(11) Application No. AU 2005297068 B2

(19) AUSTRALIAN PATENT OFFICE

(54) Title

Continuous extrusion apparatus

(51)[6] International Patent Classification(s)

B21C 23/00 (2006.01) 23/08

B21C 23/08 (2006.01) 20060101ALI2006072

B21C 23/30 (2006.01) 2BMEP B21C

B21C 23/00 23/30

20060101AFI2006072 20060101ALI2006072

2BMEP B21C 2BMEP

PCT/GB2005/004048

(21) Application No: 2005297068 (22) Application Date: 2005.10.20

(87) WIPO No: WO06/043069

(30) Priority Data

(31) Number	(32) Date	(33) Country
0423222.9	2004.10.20	GB

(43) Publication Date : 2006.04.27

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(56) Related Art

EP 0125788

WO 2004/073901

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 April 2006 (27.04.2006)

PCT

(10) International Publication Number
WO 2006/043069 A1

(51) International Patent Classification[7]: B21C 23/00, 23/30, 23/08

(21) International Application Number:
PCT/GB2005/004048

(22) International Filing Date: 20 October 2005 (20.10.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0423222.9 20 October 2004 (20.10.2004) GB

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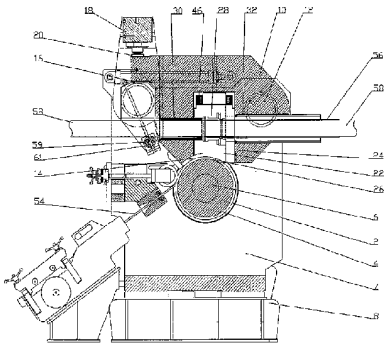
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: CONTINUOUS EXTRUSION APPARATUS



(57) Abstract: Apparatus for continuous extrusion of an aluminium sheathing (56) free from imperfections or discontinuities on to a core cable a (58), such as an insulated copper cable, includes a rotatable wheel (2) formed with a pair of circumferential grooves (4), arcuate tooling (14) bounding radially outer portions of the respective grooves (4), a die body (22) provided with divergent exit apertures (34) discharging laterally to an extrusion chamber (36) through 90° elbows (37) and short divergent passages (39) at diametrically opposed locations (35). An electrical induction heater (46) consists of coils of copper tubing connected to an electrical power source and to a coolant circulating means is positioned at a radially outer portion (48) of the die body (22) and is energisable to supply heat to the die body to maintain a uniform temperature of approximately 480°C, controlled by signals from thermocouples (50,52), around the extrusion chamber (36).

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Continuous Extrusion Apparatus

Description

This invention relates to continuous extrusion apparatus for continuously extruding a sheath around a core cable.

EP – A – 0125788 discloses continuous extrusion apparatus having a rotatable wheel formed with two identical circumferential grooves, arcuate tooling bounding radially outer portions of the respective grooves, a die body provided with exit apertures extending in a generally radial direction from the respective grooves to an extrusion chamber positioned around a portal mandrel and discharging axially of the mandrel through a die orifice of uninterrupted annular cross-section intermediate the mandrel and a die body wall and means are provided arranged to supply a core through the mandrel.

According to the present invention, heating means are provided arranged to supply heat to a portion of the die body radially outward of the wheel from the extrusion chamber.

Preferably, the heating means include electric induction heating coils. The coil may be positioned on the die body.

Suitably, thermocouples are provided at locations in the die body radially inwardly and outwardly of the wheel from the extrusion chamber and are connected to provide a signal utilisable to regulate input of heat from the heating means to maintain a substantially uniform temperature in the die body around the extrusion chamber.

Desirably, the die body is a removable sliding fit in a pocket formed in a shoe pivotable into contact with the rotatable wheel.

Advantageously, the exit apertures extending in a generally radial direction from the respective circumferential grooves connect laterally at diametrically opposed locations into the extrusion chamber through 90° elbows and short passages extending tangential to the rotatable wheel. The exit apertures may be of divergent cross-section in the direction of flow.

With further advantage, the arcuate tooling is mounted on the die body and is positionable against the rotatable wheel by means of a pressure yoke arranged to bear against a face of the die body radially outward of the rotatable wheel. A pair of abutments obturating the respective circumferential grooves may be mounted to be moveable in a direction tangential to the rotatable wheel in to or out from the circumferential grooves in sliding contact with an associated face of the die body adjoining the rotatable wheel. The die body may be located against a stop provided on a framework supporting the rotatable wheel, a pivot carrying the pressure yoke and a ram arranged to apply an adjustable force to the pressure yoke urging the die body toward the stop.

The invention will now be described, by way of example, with reference to the accompanying, partly diagrammatic, drawings, in which:-

Figure 1 is a cross-sectional side elevation of a continuous extrusion apparatus with a die body portion shown in outline;

Figure 2 is the die body a portion of Figure 1 to an enlarged scale, omitting feed material.

Figure 3 is a cross-sectional side elevation of an alternative arrangement of a continuous extrusion apparatus;

Figure 4 is a cross-sectional end elevation of a die body portion taken on the line IV – IV of Figure 3; and

Figure 5 is a cross-sectional plan view of the die body portion taken on the line V – V of Figure 4.

As shown, the continuous extrusion apparatus includes a rotatable wheel 2 provided with a pair of circumferential grooves 4 and is mounted on a horizontal drive shaft 6 running in bearings (not shown) positioned in side frames 7 mounted on a base 8. A shoe 10 mounted on a pivot 12 extending intermediate the side frames 7 and parallel to the horizontal drive shaft 6 carries arcuate tooling 14 registering with the respective grooves 4 and is urged against a stop 16 positioned adjacent the wheel 2 and above the drive shaft 6 by means of a hydraulic ram 18 bearing against a shoulder 20 formed on the shoe 10.

A die body 22, of rectangular cross-section, is removably seated in a pocket 24 formed in the shoe 10 and is provided with a pair of abutments 26 arranged to register with, and obturate, the respective grooves 4. A stepped passage 28 in the die body 22 registers with passages 30, 32 penetrating the shoe 10 and extending in a direction tangential to the wheel 2.

Exit apertures 34 extending generally radially from the respective grooves 4 and of divergent cross-section connect laterally at diametrically opposed locations 35 into an extrusion chamber 36 through 90° elbows 37 and short divergent, passages 39 extending in a direction tangential to the wheel 2. The open end of the extrusion chamber 36 is provided with a guide ring 38 and a die ring 40 seating on a face on the die body 22. A cylindrical, tubular, mandrel 42 is seated on a step 43 in the passage 28 and co-acts with the die ring 40 to form an annular extrusion orifice 44.

Coils 46 of an electrical induction heater consisting of copper tubing connected to a coolant circulating pump (not shown) and a source of electrical power (not shown) are positioned at a radially outer end portion 48 of the die body 22. Thermocouples 50, 52 are positioned in the die body 22 radially inwardly and outwardly of the extrusion chamber 36 and are connected through electrical conductors (not shown) to a control circuit (not shown) regulating energisation of the induction heater coils 46.

In operation, to form an aluminium sheath 56 on a core cable 58, such as a copper conductor clad with insulating material, having a diameter in the range of 50mm to 200mm, preparatory to commencing extrusion the die body 22 is removed from the

shoe and heated to a temperature approximating to the desired extrusion temperature of approximately 480 - 500°C. The die body 22 is then re-positioned in the pocket 24, the shoe 10 pivoted into contact with the wheel 2 and the hydraulic ram 18 actuated to apply force to the shoe. A drive (not shown) connected to the drive shaft 6 is energised and aluminium rod feedstock 54 fed into the grooves 4, which, by virtue of the frictional forces generated between the aluminium feedstock, the walls of the grooves, the arcuate tooling 14 and the abutments 26, is brought to a plastic state and flows through the exit apertures 34 to the extrusion chamber 36 as a continuous extrusion process. The flows from the respective exit apertures 34 combine in the extrusion chamber 36 and extrude through the annular extrusion orifice 44 to produce the continuous sheath 56 for the core cable 58 fed over a guide roller 59 mounted on an eccentric shaft 61 adjustable in order that the core cable 58 is supplied substantially co-axially of the mandrel 42. A substantially uniform temperature of approximately 500°C is maintained in the die body 22 around the extrusion chamber 36 by augmenting the heat input arising from the frictional forces transmitted to the radially inner portion 62 with a heat input generated by energising the electrical induction heater coils 46 transmitted to the radially outer portion 48. Output signals from the thermocouples 50, 52 are utilised to regulate energisation of the coils 46 to achieve the required heating of the die body 22. By maintaining a substantially uniform temperature around the extrusion chamber 36 free flow and mixing of the two flows from the exit apertures 34 is achieved thereby producing sound sheathing free from imperfections or discontinuities.

Upon exit from the continuous extrusion apparatus, the sheath 56 is subjected to rapid cooling in order to limit any deleterious effects of heat on the insulating cladding material of the core cable 58. A roller corrugator (not shown) is positioned downstream of the continuous extrusion apparatus to form a spiral corrugation in the sheath 56 contacting the core cable 58.

It will be appreciated that, whilst in the foregoing description, the continuous extrusion apparatus is arranged such that the core cable 58 is fed in a horizontal direction, the arrangement may be rotated through 90° such that the core cable is fed in a vertical direction, thereby facilitating co-axial alignment of the core cable and the sheath during extrusion.

It will also be appreciated that mixing and combining flows of aluminium in the extrusion chamber 36 may be enhanced by grooving and shaping the wall surfaces of the extrusion chamber.

It will further be appreciated that the electric induction heater coils 46 may be positioned in the shoe.

In the arrangement shown in Figures 3 to 5, the rotatable wheel 2 provided with the pair of circumferential grooves 4 is mounted on the horizontal drive shaft 6 running in bearings (not shown) positioned in the side frames 7 mounted on the base 8. A pressure yoke 60 mounted on a pivot 61 extending intermediate the side frames 7 and parallel to the horizontal drive shaft 6 co-acts with a die body 62 carrying arcuate tooling 64 registering with the respective grooves 4. The pressure yoke 60 is urged towards the wheel 2 by means of a hydraulic ram 68 bearing against a shoulder 70 formed on the pressure yoke 60.

The die body 62, of rectangular cross-section, is removably located intermediate the side frames 7 and is formed with a stepped portion 72 arranged to seat on flanges 74 provided on the side frames 7. A radially outer head portion 76 is formed with a curved face 77 co-acting with a curved face 78 recessed into the pressure yoke 60 to facilitate transmission of pressure loading exerted by the hydraulic frame 68 through the pressure yoke 60 to the head portion 76.

A pair of abutments 80 are positioned on a carriage 82 slidably mounted on the side frames 7 and are movable in to and out from the respective grooves 4 by means of an actuating, hydraulic, ram 84 extending between the carriage 82 and a fixed mounting 86 on the side frames 7. The abutments 80 have associated faces which slidably contact faces 88 on a radially inner portion of the die body 62 such that the abutments 80 are held in position obturating the grooves 4 by virtue of the forces applied by means of the hydraulic ram 68, acting through the pressure yoke 60 and die body 62 and the actuating, hydraulic, ram 84 acting through the carriage 82.

Exit apertures 34 extending generally radially from the respective grooves 4 and of divergent cross-section connect laterally at diametrically opposed locations 35 into

an extrusion chamber 36 through 90° elbows 37 and short divergent, passages 39 extending in a direction tangential to the wheel. The open end of the extrusion chamber 36 is provided with a guide ring 38 and a die ring 40 seating on a face on the die body 22. A cylindrical, tubular, mandrel 42 is seated on a step 43 in the passage 28 and co-acts with the die ring 40 to form an annular extrusion orifice 44.

Coils 46 of an electrical induction heater consisting of copper tubing connected to a coolant circulating pump (not shown) and a source of electrical power (not shown) are positioned at a radially outer end portion 48 of the die body 22. Thermocouples 50, 52 are positioned in the die body 22 radially inwardly and outwardly of the extrusion chamber 36 and are connected through electrical conductors (not shown) to a control circuit (not shown) regulating energisation of the induction heater coils 46.

In operation, the apparatus described in conjunction with Figures 3 to 5 functions in a manner similar to the operation of the apparatus described in conjunction with Figures 1 and 2. Positioning the stepped portion 72 of the die body 22 on the flanges 74 on the side frames 7 enables the spacing between the die body 22 together with the arcuate tooling 64 and the abutments 80 to be maintained within close limits despite overall thermal expansion of the die block 22 during operation arising from the high temperatures approaching 500°C, occurring.

It is to be understood that a reference herein to a prior art document does not constitute an admission that the document forms part of the common general knowledge in the art in Australia or any other country.

In the claims which follow and in the preceding description of the invention, except where the context requires otherwise due to express language or necessary implication, the word "comprise" or variations such as "comprises" or "comprising" is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific

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embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

Claims

1 Continuous extrusion apparatus having a rotatable wheel formed with two identical circumferential grooves, arcuate tooling bounding radially outer portions of the respective grooves, a die body provided with exit apertures extending in a generally radial direction from the respective grooves to an extrusion chamber positioned around a portal mandrel and discharging axially of the mandrel through a die orifice of uninterrupted annular cross-section intermediate the mandrel and a die body wall and means are provided arranged to supply a core through the mandrel, characterised in that heating means are provided arranged to supply heat to a portion of the die body radially outward of the wheel from the extrusion chamber.

2 Continuous extrusion apparatus as claimed in Claim 1. characterised in that the heating means include electric induction heating coils.

3 Continuous extrusion apparatus as claimed in Claim 2, characterised in that the coils are positioned on the die body.

4 Continuous extrusion apparatus as claimed in any preceding Claim characterised in that thermocouples are provided at locations in the die body radially inwardly and outwardly of the wheel from the extrusion chamber and are connected to provide a signal utilisable to regulate input of heat from the heating means to maintain a substantially uniform temperature in the die body around the extrusion chamber.

5 Continuous extrusion apparatus as claimed in any preceding Claim, characterised in that the exit apertures extending in a generally radial direction from the circumferential grooves connect laterally at diametrically opposed locations into the extrusion chamber through 90° elbows and short passages extending tangential to the rotatable wheel.

6 Continuous extrusion apparatus as claimed in Claim 5, characterised in that the short passages are of divergent cross-section in the direction of flow.

7 Continuous extrusion apparatus as claimed in any preceding Claim, characterised in that the exit apertures are of divergent cross-section in the direction of flow.

8 Continuous extrusion apparatus as claimed in any preceding Claim, characterised in that the die body is a removable sliding fit in a pocket formed in a shoe pivotable into contact with the rotatable wheel 2.

9 Continuous extrusion apparatus as claimed in any one of Claims 1 to 7, characterised in that the arcuate tooling is mounted on the die body and is positionable against the rotatable wheel by means of a pressure yoke arranged to bear against a face of the die body radially outward of the rotatable wheel.

10 Continuous extrusion apparatus as claimed in Claim 9, characterised in that a pair of abutments obturating the respective circumferential grooves are mounted to be moveable in a direction tangential to the rotatable wheel in to or out from the circumferential grooves in sliding contact with an associated face of the die body adjoining the rotatable wheel.

11 Continuous extrusion apparatus as claimed in Claim 9 or Claim 10, characterised in that the die body is located against a stop provided upon a framework supporting the rotatable wheel, a pivot carrying the pressure yoke and a ram arranged to apply an adjustable force to the pressure yoke urging the die body toward the stop,

12 Continuous extrusion apparatus substantially as hereinbefore described with reference to the accompanying Figures.

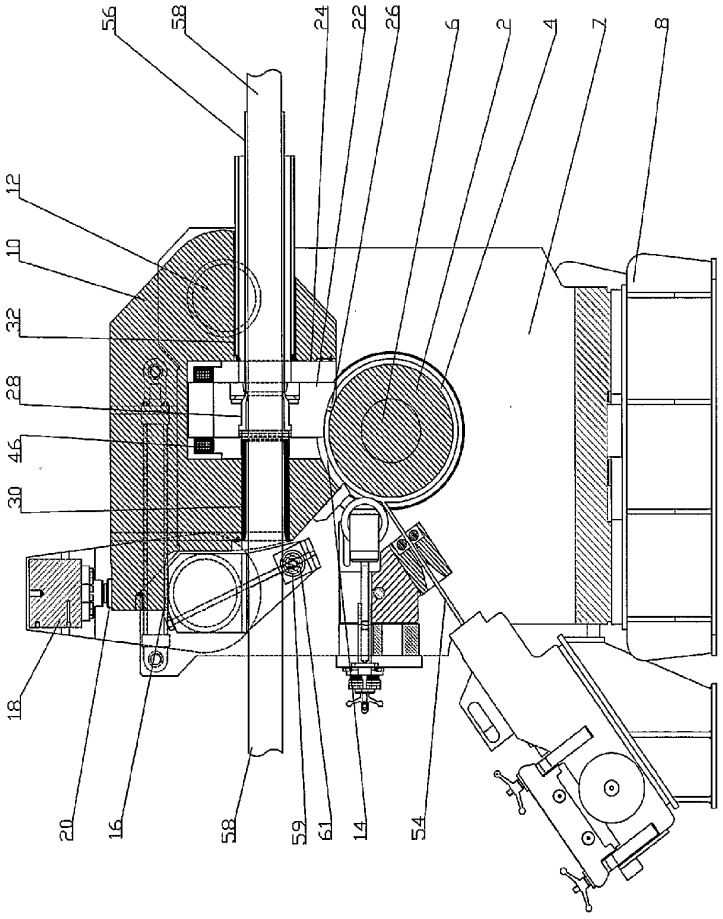

Fig 1

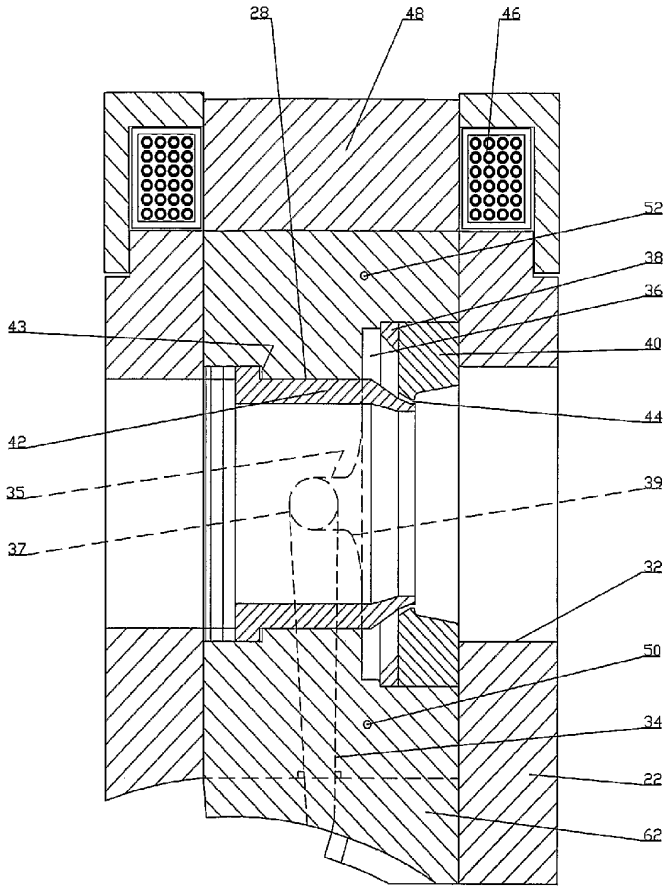

Fig 2

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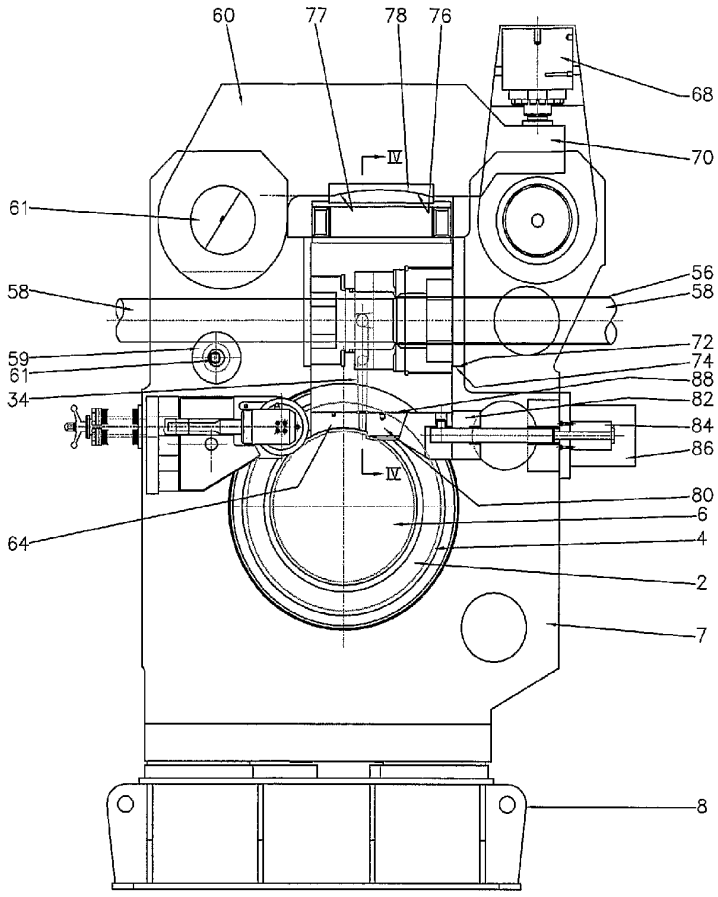
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FIG. 3

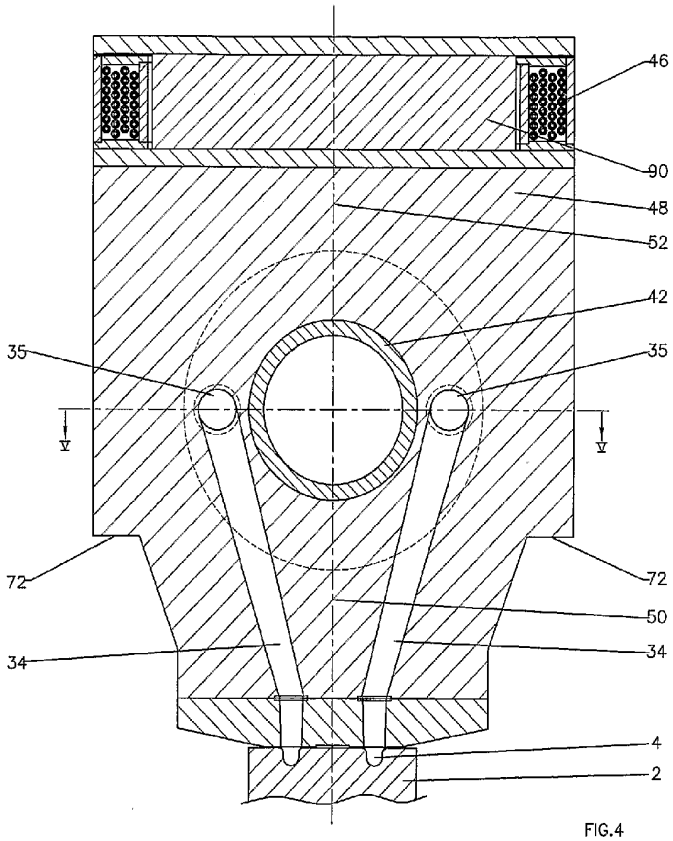

FIG.4

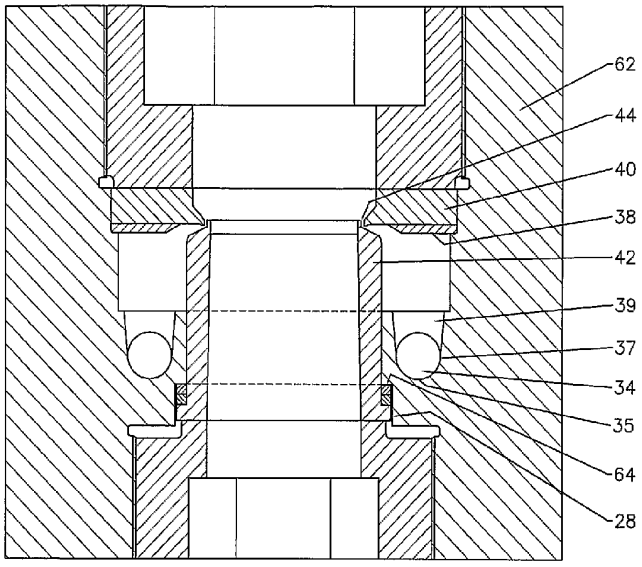

FIG. 5