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I-00198 Roma (IT)**(54) **A portable hydraulic pipe bending apparatus with a rotary chain actuated groove pulley matrix and groove countermatrix bending head.**

(57) The subject of the invention is a hydraulically actuated pipe bending apparatus with a rotary bending head, comprising a rotary groove pulley matrix and a countermatrix, which has a groove too, a drive shaft (4) of the matrix and an actuating hydraulic cylinder (8) with a piston rod (6) which by means of its forward active displacements moves the drive shaft (4) of the matrix, wherein the drive shaft (4) of the matrix is moved by the piston rod (6) through two chains (22, 22') wound on the drive shaft so as to be spaced apart from each other and parallel to each other, connected with the piston rod (6) sym-

metrically and parallelly to the axis of the same through a head element (28); the drive shaft (4) being biased to the position of winding of the chains (22, 22') by a spring (26); as well as endowed with an adjustable end of stroke for the piston rod (6), made up by a graduated screw (34) with its axis on the axis of the piston rod (6), the indexes whereof indicate angles of bending of a pipe, with their coinciding with the outer edge of a screw nut (36), through which the graduated screw (34) itself is assembled on the wall of the housing (32) that receives the stroke of the piston rod (6).

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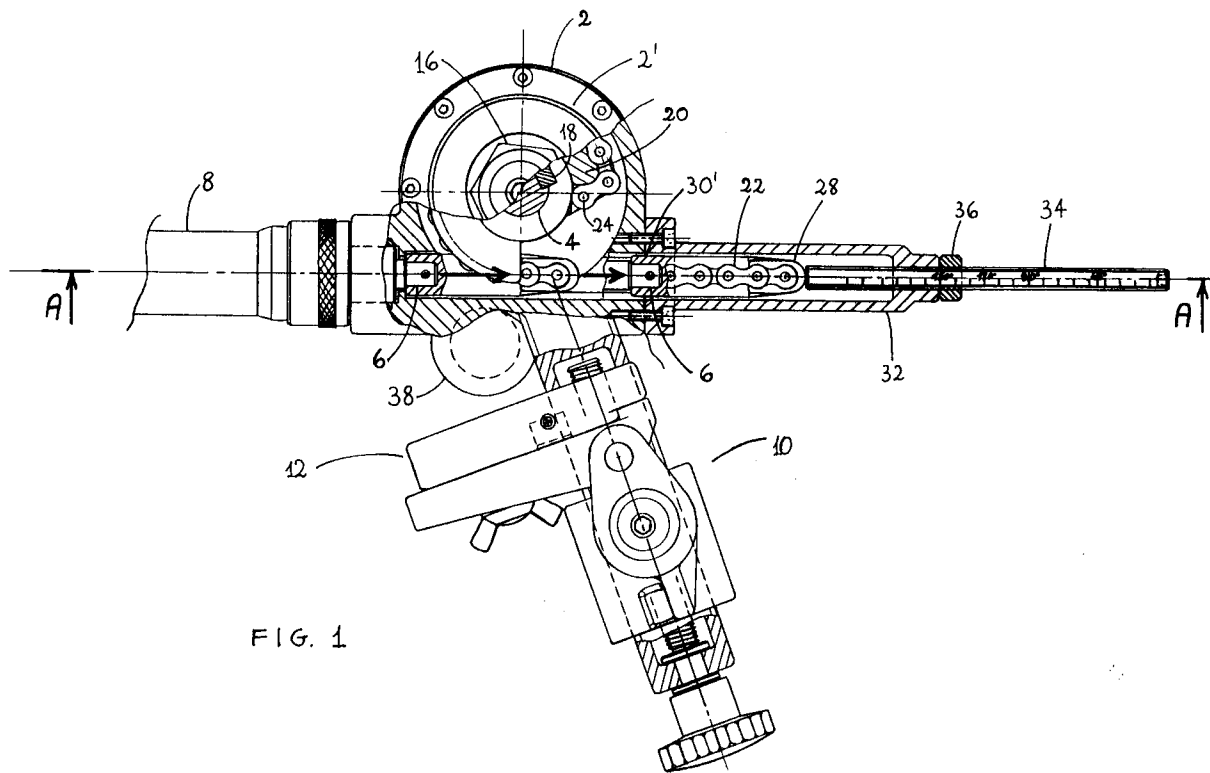


FIG. 1

Field of the Technics

The present invention relates to a pipe bending apparatus.

More particularly, the present invention relates to a hydraulically actuated portable pipe bending apparatus with a rotary chain actuated groove pulley matrix and groove countermatrix bending head.

Prior Art

Pipe benders are apparatuses used to bend pipes according to given curvature radiuses. The bending is performed by means of plastic strain of the tract of pipe to be bent, arranged between two or more supports.

A problem inherent in such an operation consists in the flattening or ovalization of the section of the pipe in correspondence to the tract that undergoes the bending, due to the fact that the fibers at the exterior of the bending are tightened, while those at the interior are compressed.

In order to reduce the ovalization as much as possible, various contrivances have been devised, among the most immediate of which the filling of the pipes with inconsistent materials, such as sand, and the introduction of pliable mandrels into the pipes are enumerated.

However, the entity of the ovalization depends to large measure on the bending conditions too. So, by working on the geometry of the bending head in the art cold pipe bending apparatuses have been realized which require neither fillings, nor special mandrels, with which it is possible to carry out the bending in a simple and quick manner, substantially without ovalization.

In the practice one uses apparatuses of the said type, actuated by means of a pump that generates pressure in a hydraulic cylinder, the piston rod whereof, through its active displacements, moves a bending head.

A particular type of pipe bending apparatus of such a kind is that in which the bending head is made up by a semicircular groove pulley and by a countermatrix, it also with a groove, cooperating with each other, disclosed in the Italian Patent No. 1,155,757, granted to the same Applicant of the present invention. The principle of operation of such an apparatus is that of stress the pipe to be bent to bending arranging the pipe between the grooves of the matrix and of the countermatrix and making the pulley matrix to rotate, under control through the pump, on its axis, the groove of the pulley dragging the pipe by friction along a given bending path.

The bending path corresponding to the desired curvature angle is determined, as disclosed in the Italian Patents No. 1,147, 601 and No. 1,172,068,

granted to the same Applicant of the present invention, by a goniometric scale provided on the periphery of the pulley matrix, that displays the angle to which the pipe bends during the rotation of the matrix, with its index that goes to coincide with a reference position indicated by a notch provided on the periphery of the countermatrix.

The members for driving the pulley matrix are arranged in a box, whereto the hydraulic cylinder converges, and include a drive shaft and a device for transmitting the translatory motion of the piston rod to the shaft. An extremity of the shaft protrudes outside the box and is endowed with a hexagonal head on which the pulley matrix is removably assembled. With such an arrangement this latter can be readily changed to bend pipes of different diametres.

The device for transmitting the displacements of the piston rod to the shaft essentially includes a saw tooth wheel and a pawl, provided on the free extremity of the piston rod, which makes the wheel to rotate by pushing on its teeth, and cooperates with another pawl, loaded by a spring, that stops the saw tooth wheel in the subsequent angular positions whereinto it brings it.

Endless screw and rack transmission devices have been suggested too.

In the above mentioned Italian Patent No. 1,155,757 such an apparatus is disclosed as manually operated by means of a lever, but for it an electromechanical drive is also provided, as disclosed in the Italian Patents No. 1,147,601 and No. 1,172,068, granted to the same Applicant of the present invention, in which the lever is still present, but serves only as a control means.

Technical Problem

A problem relevant to the groove pulley matrix and groove matrix hydraulic pipe bending apparatuses known heretofore relates to the transmission of the displacements of the piston rod of the hydraulic cylinder to the drive shaft of the groove pulley matrix. The transmissions as disclosed above have the drawback that the force applied by the free extremity of the piston rod by means of them is never purely tangential, but has a normal component, which exerts a thrust that doesn't do any useful work, and which, on the contrary, must be contained. Therefore, the presence of this normal component involves that suitable thrust containment means are provided, and the friction consequent to it causes a loss in the power delivered to actuate the bending head, a power loss that can also render the apparatus useless.

Objects of the Invention

The main object of the present invention is to obviate the above mentioned drawback of the power loss that one has with the pipe bending apparatuses of prior art, providing a transmission device through which the piston rod of the hydraulic cylinder exerts a purely tangential force upon the drive shaft of the pulley matrix.

Another object of the present invention is to provide a pipe bending apparatus in which the bending path can be set before the operation.

Summary of the Invention

Therefore, the present invention relates to a hydraulically actuated pipe bending apparatus with a rotary bending head, comprising a rotary groove pulley matrix and a counter matrix, which has a groove too, a shaft for driving the matrix and an actuating hydraulic cylinder with a piston rod that by means of its forward active displacements moves the drive shaft, wherein the drive shaft of the groove pulley matrix is moved by the piston rod through two flexible transmission means wound on the drive shaft in such a manner as to be spaced apart from each other and mutually parallel, connected to the piston rod symmetrically and parallelly with respect to the axis of the same, the shaft being biased to the winding position of the flexible transmission means by elastic reaction means.

According to a preferred embodiment of the present invention, piston rod stroke end means are also provided, adjustable as a function of the desired angle of bending, displayed by a linear scale with the displacement of the latter, with respect to a reference, integrally with the stroke end means themselves.

Particularly preferred embodiments are set forth in the subclaims.

Advantages of the Invention

The basic advantage of the pipe bender of the present invention consists in the fact that applying the driving force to the drive shaft in a purely tangential manner, one hasn't losses in the power delivered to actuate the bending head.

Moreover, with the preadjustable end of stroke, it has an automatism degree that allows the operator not to monitor the course of the bending.

Disclosure of the Preferred Embodiment

The present invention will be best understood on the basis of the following disclosure of its preferred embodiment, given only as a matter of ex-

ample and absolutely not of restriction, with reference to the annexed drawings, wherein:

- figure 1 represents a top view of the pipe bending apparatus according to the present invention, with the pulley matrix removed and with partial removals, and
- figure 2 represents a section view of the same according to line A-A in figure 1.

As can be observed in figure 1, the bending apparatus of the present invention has a box body 2 which houses the drive shaft 4 of the groove pulley matrix (not shown) and the transmission device, and which receives the stroke of the piston rod 6 of the hydraulic cylinder 8. The drive shaft 4 protrudes out of the box 2 with an extremity of its endowed with a hexagonal head 16, as better depicted in figure 2, upon which the pulley matrix is assembled, as disclosed in detail in the above mentioned Italian Patent No. 1,155,757. From the box 2 an arm 10 protrudes which supports the counter matrix assembly 12.

The box 2 has a generally cylindrical wall, integrally with its lower base 2" and closed at its upper base by a circular flanged and axially pierced plate 2', removably joined with screws. The hydraulic cylinder 8 is connected with the box 12 with its axis coplanar with a cross section of the box, and passing through a chord of such a cross section very offset towards the periphery.

The drive shaft 4 has an end tract having minimum diameter 4', with which it is supported by the lower base 2" through a bush 14 assembled in a chamber 14' provided on the lower base 2". The opposite end tract 4" of the drive shaft 4 has maximum diameter and passes through the upper pierced plate 2', as already mentioned. The middle tract has intermediate diameter and on it a tongue 18 is assembled, which couples it in rotation with the transmission device.

The transmission device comprises two equal full disc groove pulleys 20, 20' having the hub in common, constituting an integral piece coupled in rotation with the drive shaft 4 by means of a slot 18' that receives the slid tongue 18. In the grooves of such pulleys 20, 20' corresponding chains 22, 22', fixed to the rims through an extremity of theirs by means of pins 24, 24', are wound substantially for a turn. The assembly of the two pulleys 20, 20' is loaded by a spring 26, as depicted in section in figure 2, which in the rest position keeps the chains 22, 22' wound and which is stressed when these are unwound, exerting a return force. The two chains 22, 22' have the free extremities connected through screws to a common head element 28, which in the winding position is received within notches provided on the pulleys 20, 20' and through which the piston rod 6 of the hydraulic cylinder 8 exerts the traction force on the two

chains 22, 22', unwinding them from the pulleys 20, 20' under a mutual parallelism relationship. The piston rod 6 is connected with the head element 28 through a post 30. The connection takes place parallelly to the two chains and at equal distances from the one and from the other.

Therefore, in the disclosed pipe bending apparatus undesired thrusts don't arise, and the power loss of prior art apparatuses is avoided. Therefore, such an apparatus achieves the object of the present invention.

In its motion the head element 28 gets, together with a tract of the chains 22, 22', out of the box 2 through an aperture 30' made in the side wall of this, to the edges whereof an extended housing 32 is connected, into which the head element 28 penetrates. This extended housing is a metal shell, joined with screws, and endowed at its distal extremity with a graduated stroke end screw 34, arranged on the axis of the piston rod 6, the indexings whereof indicate bending angles of the pipe, with their coinciding with the outer edge of the screw nut 36. It is to be put into evidence that such a housing 32 only performs a function of protection, and not of guide of the forward stroke of the piston rod 6.

Both manual and electrohydraulic drives are provided for the disclosed apparatus. The forward active displacements of the piston rod 6 are imparted through a lever (not shown), while the return displacements are imparted by opening a bleed valve (not shown) of the hydraulic cylinder.

Finally, the body of the apparatus is endowed with a bracket 38 for inserting it on a tripod.

The present invention has been disclosed with reference to a preferred embodiment thereof, but it is to be understood that changes and/or addition can be made, without departing from the scope of protection defined by the appended claims.

Claims

1. A hydraulically actuated pipe bending apparatus with a rotary bending head, comprising a rotary groove pulley matrix and a counter-matrix, which has a groove too, a drive shaft (4) of the matrix and an actuating hydraulic cylinder (8) with a piston rod (6) which by means of its forward active displacements moves the drive shaft (4) of the matrix, **characterized in that**, the drive shaft (4) of the groove pulley matrix is moved by the piston rod (6) by means of two flexible transmission means (22, 22') wound on the drive shaft so as to be spaced apart from each other and parallel to each other, connected to the piston rod (6) symmetrically and parallelly to the axis of the same, the drive shaft (4) being biased to

the position of winding of the flexible transmission means (22, 22') by elastic reaction means (26).

2. The apparatus according to claim 1, further **characterized in that** it comprises means (34, 36) for the end of the stroke of the piston rod (6), adjustable as a function of the desired angle of bending, displayed by a linear scale (34) with the displacement of the latter, with respect to a reference, integrally with the means for the end of the stroke themselves.

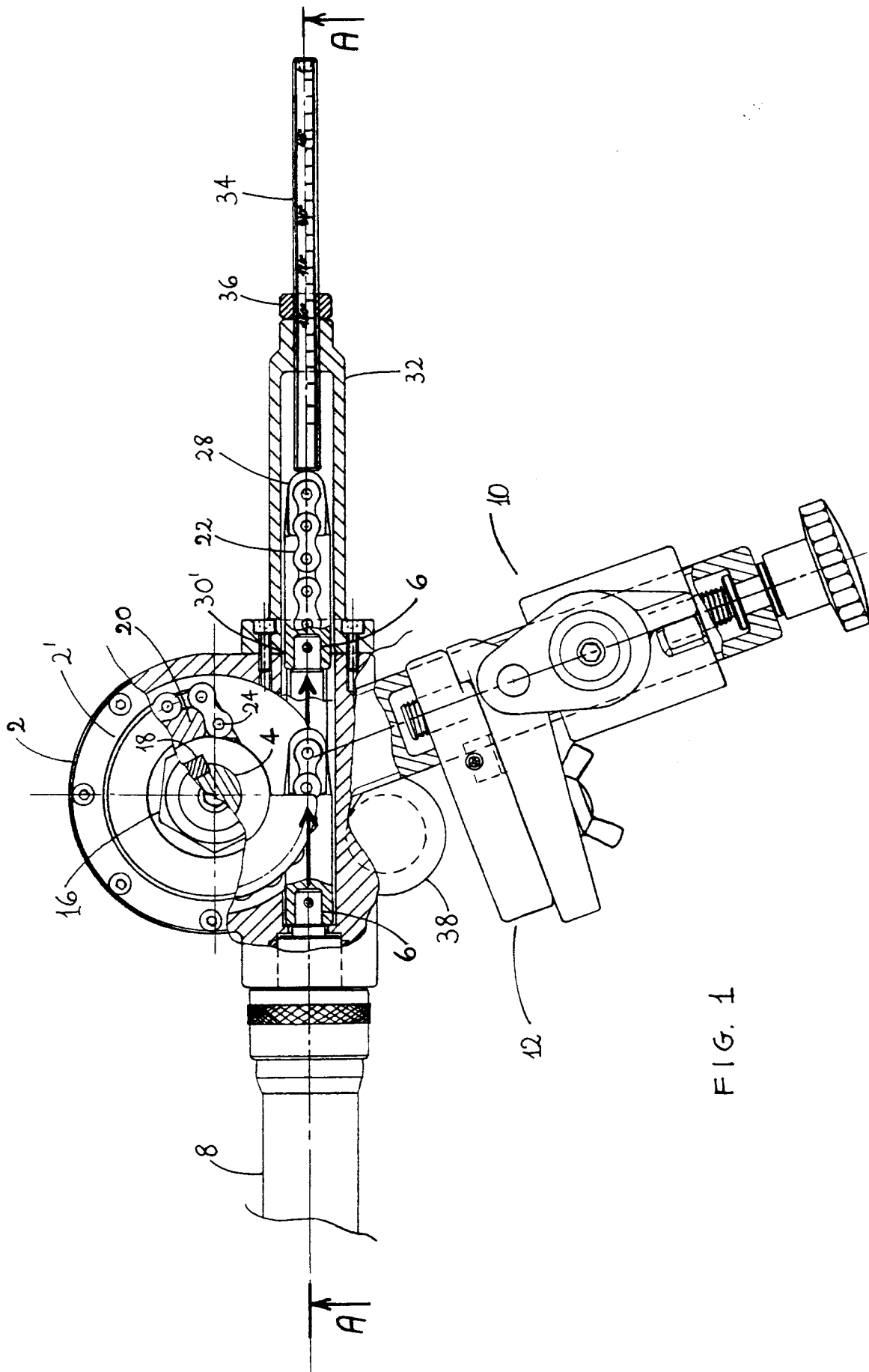
3. The apparatus according to claims 1 or 2, **characterized in that** the flexible transmission means are two chains (22, 22') assembled in the grooves of respective pulleys (20, 20') connected with the drive shaft (4) so as to be spaced apart from each other, in which pulleys they are assembled substantially for a turn, the connection (28) of which chains (22, 22') with the piston rod (6) being received, in the winding position, within notches provided in the pulleys (20, 20').

4. The apparatus according to claim 3, in which the pulleys (20, 20') are full disc pulleys.

5. The apparatus according to claims 3 or 4, in which the pulleys (20, 20') have the hub in common, coupled with the drive shaft (4) through a tongue (18), provided on this, that is received in a slot (18) made in it.

6. The apparatus according to claims 3, 4 or 5, wherein the chains (22, 22') are connected with the piston rod (6) by means of a head element (28) assembled on the piston rod (6) through a post (30).

7. The apparatus according to claim 2, **characterized in that** the adjustable means for the end of the stroke of the piston rod (6) are made up of a graduated screws (34), arranged with its axis on the axis of the piston rod (6), the indexes whereof indicate angles of bedding of a pipe, with their coinciding with the outer edge of a nut screw (36), through which the graduated screw (34) itself is assembled on the wall of the housing (34) that receives the stroke of the piston rod.



Sezione A-A

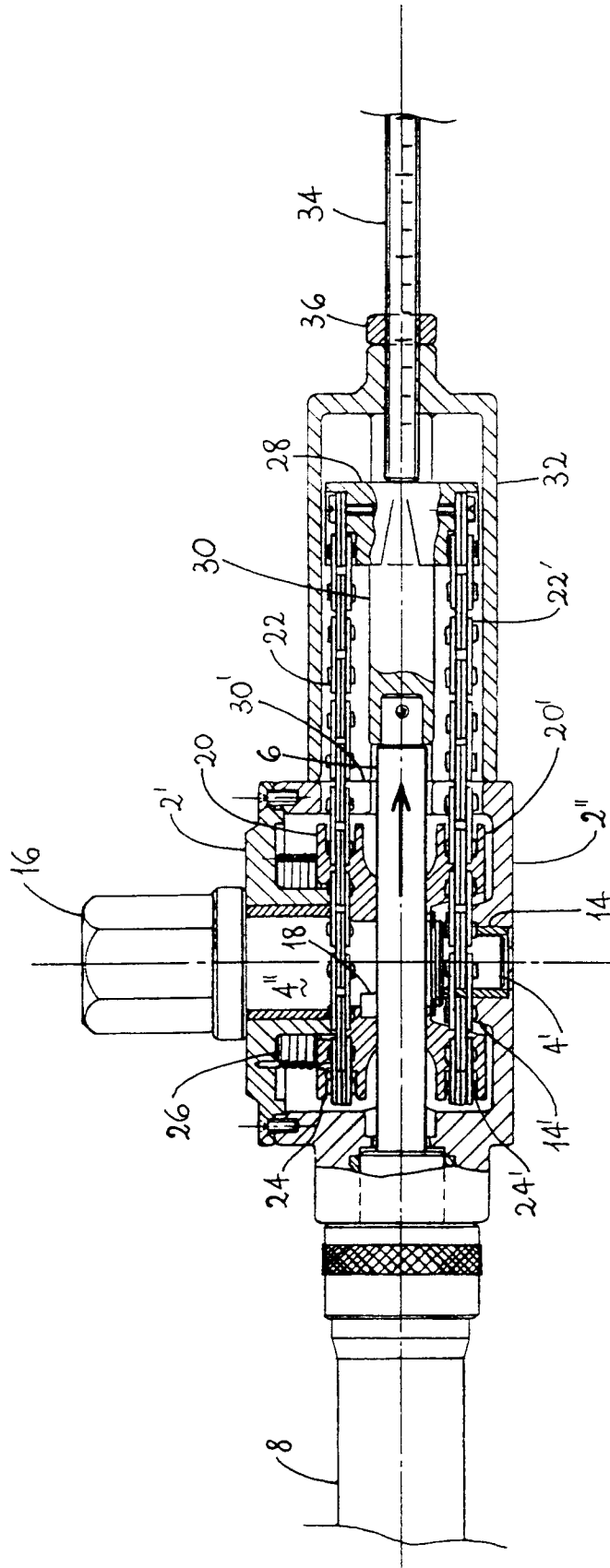


FIG. 2



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EUROPEAN SEARCH REPORT

Application Number

EP 93 83 0092

DOCUMENTS CONSIDERED TO BE RELEVANT

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	DE-A-1 810 226 (COMBUSTION ENGINEERING INC.) * page 4, line 8 - line 31 * * page 5, line 23 - line 31 * * page 6, line 12 - page 7, line 31; figures 1-4 *	1	B21D7/024
Y	---	2-7	
Y	DE-A-2 262 357 (BANNING AG) * page 4, line 16 - page 5, line 12; figures 1,2 *	2,7	
Y	---		
Y	US-A-4 269 054 (HOMER) * column 5, line 28 - line 42; figures 3-10 *	3-6	
A	---		
A	FR-A-1 350 717 (RAMET) -----	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B21D
The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
THE HAGUE	09 JUNE 1993	GERARD O.J.	
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
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