.03.94**

(51) Int. Cl.[5] : **B21K 1/76,** B21K 27/04, B21J 5/08

(30) Priority : **05.03.93 IT TO930157**

(43) Date of publication of application : **09.11.94 Bulletin 94/45**

(84) Designated Contracting States : **DE ES FR GB**

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(54) Method and apparatus for manufacturing a metal element.

(57) A method for the manufacture of a metal element (2) for a joint, the metal element (2) having a head (3) for coupling with a body of the joint and a shank (4) integral with the head (3) and having a blind hole (11) for positive engagement by a control member for the metal element (2) ; the method including the steps of producing a substantially cylindrical piece (17) of metal, of permanently cold deforming a first end portion (50) of the piece (17) by means of at least one first forming assembly (23, 24, 25) so as to form the head (3) and of cold extruding a second end portion (80) of the piece (17) so as to form the shank (4) and the blind axial hole (11) by means of at least one second forming assembly (26, 27).

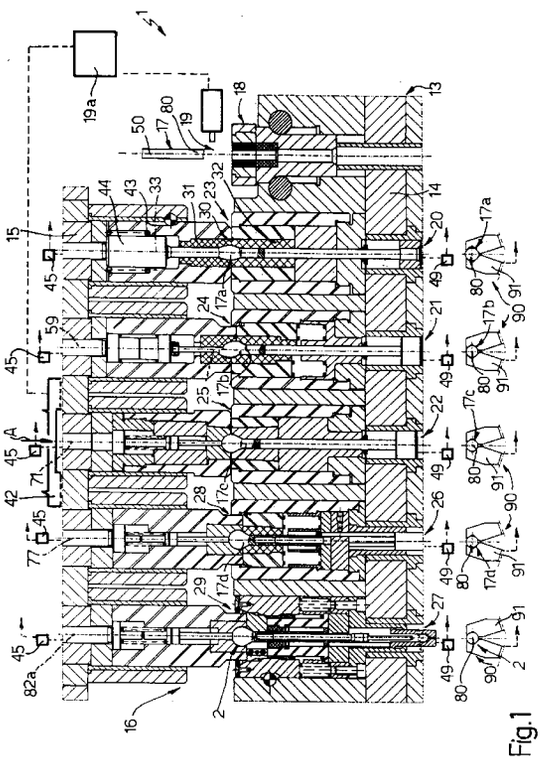

Fig.1

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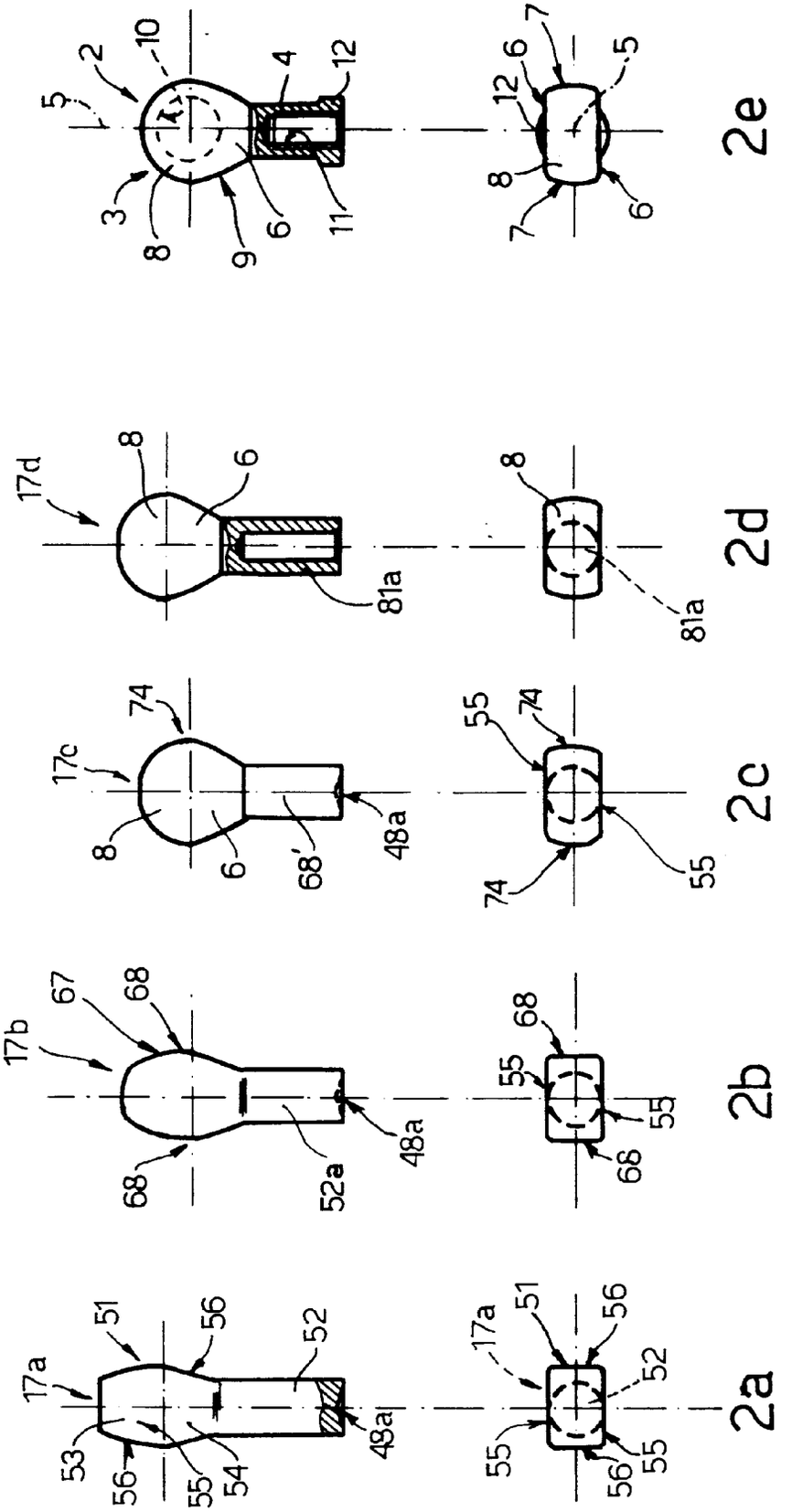
Fig. 2



The present invention relates to a method for the manufacture of a metal element for a joint, in particular for a ball joint.

The present invention may be applied to advantage, but not exclusively, to the manufacture of a metal element of the type intended to be connected to one end of a drive rod and which includes a head with a seat for receiving a portion of another element of the ball joint and a shank which is usually cylindrical and is integral with the head. The shank generally has a blind hole which extends from the opposite end of the shank from the head and is adapted for positive engagement by the end portion of an associated drive rod.

Normally, the joint element described above is manufactured mechanically, by machine-shaving from a rod, preferably a circular-section rod. However, this method of manufacture is extremely expensive, a fact which is not of negligible importance in the case of large scale production. In fact, during this machine-shaving, a considerable quantity of material is not used as it forms the shavings, which are very expensive to recover. Furthermore the manufacturing process described above requires the use of a considerable number of machine tools assembled in work stations which, in addition to being relatively expensive in themselves, carry not inconsiderable operating and maintenance costs which noticeably increase the unit cost of the manufactured joint.

Alternatively, the joint element described above is manufactured by a series of operations including a first working process constituted by permanent hot deformation, in which a semifinished product is formed from a piece of rod and has a geometry similar to that of the piece to be manufactured, and a second operation involving the removal of shavings.

This manufacturing process is highly unsatisfactory as it places a ceiling on the production rate. In fact, the manufacturing process described above requires considerable time to heat the pieces of rod to the working temperature, as well as particular technical arrangements for preserving the material's initial characteristics substantially unaltered. In addition, the various operations carried out on the piece of rod require the use of special handling equipment as the rod is at different temperatures in the different steps of the working cycle.

The object of the present invention is to provide a method for the manufacture of a metal element for a joint which overcomes the disadvantages described above simply and economically.

The present invention provides a method for the manufacture of a metal element for a joint, particularly a ball joint, this metal element including a head and a shank integral with the head and defining its own axis, the shank having a blind hole coaxial with this axis for positive engagement by a drive member for the metal element; the method being characterised in that it includes the steps of producing a substantially cylindrical piece of metal, of permanently cold deforming a first end portion of the piece by first forming means so as to form the head, and of cold extruding a second end portion of the piece so as to form the shank and the axial hole by second forming means.

The present invention also relates to a plant for the manufacture of a metal element for a joint, particularly for a ball joint.

The present invention provides a plant for the manufacture of a metal element for a joint, particularly a ball joint, the metal element including a head and an integral shank defining its own first axis, the shank having a blind hole coaxial with the first axis and adapted for positive engagement by a drive member for the metal element; the plant being characterised in that it includes cutting means for producing a substantially cylindrical piece of metal, first forming means for the permanent cold deformation of a first end portion of the piece so as to form the head, and second forming means for the cold extrusion of a second end portion of the piece to form the shank and the axial blind hole.

The invention will now be described with reference to the appended drawings which illustrate one, non-limitative embodiment, and in which:

Figure 1 is a sectioned side elevation of a preferred embodiment of the plant for the manufacture of a metal element for a ball joint according to the present invention;

Figure 2 shows the metal element at successive stages of its forming; and

Figures 3 to 7 show various details of Figure 1 in section and on an enlarged scale.

In Figure 1, a plant is generally indicated 1 for the manufacture of a metal element 2 (Figure 2e) designed to form part of a ball joint (not shown) and to be coupled to a drive member, preferably a motor-driven rod (not shown).

As illustrated particularly in Figure 2e, the element 2 includes a head 3 and a cylindrical shank 4 integral with the head 3 and defining its own axis 5. The head 3 has two flat side faces 6, parallel to each other and to the axis 5 and spaced by a distance substantially equal to the diameter of the shank 4, and two further convex side faces 7 which are symmetrical about a plane perpendicular to the faces 6 and containing the axis 5. The head 3 has a central seat 10 which is preferably cylindrical and is defined by two portions 8 and 9, of which the portion 8 is substantially a portion of a spherical cap with a cross-section transverse the axis 5 which is substantially rectangular. The portion 9, on the other hand, is substantially frustoconical with its larger base, also substantially rectangular, coincident with a base of the portion 8.

The shank 4 extends from the smaller base of the portion 9 and has a blind hole 11 which extends coaxially of the axis 5 from the end of the shank opposite

the head 3 and is threaded to enable the element 2 to be engaged, in use, with a threaded end of a drive rod (not shown). The shank 4 also has a circumferential rib or flange 12 around a free end portion of the shank itself.

As seen in Figure 1, the plant 1 includes a support frame 13 which in turn includes a fixed, flat bottom plate 14, which forms a base for the plant 1 itself, and a movable upper plate 15 which is parallel to and spaced from the plate 14 and defines with the latter a space 16 of varying size which houses a plurality of presses for manufacturing the element 2. In particular, the element 2 is formed from a cylindrical piece 17 of ferrous material, preferably lead-bearing steel or, alternatively, manganese-silicon steel, cut from a reel of rod (not shown) by means of a known cutting assembly, illustrated schematically, which is arranged in a cutting station 19 and controlled by a known control unit 19a.

Still with reference to Figure 1, the plant 1 includes, in addition to the cutting station 19, three cold press assemblies 20, 21 and 22 arranged in the space 16 alongside each other and adjacent the station 19 and comprising respective forming stations 23, 24 and 25 for forming the head under the control of the control unit 19a.

The plant 1 also includes two further cold press assemblies 26 and 27 which are also housed alongside each other in the space 16 and are controlled by the control unit 19a and comprise, respectively, an extrusion station 28 at which the hole 11 is formed and an upsetting station 29 at which the flange 12 is formed.

With reference to Figures 1 and 3, the assembly 20 includes a press 30 which in turn includes an upper die 31 and a lower die 32 which are aligned on a vertical axis 33, the lower die 32 being a button die coupled to a support body 34 (Figure 3) and securely fixed to the lower plate 14, and the upper die 31 being a movable punch. When closed, the dies 31 and 32 define a cavity 35 which communicates with the exterior through two cylindrical ducts 36 and 37 formed, respectively, in the die 31 and the die 32 in positions coaxial with the axis 33 and each having a diameter slightly greater than that of the piece 17. The cavity 35 is defined by two flat side faces 38, parallel to each other and to the axis 33 and spaced by a distance substantially equal to the diameter of the ducts 36 and 37. The cavity 35 is further defined by two convex side faces 39 which are symmetrical about a plane perpendicular to the faces 38 and containing the axis 33.

The upper die 31 is carried by a tubular support body 40 which is slidable axially in a tubular guide body 41 which is securely fixed to the plate 15 which is movable towards and away from the plate 14 along a line A parallel to the axis 33 so as to move the upper die 31 towards and away from the lower die 32 under the action of a known actuator 42, preferably a mechanical actuator, controlled by the control unit 19a. The support body 40 houses a compression spring 43 interposed between the body 40 itself and the body 41, and houses a cylindrical body 44 which is movable along the axis 33 under the action of a mechanical actuator 45 and carries a cylindrical punch 46 securely fixed thereto. This latter has a diameter slightly smaller than that of the duct 36 and is slidable axially in the duct 36 itself and in holes formed in the plate 15 and the body 41.

Finally, the assembly 20 includes a piercing punch 47 which extends coaxially of the axis 33 and is slidable in the duct 37 and holes formed in the plate 14 and the body 34. The pointed punch 47 ends in a pointed tip 48 coaxial with the axis 33 and is movable along this axis 33 relative to the lower die 32 between a withdrawn position (Figures 1 and 3) and an extended position, not shown, under the action of a mechanical actuator 49.

The press 30 enables a first end portion 50 (Figure 1) of the piece 17 to be permanently cold formed, thus providing a semifinished piece 17a, shown in Figure 2a, which includes an elongate head 51 and a cylindrical shank 52 with a diameter substantially equal to the diameter of the piece 17 and having a tapered centring hole 48a formed by the tip 48. The head 51 includes a first portion 53 and a second portion 54, each being shaped substantially like a truncated pyramid with a substantially rectangular base (Figure 2a). The larger bases of the portions 53 and 54 coincide and the smaller base of the portion 54 is connected to the shank 52. The head 51 has two parallel flat side faces 55 spaced by a distance substantially equal to the diameter of the shank 52 and two convex side faces 56 which are symmetrical about a plane perpendicular to the faces 55 and containing the axis of the shank 52.

Still with reference to Figure 1 and, in particular, to Figure 4, the assembly 21 enables the head 51 to be worked further and differs from the assembly 20 only in a few structural details. In the following description, the component parts of the assembly 21 are indicated, where possible, by the same reference numbers as those used for the corresponding parts of the assembly 20.

As best shown in Figure 4, the assembly 21 differs from the assembly 20 in that it includes an upper die 57 and a lower die 58 aligned on an axis 59 parallel to the axis 33 and differing from the dies 31 and 32 in that they define a cavity 60 which differs, in turn, from the cavity 35 only in that it is defined, as well as by the side faces 38, by two side faces 61 each of which is more curved than the faces 39.

Still with reference to Figures 1 and 4, the assembly 21 also differs from the assembly 20 in that the upper die 57 is carried by an associated tubular support body 62 which is securely fixed to the plate 15 and houses two bodies 63 aligned along the axis 59

with a compression spring 64 acting between them.

As to the die 58, this is carried by a body 65 which is coupled to its guide body 34 for sliding along the axis 59 with the interposition of a pair of springs 66.

The semifinished piece 17a is transformed in the assembly 21 into a semifinished piece 17b, shown in Figure 2b, which differs from the semifinished piece 17a in that its head has respective faces 68 which are substantially more curved than the faces 56 of the semifinished piece 17a. The semifinished piece 17b also has a shank 52a which is shorter than the shank 52.

Still with reference to Figure 1 and, in particular, to Figure 5, the assembly 22 is similar to the assembly 21 and its constituent parts are indicated, where possible, by the same reference numbers as the corresponding parts of the assembly 21. In particular, the assembly 22 differs from the assembly 21 in that it includes an upper die 69 and a lower die 70 which are aligned on an axis 71 parallel to the axis 33 and which form a cavity 72 which differs from the cavity 60 only in that it is defined, as well as by the side faces 38, by two concave side faces 73 which are substantially symmetrical about a plane perpendicular to the faces 38 and containing the axis 71 and each of which is more curved than the faces 61 and includes a spherical portion.

In the assembly 22 it is possible to work the head 67 of the semifinished piece 17b further so as to obtain a semifinished piece 17c, shown in Figure 2c, which differs from the semifinished piece 17b in that it has a head 74 of substantially the same shape and dimensions as the head 3 of the element 2 and a shank 68' substantially the same as the shank 52a.

Still with reference to Figure 1 and, in particular, to Figure 6, the assembly 26 is substantially the same as the assembly 22 and its constituent parts are indicated by the same reference numbers as the corresponding parts of the assembly 22. The assembly 26 is an upsetting extrusion assembly which enables the hole 11 to be formed in a second end portion 80 of the piece 17, opposite the first portion 50 (see Figure 1) and forming part of the shank 4, and includes an upper die 75 and a lower die 76 which are aligned on an axis 77 parallel to the axis 33 and are substantially the same as the dies 69 and 70. The assembly 26 differs from the assembly 22 in that the lower die 76 is coupled to the plate 14 so as to be slidable along the axis 77 with the interposition of a pair of springs 78 and the pointed punch 47 associated with the dies 32, 58 and 70 is replaced by a pointed punch 79 which has a diameter substantially equal to the diameter of the hole 11 and extends through a bush 79a, an upper portion of which partly engages the duct 37 and a lower, end portion of which bears on a shoulder carried by the plate 14.

With the extrusion assembly 26 it is possible to work only the portion 80, thereby obtaining a further semifinished piece 17d, shown in Figure 2d, which has a bored shank 81a longer than the shank 4.

The rib or flange 12 of the element 2 on the shank 4 may be formed by the assembly 27, shown in Figure 7, which differs from the assembly 26 only in a few structural details and includes, in particular, an upper die 81, substantially the same as the die 75, and a lower die 82, aligned on an axis 82a parallel to the axis 77. The die 82 comprises two portions 83 and 84, the portion 83 being a button die with a cavity 85 shaped to complement the flange 12, and the portion 84 being an annular body interposed between the die 83 and the upper die 81 so as partly to close the cavity 85. In particular, the annular body defining the portion 84 is divided into three sectors 86 which are interconnected in known manner and include respective reference and guide appendages each of which engages a respective guide 88 for axial sliding movement. The guides 88 are formed in a body 88a coupled to the respective body 34 so as to be slidable axially and to the plate 14 with the interposition of a pair of springs 89. The pointed punch 79 associated with the assembly 27 extends through the portion 83 of the die 82 and through the associated bush 79a and is loaded by a spring 93 interposed between a shoulder of the punch 79 and a flat wall of a drive cylinder controlled by the actuator 49.

Still with reference to Figure 1, the plant finally includes a known handling device 90 for simultaneously transferring the semifinished pieces 17a, 17b, 17c and 17d from one machining station to the next. In particular, the device 90 includes, for each assembly 20, 21, 22, 26 & 27, a pair of jaws 91 which can couple positively with the portion 80 of a semifinished piece and a known unit, not shown, for controlling the jaws 91.

The operation of the plant 1 will now be described with reference to only one piece 17, starting from the condition in which the plate 15 is in its raised position so that the dies in each assembly 20, 21, 22, 26 and 27 are arranged in their open positions, the pointed punches 47 of the assemblies 20, 21 and 22 and the bushes 79a are arranged in advanced, reference positions in which they each engage a respective duct, and in which the pointed punch 79 of the assembly 26 is withdrawn into a position disengaged from its lower die 76, the pointed punch 79 of the assembly 27 is extended into an advanced position under the action of the spring 93, the punches 46 of the assemblies 20 and 21 each extend through a respective duct 36 and the jaws 91 are arranged in their open positions.

Starting from this condition, the metal rod wound on the reel (not shown) is cut by the cutting assembly 18 to form the piece 17 which is then placed in the die 32 against the pointed punch 47. The actuator 42 is then actuated to move the plate 15 towards the plate 14. During the advancing of the plate 15, the die 31 is positioned against the surface of the die 23 to de-

fine the cavity 35 and moves backwards relative to the plate 15 against the action of the spring 43. Also during the advance of the plate 15, the portion 50 of the piece 17 is deformed progressively between the punch 46 which bears against the plate 15 and the pointed punch 47, and the pointed tip 48 punches into the end face of the portion 80 of the piece 17. At the end of this operation, which forms the semifinished piece 17a, the actuator 42 is reactivated and moves the plate 15 in the opposite direction from the previous one, separating the dies 31 and 32 again, while the actuator 49 is activated to force the semifinished piece 17a out of the duct 37 by means of the pointed punch 47. At this point, the device 90 is activated and the appropriate pair of jaws 91 lifts the semifinished product 17a and moves it onto the axis 59 of the dies 57 and 58. The actuator 42 is then activated again and moves the plate 15 and the punch 46, which initially projected, back again, this latter causing the face 38 to be inserted into the die 57 under the action of the spring 64. At the same time, the plate 15 moves the die 57 against the die 58 which is supported by the spring 66, so as to define the cavity 60 in which the semifinished piece 17a is further deformed by the punch 47 to give the semifinished piece 17b. The semifinished piece 17b is then removed from the dies 57 and 58, by the same steps as those described for the dies 31 and 32, and is moved onto the axis 71 between the two dies 69 and 70 after which, again in the way described earlier, the die 69 is moved towards the die 70 and the semifinished piece 17b is deformed so as to form the further semifinished piece 17c.

At the end of this operation, the die 69 is moved away from the die 70 and the semifinished piece 17c is removed and transferred to the subsequent assembly 26 by means of the steps described above after which the semifinished piece 17c is held between the dies 75 and 76 and, as a result of a new advance of the plate 15, the fixed pointed punch 79 penetrates the shank 68' of the semifinished piece 17c, forming the hole 11 by extrusion and thereby lengthening the shank 68' and forming the semifinished piece 17d.

At this point, the semifinished piece 17d is transferred to the assembly 27 and arranged coaxially of the axis 82a and then, following the advance of the plate 15, the sprung punch 46 pushes the semifinished piece 17d towards the plate 14 until the pointed punch 79 has completely engaged the hole formed in the shank 81a and is thus able to support this semifinished piece 17d. As a result of a further advance of the plate 15, the die 81 pushes the three sectors 86, which tighten radially around the shank 81a of the semifinished piece 17d and, at the same time, advances both the body 88a supported by the springs 89 and the semifinished piece 17d, the free end of which is first positioned against an end wall of the cavity 85 and is then progressively deformed into this cavity 85 so as to form the flange 12.

At the end of this operation, the dies 81 and 82 are moved apart once again and the finished element 2 is removed from the die 82, after which the seat 10 is formed by machine-shaving.

Under normal operating conditions, at each withdrawal of the plate 15 the jaws 91 move one semifinished piece from one assembly to the next and hence one element 2 is obtained after each withdrawal of this plate.

In a variant which is not illustrated, the plate 15 is replaced by a fixed plate and the dies 31, 57, 69, 75 and 81 are moved by a plurality of independent actuators controlled by the control unit 19a and connected to the fixed plate.

It is clear from the above that the method described not only significantly reduces the production costs of the elements 2 as it eliminates any waste of material during manufacture but, at the same time, it increases the rate of production of the elements 2.

As to the plant 1, on the other hand, this is of relatively simple construction and is extremely reliable in operation. In particular, it does not require complicated setting or maintenance operations while having the characteristic of being extremely compact and thus requiring relatively little space.

Finally, it is clear that alterations and variations may be made both to the method and to the plant 1 described without departing from the protective scope of the present invention. In particular, the head 3 of the element 2 may be manufactured in only two forming operations or even, if materials are used which are relatively easily cold-formed, in a single operation in which the piece 17 is formed straight into the final shape of the head 3. In the same way, the piercing of the piece 17 to form the hole 11, and the formation of the rib or flange 12 may be carried out in a single operation.

Claims

1. A method for the manufacture of a metal element (2) for a joint, in particular a ball joint, the metal element (2) comprising a head (3) and a shank (4) integral with the head (3) and defining its own axis (5), the shank (4) having a blind hole (11) coaxial with this axis (5) for positive engagement by a drive member for the metal element (2); the method being characterised in that it includes the steps of producing a substantially cylindrical piece (17) of metal, of permanently cold deforming a first end portion (50) of the piece (17) by first forming means (20, 21, 22) so as to form the head (3), and of cold extruding a second end portion (80) of the piece (17) so as to form the shank (4) and the axial hole (11) by second forming means (26).

2. A method according to Claim 1, characterised in that the step of cold forming the first end portion (50) of the piece (17) includes at least a first operation in which the first end portion (50) is deformed so as to obtain a first intermediate portion (6) of substantially frustoconical shape with a substantially rectangular base and a second portion (8) shaped substantially like a portion of a spherical cap, the first portion (6) and the second portion (8) having respective larger bases which are coincident and having a first pair of parallel flat side faces (6) and a second pair of convexly curved side faces (9).

3. A method according to Claim 2, characterised in that the step of cold deforming the first end portion (50) of the piece (17) also includes a second forming operation, anteceding the said first forming operation, in which the first end portion (50) of the piece (17) is deformed so as to obtain a third portion (53) and a fourth portion (54) of substantially frustoconical shape with a pair of flat parallel side faces (55) and a further pair of convex side faces (68), each having a different curvature from that of the said second convexly curved faces (9).

4. A method according to Claim 3, characterised in that the step of cold deforming the first end portion (50) of the piece (17) further includes a third forming operation, anteceding the said second forming operation, in which the further faces (68) again have a different curvature from that imposed by the second forming operation.

5. A method according to any one of the preceding Claims, characterised in that it includes a punching step, the punching being carried out on a free end surface of the second end portion (80) before the cold extrusion step.

6. A method according to any one of the preceding Claims, characterised in that it includes a step of upsetting the second end portion (80); this upsetting step being carried out after the cold extrusion step.

7. A method according to any one of the preceding Claims, characterised in that a seat (10) is formed in the formed head (3); this seat (10) being formed by machine-shaving and being adapted for positive engagement by the body of the joint.

8. A plant (1) for the manufacture of a metal element (2) for a joint, in particular for a ball joint, this metal element (2) including a head (3) and a shank (4) integral with the head (3) and defining its own first axis (5), the shank (4) having a blind hole (11) coaxial with the first axis (5) and adapted for positive engagement by a drive member for the metal element (2); the plant (1) being characterised in that it includes cutting means (18) for cutting off a substantially cylindrical piece (17) of metal, first forming means (20, 21, 22) for cold deforming a first end portion (50) of the piece (17) so as to form the head (3) and second forming means (26) for cold extruding a second end portion (80) of the piece (17) so as to form the shank (4) and the axial blind hole (11).

9. A plant according to Claim 8, characterised in that the first forming means include at least one first forming assembly (22) and the second forming means include at least one second forming assembly (26), first handling means (90) being provided for moving the piece (17) between the forming assemblies (22) (26;27).

10. A plant according to Claim 9, characterised in that the first forming assembly (22) includes a first die (69) and a second die (70) aligned with a second axis (71), and second drive means (15, 42) for moving the dies (69, 70) relative to each other; the dies (69, 70) forming between them a first cavity (72) defined by a first pair of flat faces (38) parallel to each other and to the second axis (71) and a second pair of concave faces (73), and including at least one second cavity (36, 37) communicating with the first cavity (72).

11. A plant according to Claim 10, characterised in that the second curved faces are substantially symmetrical about a plane perpendicular to the first faces (38) and parallel to the second axis (71) and in that the second cavity (36, 37) is a cylindrical cavity coaxial with the second axis (71).

12. A plant according to Claim 10 or Claim 11, characterised in that the first forming means (20, 21, 22) also include a third forming assembly (21); the third forming assembly (21) including further dies (57, 58) which form a third cavity (60) defined by a pair of parallel flat faces (38) and by third concave faces (61) which have different curvatures from the second curved faces (73).

13. A plant according to Claim 12, characterised in that the first forming means (20, 21, 22) further include a fourth forming assembly (20); this fourth forming assembly (20) including further dies (31, 32) which form a fourth cavity (35) defined by a pair of parallel flat faces (38) and by fourth concave faces (39) which have different curvatures from the third curved faces (61).

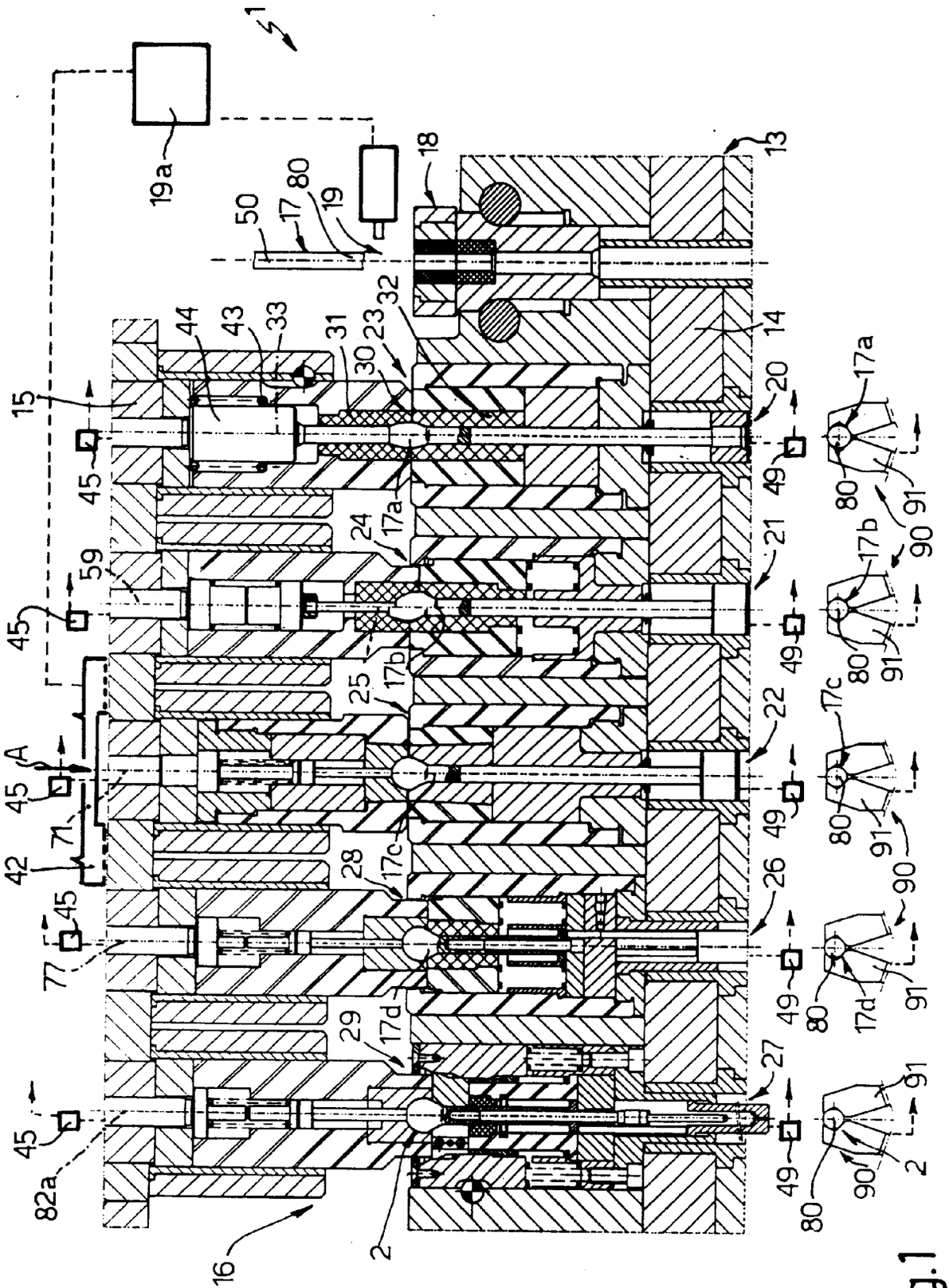
14. A plant according to Claim 13, characterised in

that it includes extractor means (47) associated with the dies (31, 32) (57, 58) for extracting the piece (17) deformed by the dies (31, 32) (57, 58) themselves.

15. A plant according to any one of the preceding Claims 8 to 14, characterised in that it includes punch means (48) associated with any one of the first forming means (20, 21, 22) and the second forming means (26, 27) for punching the second end portion (80) of the piece (17).

16. A plant according to any one of the preceding Claims, characterised in that it further includes an upsetting assembly (27) for permanently cold deforming an end portion of the shank (4).

17. A plant according to any one of the preceding Claims, characterised in that the first forming means (20, 21, 22) and the second forming means (26) are supported on a common base alongside each other.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17b
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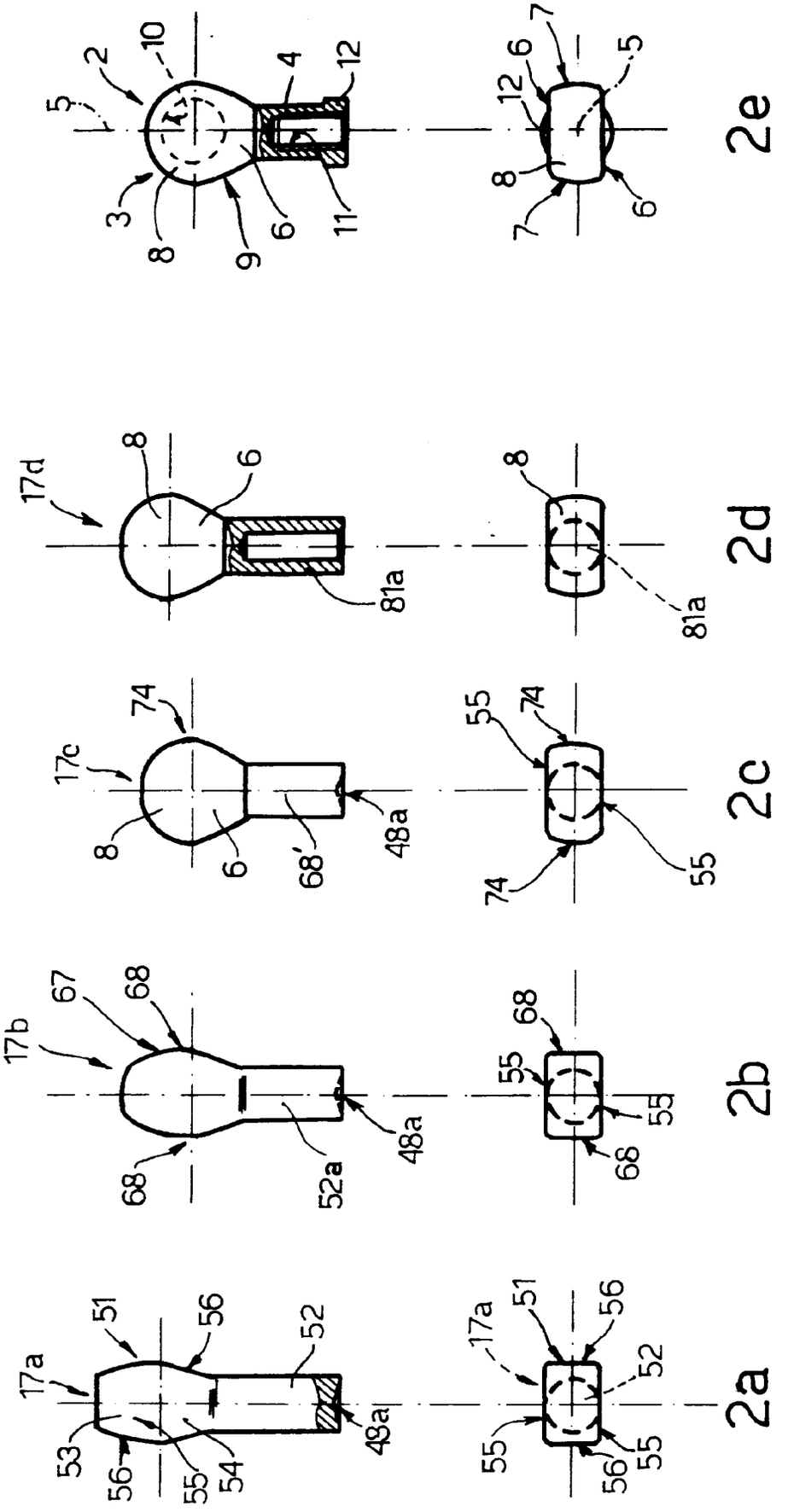
Fig.1

Fig. 2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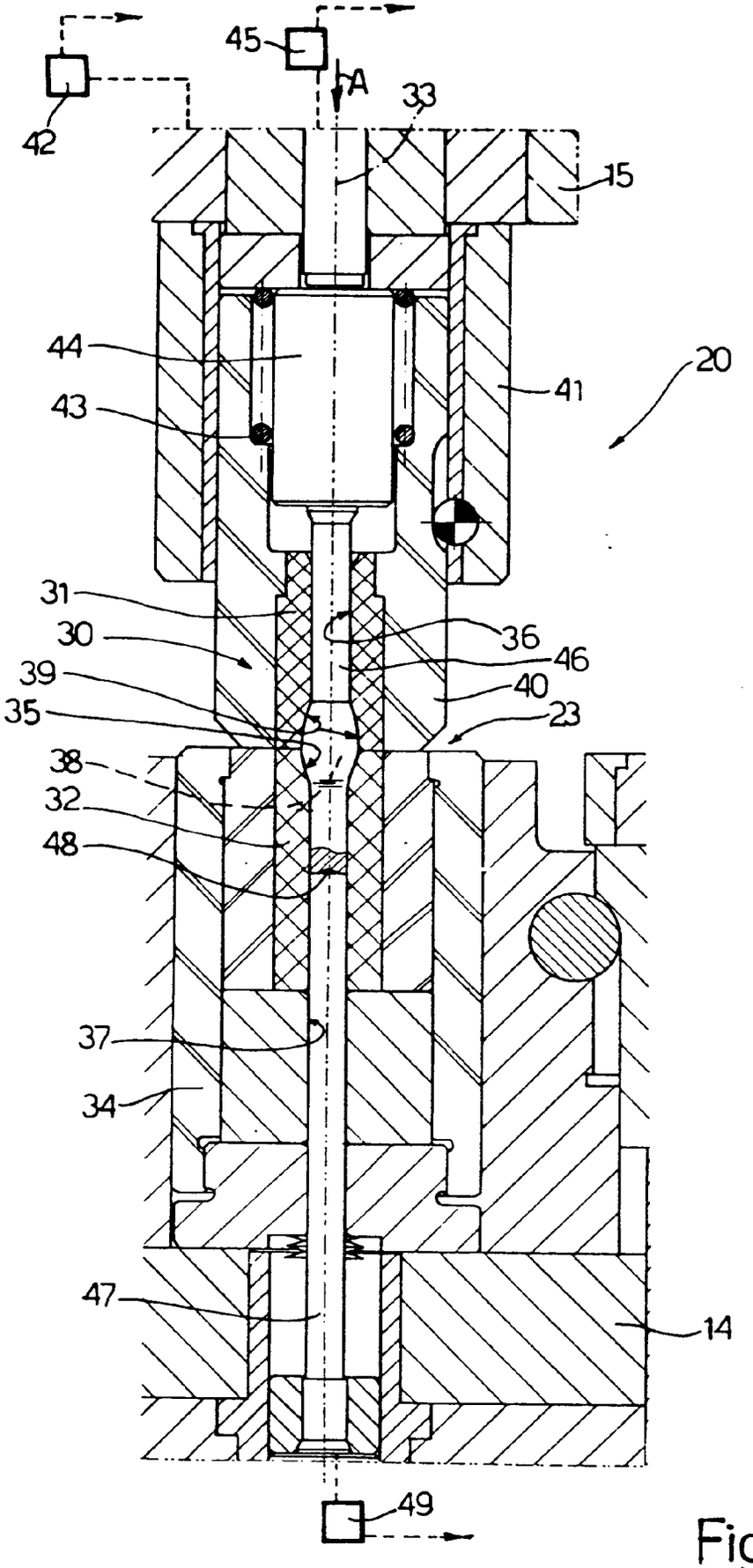

Fig. 3

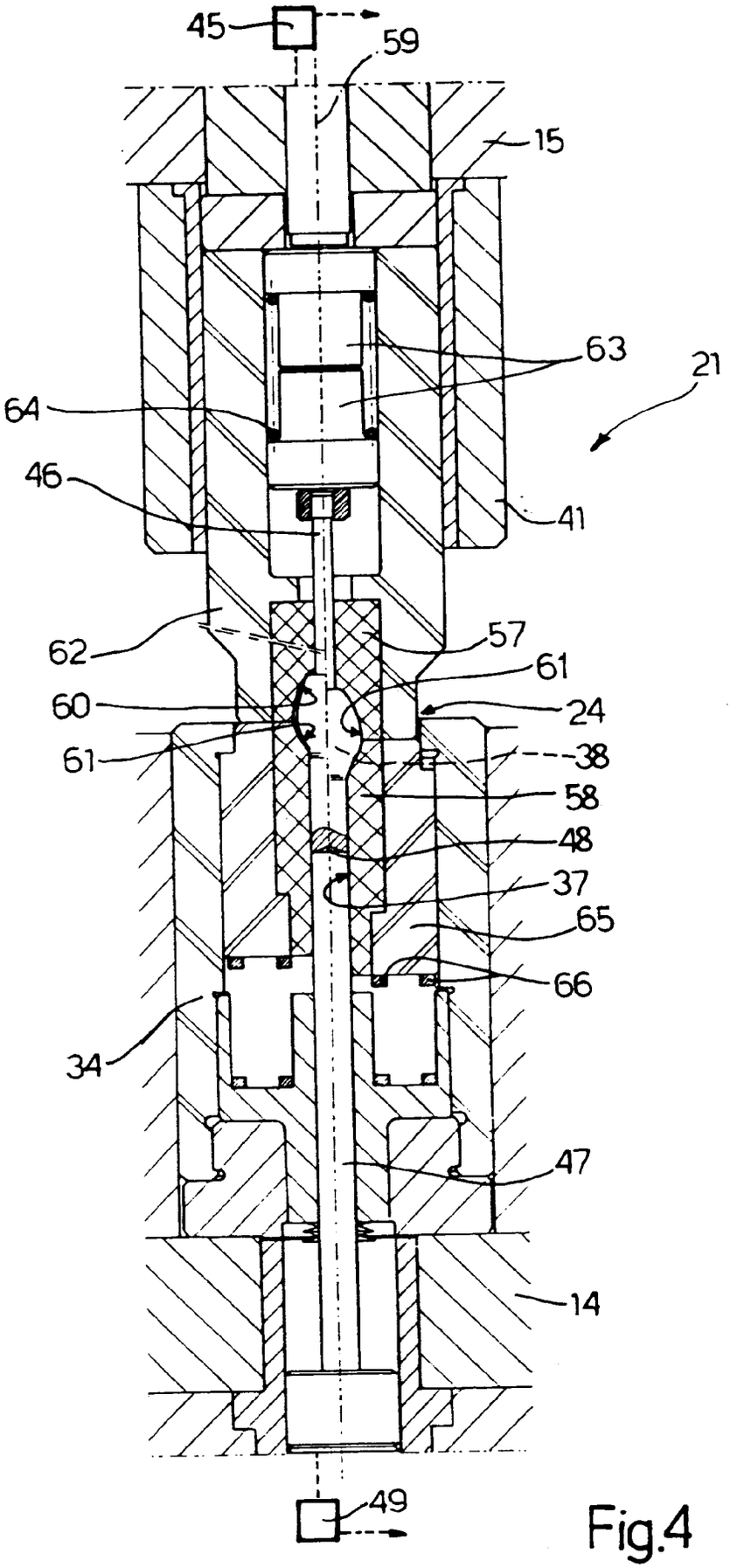

Fig.4

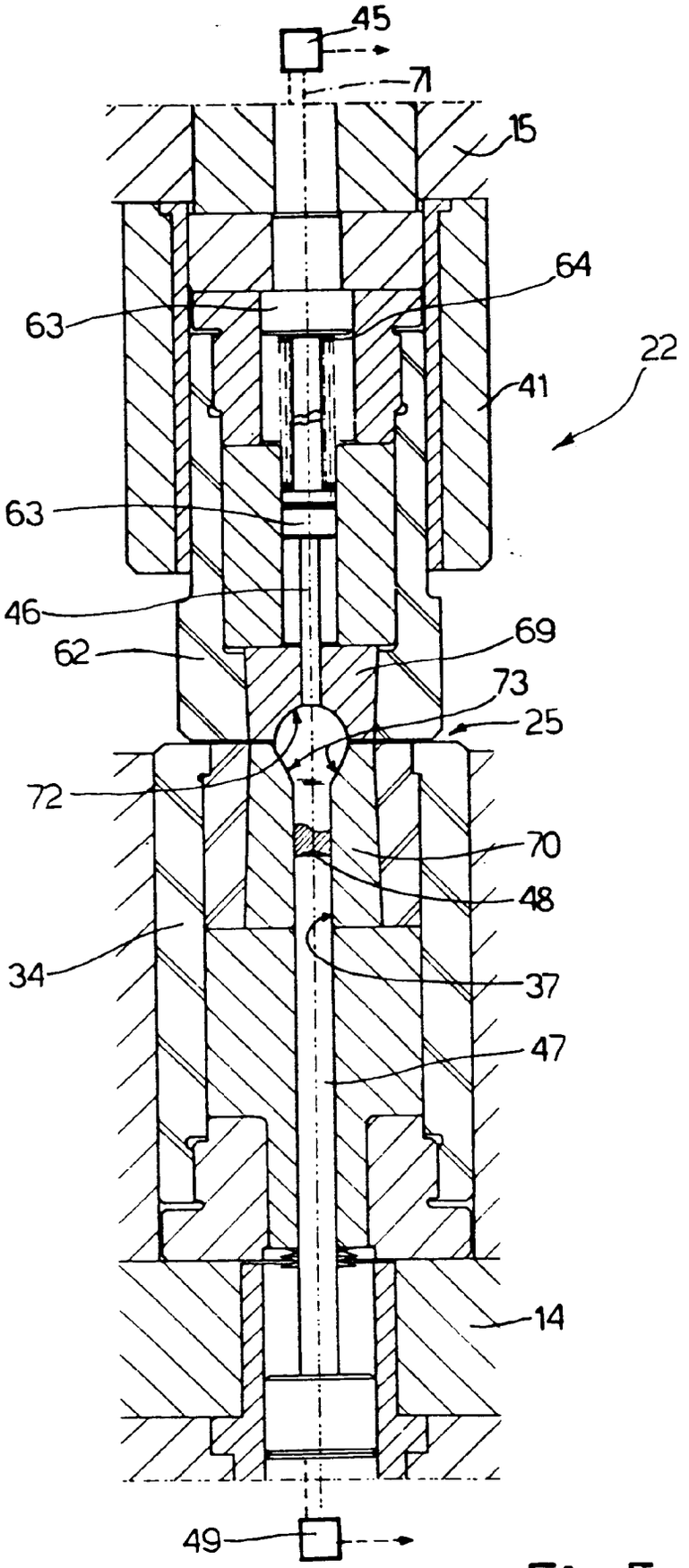

Fig. 5

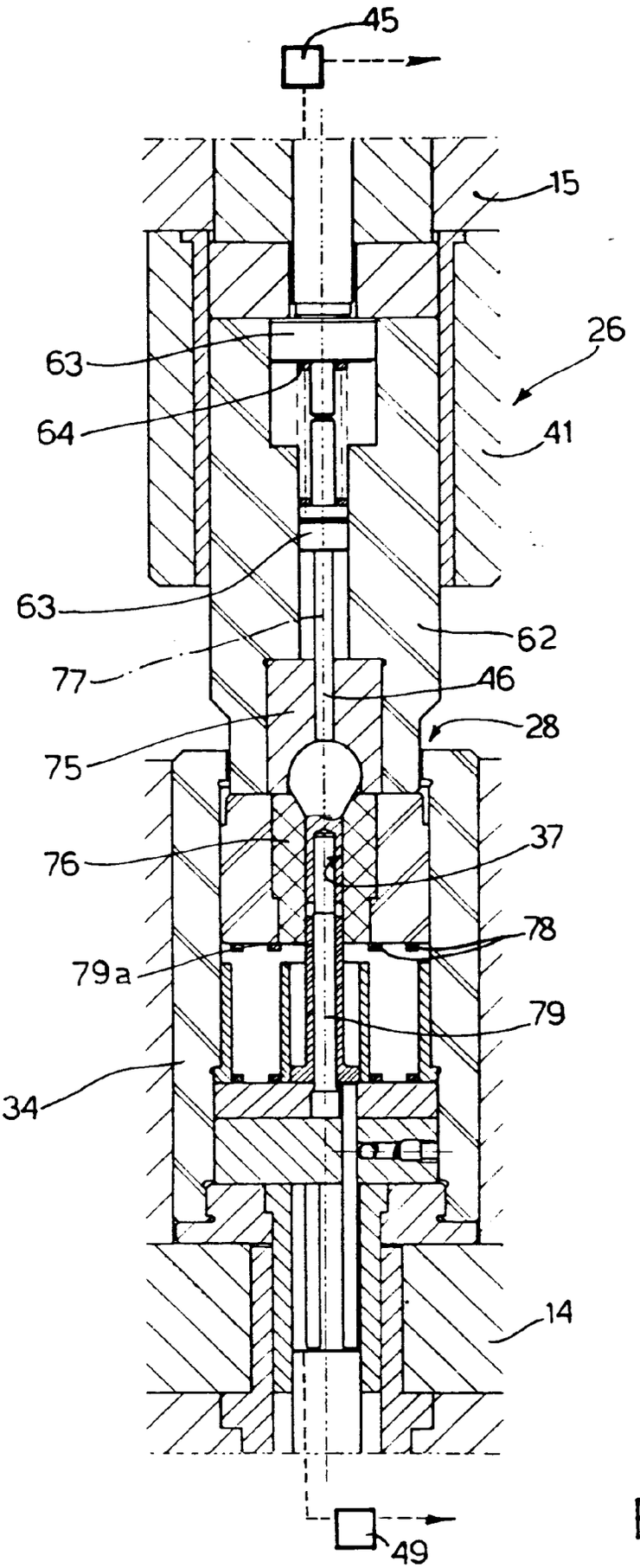

Fig. 6

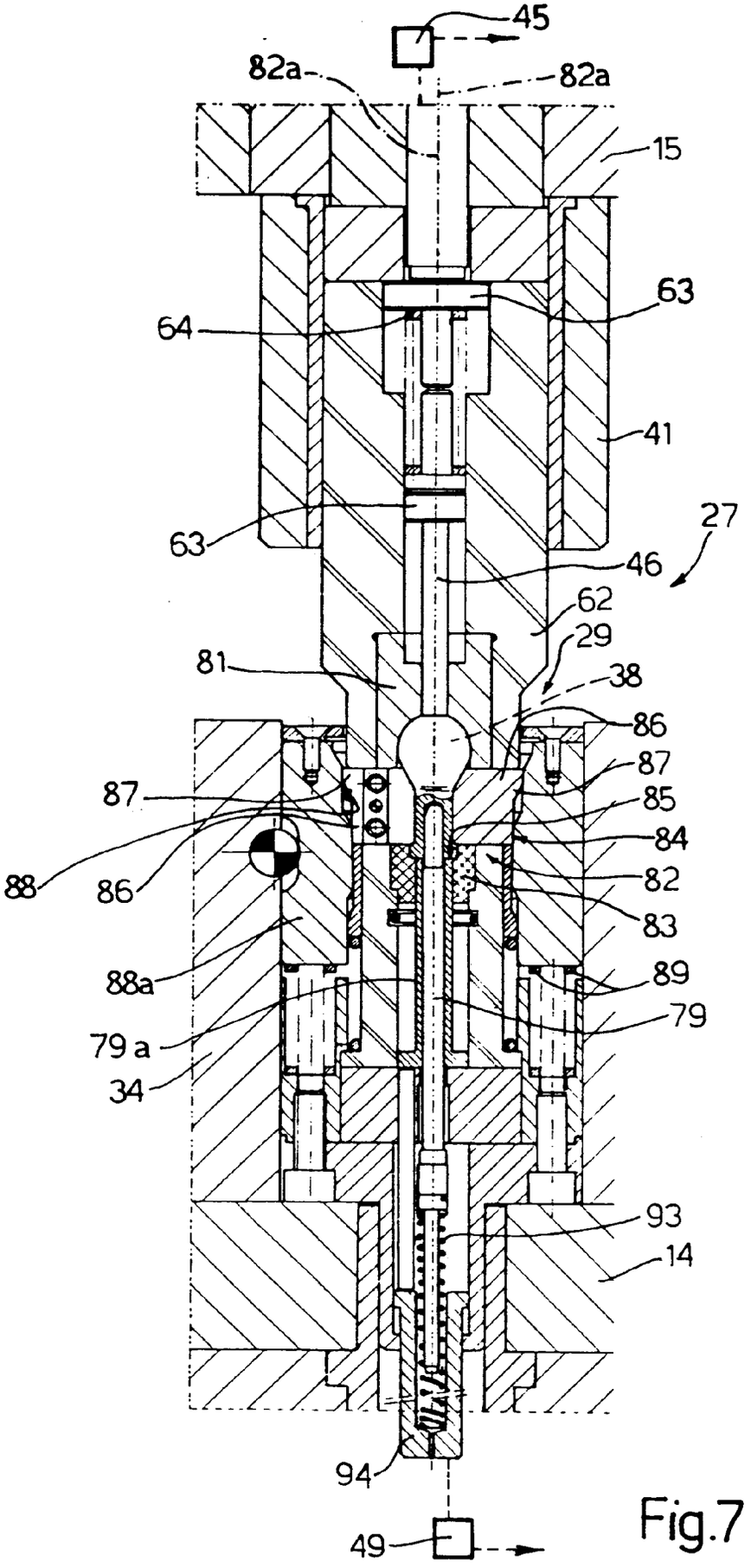
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Fig.7

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EUROPEAN SEARCH REPORT

Application Number
EP 94 10 3040

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X Y	US-A-5 129 251 (TAKIKAWA) * the whole document *	1,5,7,8,15 2-4,6,9,16	B21K1/76 B21K27/04 B21J5/08
Y	PATENT ABSTRACTS OF JAPAN vol. 5, no. 206 (M-104) (878) 26 December 1981 & JP-A-56 122 638 (FUJI KOGYO) 26 September 1981 * abstract *	2-4	
Y	US-A-4 450 703 (MC CLOSKEY) * column 3, line 35 - line 41; figures 1,2 *	6,16	
Y	EP-A-0 439 120 (HILGELAND) * abstract; figure 1 *	9	
A	US-A-3 818 746 (FUJITA) * column 4, line 11 - column 5, line 28; figures 7-9 *	10-13	TECHNICAL FIELDS SEARCHED (Int.Cl.5) B21K B21J
A	DRAHT, vol.37, no.10, October 1986, BAMBERG DE pages 557 - 562 'Sollen Normteilehersteller in die Spezilateilefertigung einsteigen?' * the whole document *	1,8	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	8 June 1994	Garella, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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