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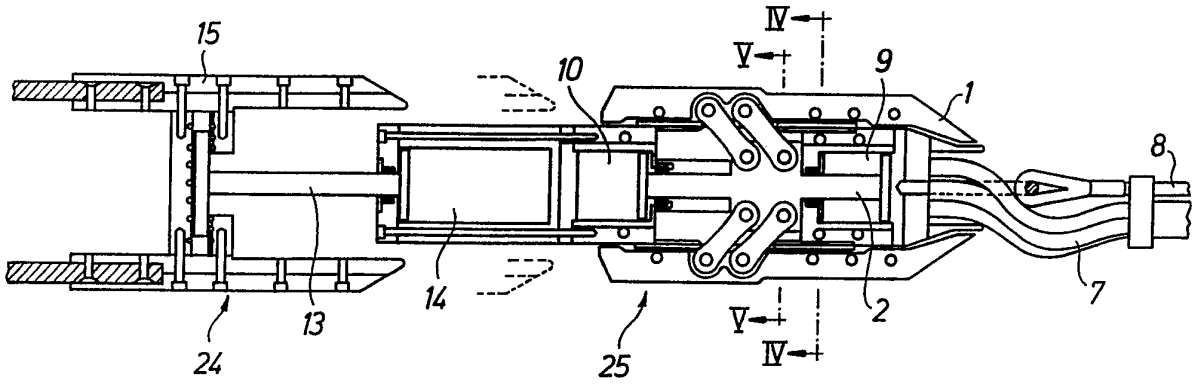
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(54) Title: A TOOL AND A PROCESS FOR REPLACEMENT OF UNDERGROUND DUCTS



(57) Abstract

The present invention relates to a tool and a means for the replacement of underground ducts. The tool being in principal self-propelling consists of a breaking part (25) and a pipe connection part (24). The tool is hydraulically operated over hydraulic tubes (7). The breaking part (25) has break segments (1) with stepwise increasing radius and the pipe connection part (24) has a feeding cylinder (14). One or several double pistons (2) are attached to the segments (1) by lifting links (4). Each double piston (2) moves in two cylinders (9, 10), which are so connected that when the pressure acts on the piston rod side in one of the cylinders then the pressure in the other cylinder acts on the side without piston rod and vice versa. The lining with new pipes (16) takes place according to the operating cycle below. The breaking part (25) is first expanded radially outwards, whereby the existing pipe is restored to a circular cross section or is expanded to a larger diameter. Then the feeding cylinder will advance the new pipe (16). At this moment a wire (8) acts as an extra counter force in order to assist the tool, which is expanded against the existing pipe. When the new pipe (16) has been advanced the breaking segments will return, whereby the diameter of the tool is decreased, and then the tool is advanced. This ends the operating cycle and, thus, the next step will be to expand the tool radially.

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A TOOL AND A PROCESS FOR REPLACEMENT OF UNDERGROUND DUCTS.

Field of the invention

The present invention relates to a tool and means for replacement of underground ducts, by which existing ducts are lined with new pipes, preferably 6 to 12 m long PEH pipes, which are welded together above ground, and by which the lining pipe is advanced by the tool restoring the existing pipe to circular cross section form or expand the same to a bigger diameter. In principle the tool is self-propelled.

The state of the art

Many different means and tools for replacement of underground ducts have been proposed in recent years. The presently known means for replacement with PEH pipes use tools with percussion and pulling or pushing force. These are limited in that vibrations from the percussion tools may damage adjacent ducts or fundaments. It is common to place several different lines close together, such as electric cables, water conduits and sewers.

One further drawback with the present technique is that it is impossible to break pipes having a diameter less then 250 mm when using tools of piston type. The previously known percussion tools are often about from 1,5 to 3,0 m long, while the tools of piston type are somewhat shorter.

For several of the tools used at present the hydraulic tubes for the tools has to go through the new pipes, which means that the tubes has to be loosen when new pipes are connected and then the tubes once again has to be attached.

Thus, one object with the present invention is to provide a tool and operation mode by which it is possible to

break pipes with a diameter down towards about 150 mm, while tools of the same configuration can be used for bigger diameters as well.

Another object is to provide a shorter tool then used at present, where it has proved that a suitable length is about 60 cm.

Yet another object with the present invention is to provide a operation mode and a tool, by which the influence on the surroundings of the existing pipe is as small as possible.

The above objects are achieved with a tool and a operation mode according to the invention as it is expressed in the enclosed claims.

Further advantages and objects with the present invention will become clear by the following detailed description of an embodiment of the invention.

While the description of one embodiment only state a double piston it is understood that further pistons may be coupled in line in a similar way, which pistons cooperates in a way which is similar to the one double piston described below. Further modifications of the embodiments within the scope of the invention are possible for a person skilled in the art.

Brief description of the drawings

Fig. 1 shows one embodiment of the tool for replacement of underground ducts according to the invention.

Fig. 2 shows a longitudinal section of the breaking part of the tool.

Fig. 3 shows a longitudinal section of the connection part of the tool.

Figs. 4 and 5 show a section taken along the lines IV-IV and V-V, respectively, in Fig. 2 and with the piston removed.

Fig. 6 shows the tool according to the invention in longitudinal section, with the breaking part and the connection part assembled.

Detailed description of the invention

In the preferred embodiment the tool consists of a connection part 24 and a breaking part 25. The connection

part 24 consists of a pipe connection part 15 and a feed piston 13. The breaking part 35 has four break segments 1. The breaking part 25 is built round a body 26 with through oil passages 11, 34, 35, 36 and uses the square inner space completely. The piston rod is made in one piece. The break segments 1 are supported in a number of links 3-5 and the tool can be made to form different outer diameters by displacement of the segments 1 outwardly or inwardly. The displacement of the break segments 1 is accomplished by lifting links 4 mounted via shafts 30 in a hydraulic double piston 2. The function of the other links in form of link arms 3, 5 is to support the control of the break segments 1. The piston 2 is double in that aspect that it is supported in two cylinders 9, 10 with a common piston rod. These cylinders 9, 10 are connected in such a way that when the pressure in one cylinder is acting on the piston rod side the pressure is acting on the side without piston rod in the other cylinder. This means that the maximal force from the piston 2 is independent of in which direction the piston moves, and, thus, is the same size in both directions.

The design of the cylinders plays an important part of the invention as these give the body 26 the required strength after assembly. The design of the lifting links 4 gives minimal distance between the link shafts and utilizes the stroke to the maximum. By the placing and design of the cylinders 9, 10 in the body 26, and, thus, the use of the double piston 2, a greater force is achieved than previously at the same time as both the piston 2 and the tool in its totality can be designed with a smaller diameter than the previous tools.

The connection part 24, consisting of a pipe connection part 15, a piston and cylinder arrangement 13, 14 and a mounting 17, is normally connected to the tool.

All cylinders 9, 10, 14 are feed through hydraulic tubes 7 attached to the tool in an end 21 at one short end. The hydraulic tubes 7 are pressurized and depressurized in a suitable way by hydraulic valves (not shown). As the hydraulic control can be accomplished in the conventional way and forms no part of the present invention it will not be further described herein.

The oil passages 11, 34, 35, 36 of the tool are through

passages. As a consequence it is relatively simple to shift side for the connection of the hydraulic tubes by, in a suitable way, just shifting the places of the ends 20, 21.

The piston rod of the double acting piston 2 has a general square cross section in the cavity 12 of the body 26 between the cylinders, where it furthermore has four projections 22 in planes squarelly arranged in relation to each other. The cavity 12 of the body 26 has a cross section adopted to the cross section of the piston rod. The part of the piston rod moving in the cylinder 9, 10 has a circular cross section. The lifting links 4 transmitting the piston movement to the segments 1 are attached to said projections 22 of the piston, respectively.

In order to protect the interior of the tool in the greatest possible extent from dust, gravel, stones and the like cover elements 6 may be arranged between the segments 1 and the body 26 of the tool. the cover elements 6 have pins 29 quided in slots 39 in the sides of the lifting links 4, whereby the cover elements 6 accompany in the movement of these links 4. In order to keep the cover elements 6 close to the tool sheets may be arranged covering the outer parts of the cover elements.

In a conventional manner seals 19, e.g. in form of O-rings, are arranged at every pressure fluid connection, piston, cylinder and possible further spaces which are to be sealed.

The purpose of the link arms 3, 5 is to stabilize the movement of the break segments 1 and thereby reduce the wear and tear of the shafts of the lifting links. These link arms 3, 5 are mounted, through shafts 30, partly in the break segments 1 and partly in the body 26 of the tool.

The tool may be used both with and without pipe connection part 24. If the connection part is not used the tool is furnished with an end 20.

With the connection part 24 mounted the operating cycle of the tool will be as stated below. By displacing the double piston 2 leftwards as viewed in Fig. 2 the break segments 1 will be forced outwardly and restor the existing pipe to a circular form or increase the diameter of it. Then the piston rod side of the pipe feeding cylinder 14 is pressurized,

whereby the pipe 16 is feed forward towards the tool. The next step will be to pressurize the cylinders 9, 10 of the double piston 2 in order for the piston to move to the right in the view showed in Fig. 2, and whereby the segments 1 are brought back to the tool. To end the operating cycle the other side of the feeding cylinder 14, i.e. the one without piston rod, is pressurized, whereby the tool is displaced to the right in the view showed in Fig. 1. Thereafter a new operating cycle can commence. Thus, the wire 8 is not used to pull the tool forward the function of it is in stead to act as a counter force, which above all is important before the pipe has been feed any substantial length.

The piston rod 13 of the feeding cylinder 14 is moveably supported in a recess 17 in the pipe connection part 15 and by a number of balls 18, this in order to avoid locking, wear and tear or other problems, partly as the tool always lies in the bottom of the existing pipe, due of course to the gravitation, when the segments 1 are brought in toward the tool, and partly due to settlings in the existing pipe line.

The tool according to the present embodiment is chiefly intended for use by lining with new pipes consisting of so-called PEH pipes which are soft pipes and normally about 6-12 m long. Hereby must a special descent shaft be digged adjacent the well. These PEH pipes are connected by welding above ground. However, it is possible to use the present tool also for stiff short pipes, e.g. so-called GAP pipes which usually are about 30 to 60 cm long, and it is then possible to go down by the existing well, as is previously known.

By arranging the hydraulic tubes 7 and the counter force wire 8 in front of the tool while the new pipes are jointed from behind, these pipes can be jointed without the need of releasing the tubes for every pipe joint. For previous tools of this kind it has been common that for every new pipe part, or parts, the tubes have to be released, these have to be brought through the new pipe part and then the tubes have to be reconnected. This is not necessary according to the present invention if you operate from two sides.

Existing ducts are lined with new PEH pipes which are 6-12 m long and flexible. These pipes 16 are welded together above ground. The new pipe is advanced by the tool, as

described above, in an operating cycle which also includes restoring of the existing pipe to circular form or the expansion of the same to a large diameter. The counter force wire 8 and the hydraulic tubes 7 rise over a guide pulley 32 through a well and to a cable pulley 23 above ground. While the wire is wound on the cable pulley 23 the pulley only acts as a guide pulley for the hydraulic tubes 7 which goes on to the hydraulic control consisting of valves, pump, reservoir etc. The cable pulley 23 has a reverse stop which means that the wire 8 can be kept stretched all the time and that it is possible to avoid that the tool reciprocate without advancing the pipe 16 if the force exercised by the break segments 1 of the tool against the walls of the existing pipe is not enough to advance the pipe. As the wire is only intended as an extra precaution the tool is in principal self-propelled.

The break segments 1 have a front part 1a and a rear part 1b with the same axial extension, but the rear part 1b is somewhat raised and, thus, has a larger diameter. The stroke length of the feeding cylinder 14 is half the axial length of the break segment, or in other words the same as the length of respective parts 1a and 1b of the break segments. This means that the breaking or extension of the existing pipe takes place in two steps. In the first step the first part 1a of the segment is acting, and then the operating cycle goes on as describes above, whereby the second part 1b of the segment is displaced to the position of the first part 1a in the previous cycle. Thus, by the repeated expansion of the tool the existing pipe is extended a further radial distance.

In order to assemble the piston 2 the body 26 is made open in both ends, where by the ends 20, 21 are attached to the body 26 after the assembly of the piston 2.

As stated above the passages 11, 34, 35, 36 of the tool are through passages and furthermore double, i.e. the eight passages 11, 34, 35, 36 shown in the embodiment could be replaced by only four passages. If, in order to simplify the description, the projections 22 of the piston 2 is seen as forming a systems of coordinates as seen in Fig. 5, then the passages 34, 11 in the first and fourth quadrant, respectively, lead to the different sides of the double piston 2. Thus,

the passages 34 lead to the piston rod free side in one cylinder and to the piston rod side in the other cylinder, while the passages 11 lead to the other sides of the cylinders 9, 10. In order to lead in and out, respectively, hydraulic oil on the piston rod sides of the cylinders 9, 10 of the double piston 2 holes 27 are drilled in the body 26 and the plate, respectively, just behind the cylinders 9, 10 in the first and fourth quadrants, as seen in Fig. 5. These drillings 27 are meet by holes 28 received in the bottoms of the cylinders 9, 10 on the piston rod side. The drillings 27 received in the body 26 and the plate 33, respectively, forms an angle of 45° with the vertical plane and punctures both the inner passages 11, 34 in respective quadrant. By the use of the tool the drillings 27 are pluged. If e.g. the passages 11 are pressurized the pressure flows to the piston rod side of the right cylinder 9 as viewed in Fig. 2 through the drillings 27 in the fourth quadrant and the aperture 28, while the pressure in the through passages 11 flows to the side without piston rod of the left cylinder 10 by a recess 38. The respective other sides of the cylinders are evacuated through the passages 34 in the first quadrant, in a similar way as above the piston rod side is evacuated to the passages 34 by an aperture 28 and a drilling 27 in the first quadrant, and the side without piston rod is evacuated by a recess 38. The apertures 28 of the cylinders 9, 10 not used are filled by suitable plugs.

The passages 36, 35 in the second and third quadrants, respectively, lead to the different sides of the feeding cylinder 14. Also these passages 35, 36 are through passages. The different cylinders are controlled in such a way that the feeding cylinder 14 is only operated when the double piston is at its extrems, i.e. pipe advancing will only take place when the tool is fully expanded, while the tool advancing will only take place when the segments 1 are adjacent to the tool body 26.

The structure of the break segments 1 gives an expansion of the existing ducts in two steps. Even if the displaced length of the break segments 1 is restricted by the stroke length of the feeding cylinder 14 the expansion takes place over the total axial length of the segments 1.

The location of the links in the longitudinal direction of the break segments 1 gives a better load carrying, whereby it has been possible to reduce the thickness of the material for the segments 1. The link arms 3, 5 are located in front of each other vertically, while they are axially displaced. The number of link arms 3, 5 and the number of lifting links 4 can be varied depending on the diameter and the number of cylinders.

CLAIMS

1. A tool for replacement of underground ducts having break segments (1) displaceable in radial direction, **characterized** by one or more double pistons (2) connected with the segments (1) by lifting links (4), each double piston (2) moving in two cylinders (9, 10), and the hydraulic lines to the cylinders (9, 10) being connected in such way that when the pressure acts on the piston rod side of one cylinder then the pressure acts on the side without piston rod of the other cylinder and vice versa.

2. A tool according to claim 1, **characterized** by a connection part (24) which can be attached to the back end of the tool, which connection part (24) has a pipe connection part (15) and a feeding cylinder (14), and the feeding piston (13) being moveably supported in the pipe connection part (15).

3. A tool according to claim 2, **characterized** by being built round a body (26) with through passages (11, 34, 35, 36) for hydraulic flow to and from the cylinders (9, 10, 14) and by each passage being double.

4. A tool according to claim 3, **characterized** by the piston rod of the double piston (2) having four projections (22) for supporting the lifting links (4), the projection (22) with the supported lifting links (4) runing in grooves in the body (26) of the tool, whereby the grooves are arranged in the body (26) of the tool between both cylinders (9, 10) of the double piston (2).

5. A tool according to any of the previous claims, **characterized** by the break segments (1) having two parts (1a, 1b) in axial direction, the rear part (1b) seen in the operating direction having a somewhat larger diameter then the forward part (1a), and both parts (1a, 1b) having the same axial length, which length is the same as the stroke length of the feeding cylinder (14).

6. A tool according to any of the previous claims, **characterized** by a counter force wire (8) supported in the forward end (21) of the tool seen in the operating direction of the tool.

7. A tool according to claim 6, **characterized** by hydraulic tubes (7) connected in the same end (21) in which

the counter force wire (8) is supported.

8. A tool according to claim 6, **characterized** in that the counter force wire (8) is wound on a cable pulley (23), which cable pulley (23) is furnished with a reverse stop.

9. A tool according to any of the previous claims, **characterized** in that cover elements (6) are arranged in order to protect the inner of the tool from dust, gravel, stones and the like.

10 A method for replacement of underground ducts with the use of a tool according to any of the previous claims, **characterized** by the tool being self-propelled and having a operating cycle in which the tool first expands radially to its outmost position, whereupon a feeding cylinder (14) advance the pipe connection part (15) to the tool, and then the diameter of the tool is reduced to its minimal diameter and is advanced by the feeding cylinder (14), whereupon the operating cycle will start all over again, and the stroke length of the feeding cylinder (14) being the same as half the axial length of the break segments (1) of the tool, which segments in the second part (1b) in the feeding direction having a somewhat larger diameter then the first part (1a), whereby respective part of the break segments (1) have an axial length which is the same as the stroke length of the feeding cylinder, and where the pipe segments (16) are weld together if necessary behind the tool.

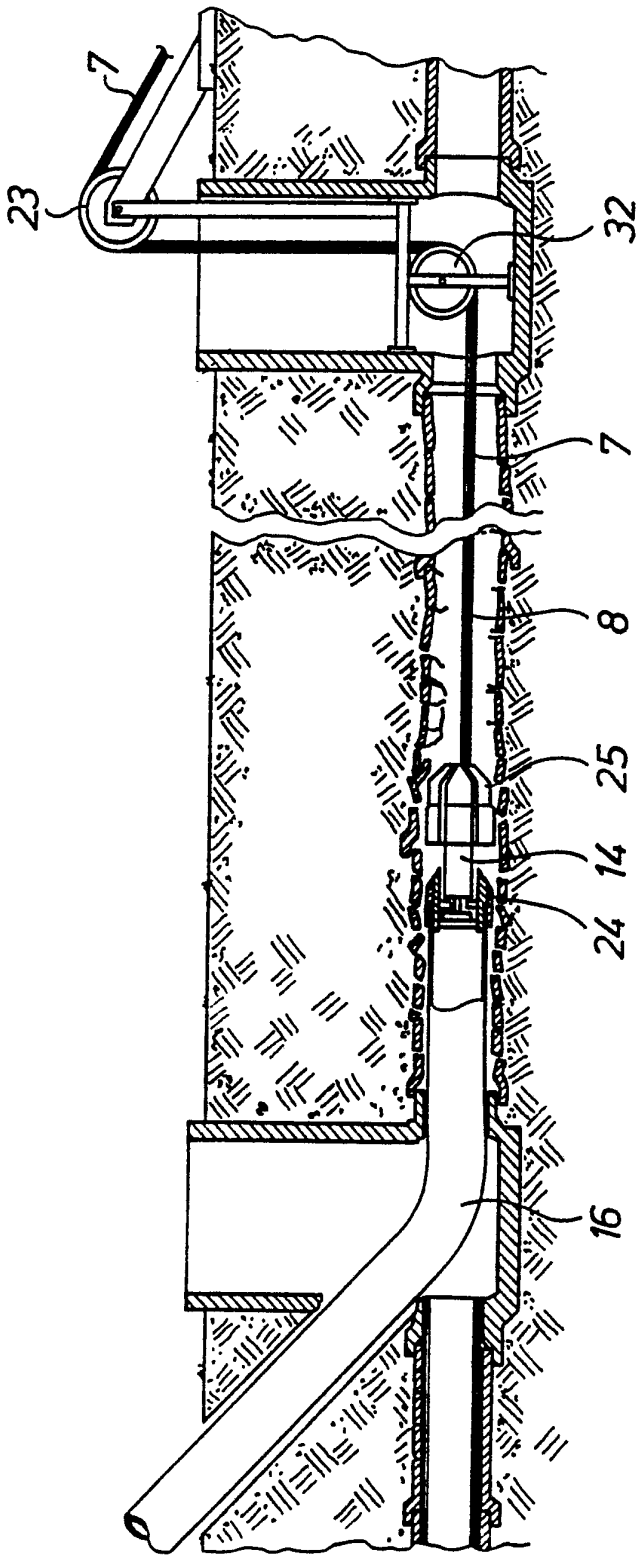


FIG. 1

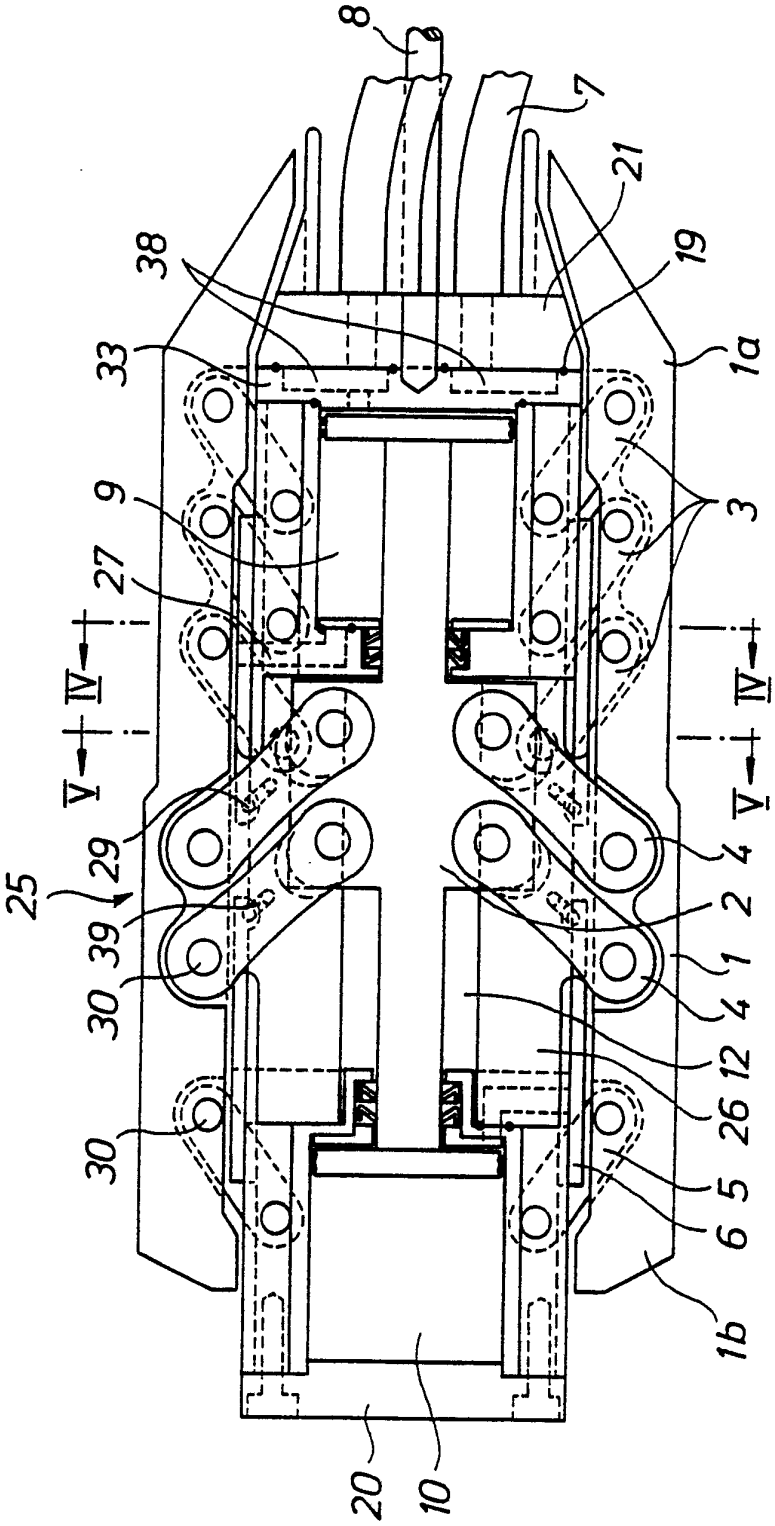


FIG. 2

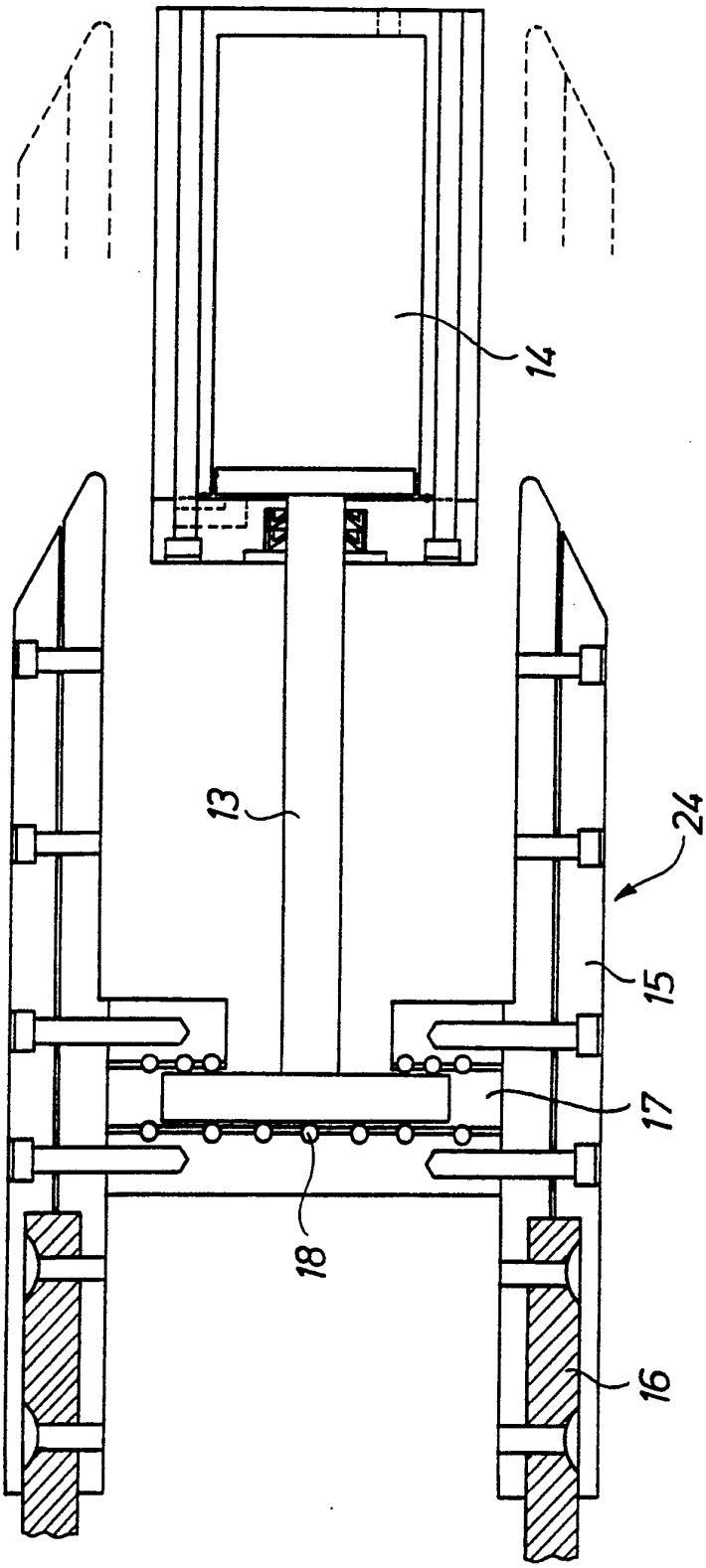


FIG. 3

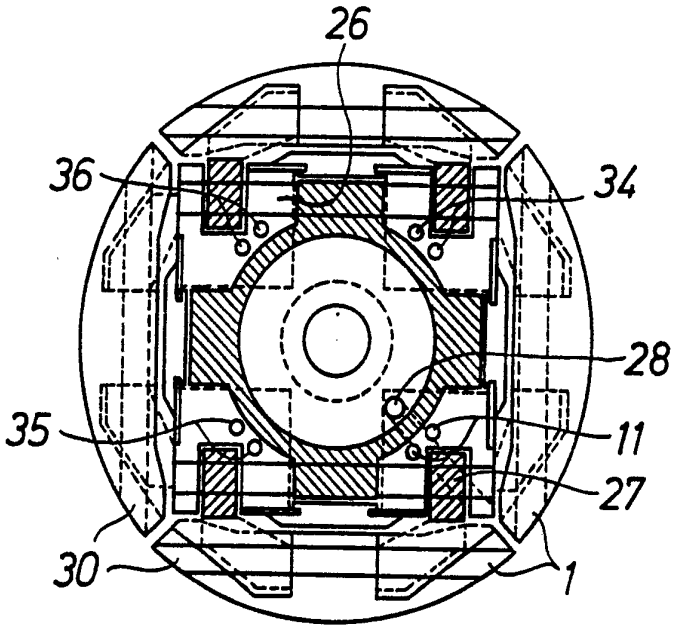


FIG. 4

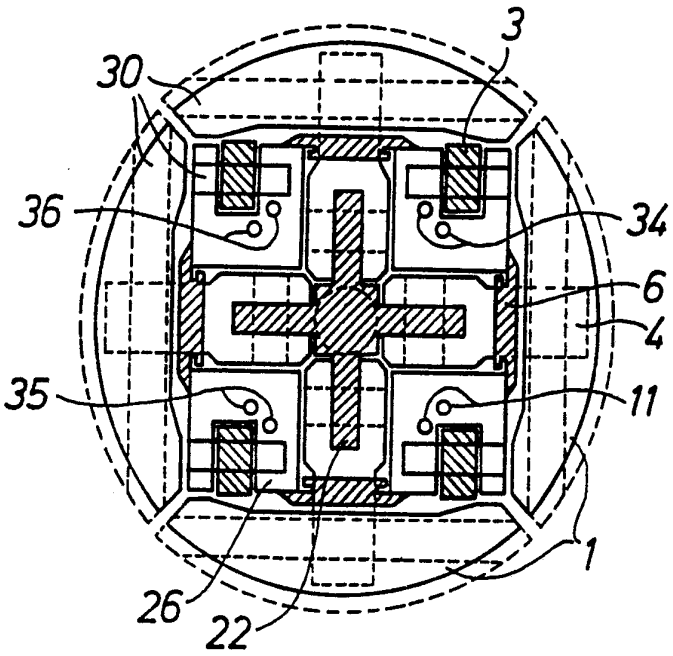


FIG. 5

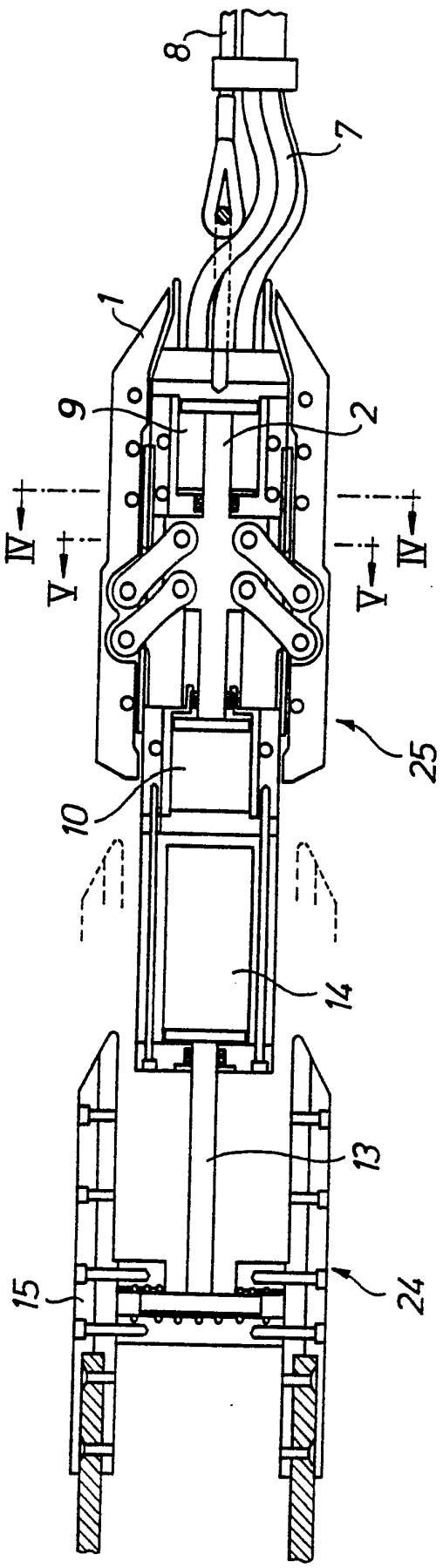


FIG. 6

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 91/00881

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: F 16 L 55/165, F 16 L 55/18

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	F 16 L; E 03 F; E 21 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
A	SE, B, 450969 (ENTREPRENAD AB E & G JÖNSSON) 17 August 1987, see page 3, line 17 - line 35; page 4, line 1 - line 13; page 8, line 2 - line 25 --	1,10
A	US, A, 4955755 (A.F. FREY) 11 September 1990, see column 4, line 56 - line 68; column 5, line 1 - line 31 --	1,10
A	EP, A1, 0149528 (BRITISH GAS CORPORATION) 24 July 1985, see page 3, line 15 - line 20; page 4, line 1 - line 4; page 8, line 1 - line 2 --	1,10

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
8th April 1992	1992 -04- 14
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Tommy Blomberg

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