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Method and installation for laying a pipeline on a surface located under water

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(56) Related Art

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ABSTRACT

The invention relates to a method for laying a pipeline (2) on a surface located under water, wherein the pipeline is held fixedly by means of tensioning means (40a-d) which comprise a plurality of tensioning elements (52) each extending between at least one clamping member (48) engaging on the pipeline (2) and at least one support member (45) connected to a vessel (3).

In the known method the tensioning means consist of a plurality of sets of endless clamping bands which apply a braking action to the pipeline. Such a method is not practically suitable for laying a heavy pipeline on for instance a deep sea-bed.

The invention has for its object to provide a method which is practically suitable for this purpose in that at least one first set of clamping jaws (48) is clamped fixedly to the pipeline (2) and then move along with the pipeline from a starting position to a releasing position, while this first set of clamping jaws (48) is held fixedly by means of easing holding means (44) while at least one other set of clamping jaws (48) is released from the pipeline and returned to a starting position.

AUSTRALIA

PATENTS ACT 1990

COMPLETE SPECIFICATION

FOR A STANDARD PATENT

ORIGINAL

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Invention Title:	"METHOD AND INSTALLATION FOR LAYING A PIPELINE ON A SURFACE LOCATED UNDER WATER"

The following statement is a full description of this invention, including the best method of performing it known to us:-

METHOD AND INSTALLATION FOR LAYING A PIPELINE ON A SURFACE LOCATED UNDER WATER

The invention relates to an apparatus and associated method for laying a pipeline on a surface located under water.

One method of laying a pipeline on a surface located under water is disclosed in US-A-5 044 825. The tensioning means consist herein of a plurality of sets of endless clamping bands which apply a braking action to the pipeline. Such a method is not practically suitable for laying a heavy pipeline on for instance a deep sea-bed.

It is an object of the present invention to overcome or ameliorate at least one of the disadvantages of the prior art, or to provide a useful alternative.

According to the invention there is provided an apparatus for laying a pipeline on a surface located under water, said apparatus comprising a vessel which is supported by upward pressure and which is provided with tensioning means for fixedly holding the pipeline, said tensioning means comprising:

a first set of at least two clamping jaws and a second set of at least two clamping jaws, each clamping jaw including a clamping member for engaging on the pipeline and being guided for displacement relative to a support member connected to the vessel by means of one or more tensioning elements;

wherein each set of clamping jaws is connected to a movable holding means and can be clamped fixedly to the pipeline and move along with the pipeline in fixedly clamped position from a starting position into a releasing position, said first and second sets of clamping jaws being alternatingly clampable and releasable and in released position are resettable from the releasing position to the starting position;

said apparatus further including control means for releasing and resetting one set of clamping jaws while the other set of clamping jaws is situated in the clamping position;

wherein said tensioning means effects a clamping force K in a clamping direction which encloses an angle with the radial direction of the pipeline, the tangent of which is smaller than the coefficient of friction of the friction surface between the pipeline and the clamping member.

The tensioning means may be individually displaceable back and forth along the pipeline and these movements may be synchronized with opening and closing of the clamping jaws.

Unless the context requires otherwise, throughout the specification and claims which follow, the word "comprise" and variations thereof, such as, "comprises" and "comprising" are to be construed in an inclusive sense, that is as "including, but not limited to".

The apparatus according to the invention, and particularly preferred embodiments thereof, are described by way of example only with reference to drawings, in which:

Figure 1 shows a side view of an installation according to the invention;

Figures 2 and 3 show on larger scale respectively a perspective view and a working diagram of detail II of figure 1;

Figure 4 shows on a larger scale cross section IV-IV of Figure 2;

Figure 5 shows cross section V-V of figure 4;

Figure 6 shows a diagram of diverse mutual positions of elements of figure 5;

Figure 6A shows detail VAI of figure 6;

Figures 7, 8 and 9 each show a working diagram of four tensioners;

Figures 10 and 11 each show a time schedule relating to the energizing of four tensioners;

Figure 12 shows a cross section corresponding with figure 4 through differently embodied tensioning means;

Figure 13 is a side view of the tensioning means of figure 12;

Figures 14 and 15 show cross sections of figure 12 along line XIV-XIV respectively XV-XV;

Figure 16 is a view according to arrow XVI of figure 15;

Figure 17 is a schematic view of other differently embodied tensioning means; and

Figure 18 shows a cross section corresponding with figure 5 relating to a different embodiment of the tensioning means.

The apparatus 1 of figure 1 for laying a pipeline 2 on a surface located deep under water 7 comprises a vessel 3 with directionally adjustable screws 4 and 5 and bow steering screws 6 with which the vessel 3 can be moved forward in arrow direction 8 under computer control at a set speed and direction irrespective of the flow direction of the water 7. The vessel 3 has a workplace (not shown) where a number, for example two, three or four, of pipe pieces are welded together and these welds protected with anticorrosive layers for the manufacture of pipes 9 with a length for example of 24 m.

At a fitting station 11 the pipes 9 are fitted piece by piece behind a pipeline 12 and an internal weld 13 is made. Other welding layers and the anticorrosive protective layers are then arranged successively from the outside.

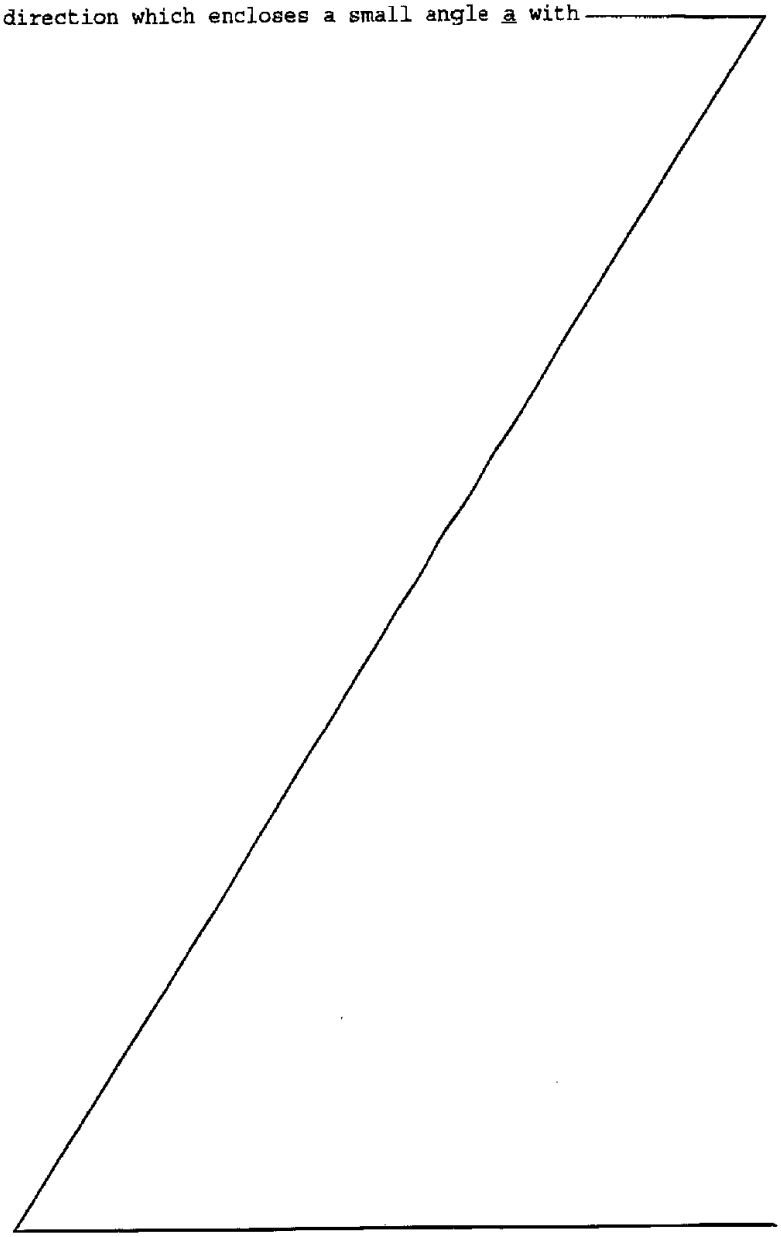
While the pipeline 12 displaces continuously in arrow direction 43 relative to the vessel 3, the pipe 9 for fitting is pushed over a tongue, placed in alignment and welded in place with an internal weld. In the meantime the pipe 9 for fitting is supported by a carriage 21 which moves along with the pipeline 12 at the same speed in arrow direction 43, as does a support carriage 28. A chain conveyor 34 connecting onto a fixed support 31 is present with clamps 35 with which pipeline 12 is supported. Over the area 37 of the chain conveyor 34 the welding layers are laid with welding devices 36 which are likewise moved along with pipeline 12 and which at the end of their area 37 are moved in the opposite direction past

operational welding devices 36 to the start of this area. In the area 38 adjoining thereto the protective layers are applied with per se known application devices 39 which are moved with pipeline 12 and which are moved back after finishing.

The weight of the pipe string 12, which is further guided away in sloping manner to a deep sea-bed via a tail unit 42, has the tendency to slide off the vessel and to sag in too sharp a bend. The vessel 3 is therefore strongly driven with its screws 4 such that the part of pipeline 12 suspended behind vessel 3 is under considerable tensile stress. Situated in the area 38 are tensioners 40a-d (FIGS. 2-6) which can be fixedly clamped independently of each other to pipeline 12 and which can support against the ship frame 41 by means of fluid cylinders 44. Each tensioner 40a-d comprisss a triangular, annular support member 45 which is embodied as a sturdy frame and which is connected to fluid cylinders 44 via hinges 46. Each tensioner 40a-d has a plurality of at least two, for instance three, clamping jaws 48 distributed over the periphery, each clamping jaw including a clamping member for engaging on the pipeline 12. In the preferred embodiment depicted the clamping member comprises a lining 50, for instance brake lining material, which has a considerable coefficient of friction on the outer surface 49 of the pipes 9. The clamping jaws 48 are guided for displacement relative to support member 45 by means of a parallelogram mechanism 51 consisting substantially of three parallel tensioning elements 52 which are connected at hinges 45 to parallel rods 53 for pivoting with some clearance and are connected for pivoting with some clearance to clamping jaws 48 at hinges 55 on one side and to a support member 45 at hinges 54 on the other side.

Further fixed to each clamping jaw 48 and to each support member 45 opposite each tensioning element 52 is a wedge 57, the wedge surface 58 of which co-acts with a roll surface 59 of a tensioning element 52. In the clamping

position, wherein a fluid cylinder 60 urges the tensioning elements 52 into their clamping position, these tensioning elements 52 effect a clamping force K in a clamping direction which encloses a small angle a with



the radial direction of pipeline 12. The tangent of angle a is preferably smaller than the coefficient of friction b between the outer surface of an outer jacket 49 and the lining 50.

If the tangent of angle a is greater than said coefficient of friction b, more tensioners 40 will have to be present and/or at least another one tensioner of another type will be required to hold the pipeline 12.

In the case the clamping force on the clamping jaws 48 engages centrally, the clamping jaws 48 are preferably formed with an inner radius which is slightly smaller than the outer radius of pipe string 12 so that after tensioning of the clamping jaws 48 onto pipeline 12 the surface tension is distributed roughly uniformly over the clamping surface. There are at least two, but preferably three, four or more tensioners 40 present.

Shown in figure 6 are the successive positions of a clamping jaw 48, tensioning elements 52 and rods 53 relative to a support member 45, wherein in figure 6A is shown on larger scale the displacement of a hinge 54 relative to a support member 45, which means that the required freedom of movement S of for instance 3-4 mm and a freedom of movement t of for instance 20 mm are present there. To this end the hinge 54 contains a rubber bearing cushion.

In the case of three clamping jaws 48 per tensioner, successive tensioners 40 are shifted through an angle of 60° relative to each other in order to reduce the required space.

Figure 7 shows schematically the successive steps of operation of the cylinders 44, wherein the energizing or non-energizing of tensioners 40 is designated in the fixedly clamped position and in the released position respectively with black wedges 57a and white wedges 57b. In figure 7 at least two tensioners 40 at a time are always energized, which then hold pipeline 12 in fixedly clamped position, while the hydraulic cylinders 44 provide power as easing holding means.

The same is shown in figure 8, although now in combination with pipe thickening 62. Figure 8 shows that

it is possible to allow the strengthening means 62 to pass through without fixedly clamping the pipeline 12 at that position.

Figure 9 shows schematically the same as figure 7, but such that now three tensioners 40 are continuously in clamping condition instead of two. The holding capacity is in this case for instance 3 x 400 = 1200 tons, i.e. a higher holding capacity at a lower displacement speed.

Figure 9 shows how the released set of clamping jaws 57b are reset from the releasing position 57b to the starting position 57b1, whereafter in a following step these same clamping jaws are clamped on and are then held fixedly in already easing manner.

Figures 10 and 11 show by means of lines E the speeds D in m/minute for the four tensioners 40 plotted against the time in seconds, in combination with the clamping condition closed (line portion F) and open (line portion G).

The embodiment variants of tensioners 40 according to figures 12-16 comprise wedge-shaped clamping jaws 48 which are each guided in a guide 65 of the annular frame 66 of a tensioner 40 using their guide element 67 and which are urged into and out of their tensioning position by means of fluid cylinders 60 which engage on ears 68. Each clamping jaw 48 has two wedge surfaces 70, wherein a roller chain 71 supports against an internal wedge surface 72 of a frame element 73 of the substantially triangular, annular support member 45, which frame element 73 inclines in the same direction as wedge 48. The roller chain 71 could be replaced by a straight series of rollers enclosed in an elongate roller cage.

According to figure 17 a pipe string 12 is held fixedly by means of clamping jaws 48 which are urged into their clamping position by sturdy parallel rods 80 which engage on these clamping jaws 48 and on an annular support member 45 by means of sturdy hinges 81. The support member 45 of each tensioner 40 is again displaced by means of cylinders 44.

Using the tensioners 40 according to the invention a heavy pipe string 12 can be laid at a depth of several

kilometres on a sea-bed. Pipeline 12 then weighs for instance 1200 tons, which is supported in each case by for instance three tensioners 40 simultaneously.

In the above stated embodiments the pipeline 12 is supported in each case by a supporting body which is the vessel 3 of a pipe-bedding installation.

It is conceivable for the pipe string to be substantially or at least partially supported by a trunk having much lifting power which is situated in the water beneath the tail unit 42. In this case the fluid cylinders 44 engage between contact points on the trunk on one side and ring frames 45 of tensioners 40 on the other.

According to figure 18 a pipeline 12 is held fixedly by for instance four sets of clamping jaws 48, of which only one set is drawn, which are clamped onto pipeline 12 in radial direction, for instance by means of hydraulic cylinders 76. Herein the clamping jaws 48 are held directly by fluid cylinders 44. During clamping on of clamping jaws 48 by means of cylinders 76 the clamping jaws 48 move in the direction of arrow 75 while cylinders 44 exert a holding force thereon. During the subsequent release of clamping jaws 48 they are retracted by cylinders 44 while pipeline 12 is then held fixedly by three other sets of clamping jaws 48.

Instead of fluid cylinders winches with cables can also be employed, wherein the holding energy of the then paying out winches is then converted into electrical energy in for instance electric generators.

The invention can also be applied with other pipeline delivery methods than that wherein the pipeline is delivered in an S-shape. The invention can thus also be applied in a method wherein a pipeline is rolled up on a large reel and unwound from this reel.

The pipeline 12 can be delivered from pipelayer 1 continuously or intermittently.

According to figure 19 the pipeline is held fixedly with four tensioners 40, each consisting of two, three or more clamping jaws 48 distributed over the periphery. Each clamping jaw 48 is connected via a hydraulic cylinder 83 and two hydraulic cylinders 84 to a frame 82

mounted fixedly on vessel 3. During normal operation at least two of the tensioners 40 are always clamped onto the pipeline 2 and in the case of calamity at least three.

The cylinders 84 of the clamped tensioners 40 mainly provide the clamping force but also a holding force, while cylinder 83 provides mainly a holding force in the clamped-on situation.

Cylinders 83 further provide for resetting of clamping jaws 48 when cylinders 84 are not energized. These tensioner 40 are easy to adapt to diverse coefficients of friction of pipelines 2 by choosing the starting position for clamping of clamping jaws 48 such that the tangent of the angle a of cylinders 84 is smaller than this coefficient of friction. Particularly if many, for instance six, clamping jaws 48 are used per tensioner an ideal grip is obtained on the pipeline, even in the case of different diameters or non-roundness of the pipeline. These tensioners can be constructed compactly with high tensioning capacity.

If desired, the pipeline 2 can be released with certainty at any moment, for instance in the case of calamity, by de-energizing all cylinders 83 and 84.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. Apparatus for laying a pipeline on a surface located under water, said apparatus comprising a vessel which is supported by upward pressure and which is provided with tensioning means for fixedly holding the pipeline, said tensioning means comprising:

a first set of at least two clamping jaws and a second set of at least two clamping jaws, each clamping jaw including a clamping member for engaging on the pipeline and being guided for displacement relative to a support member connected to the vessel by means of one or more tensioning elements;

wherein each set of clamping jaws is connected to a movable holding means and can be clamped fixedly to the pipeline and move along with the pipeline in fixedly clamped position from a starting position into a releasing position, said first and second sets of clamping jaws being alternatingly clampable and releasable and in released position are resettable from the releasing position to the starting position;

said apparatus further including control means for releasing and resetting one set of clamping jaws while the other set of clamping jaws is situated in the clamping position;

wherein said tensioning means effects a clamping force K in a clamping direction which encloses an angle with the radial direction of the pipeline, the tangent of which is smaller than the coefficient of friction of the friction surface between the pipeline and the clamping member.

2. The apparatus as claimed in claim 1, wherein the tensioning elements includes a plurality of pivoting rods enclosing a small angle with the radial direction of the pipeline.

3. The apparatus as claimed in claim 1, wherein the tensioning elements includes a plurality of roller elements, each clamping jaw and each support member including a wedge surface which cooperates with one or more

of said roller elements to effect movement of the clamping jaw to a clamped position.

4. The apparatus as claimed in any one of the preceding claims, wherein the tensioning elements are moved from their clamping position by means of a power unit.

5. The apparatus as claimed in claim 4, wherein said power unit comprises a hydraulic cylinder.

6. The apparatus for laying a pipeline on a surface located under water, substantially as hereinbefore described with reference to the accompanying drawings.

DATED this 9th Day of March, 2000

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Attorney: RUSSELL J. DAVIES
Fellow Institute of Patent Attorneys of Australia
of BALDWIN SHELSTON WATERS

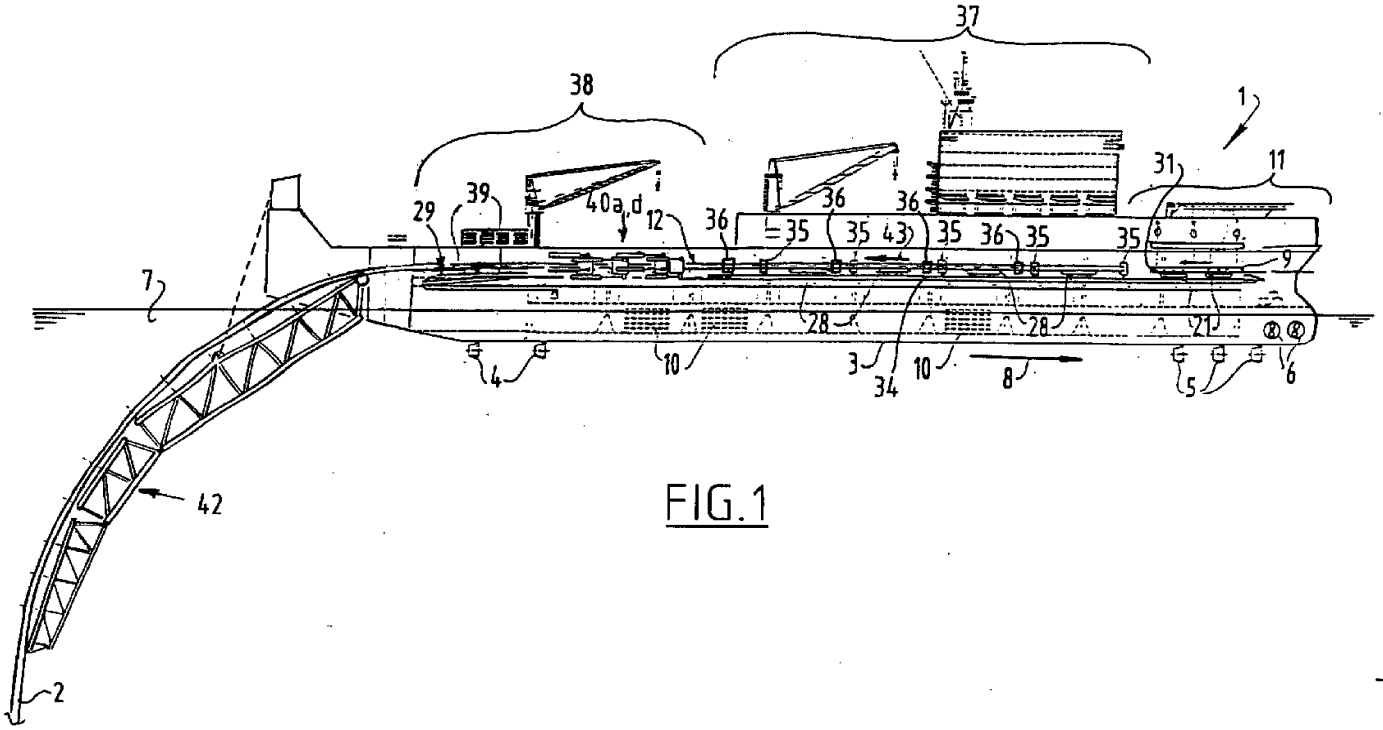

FIG.1

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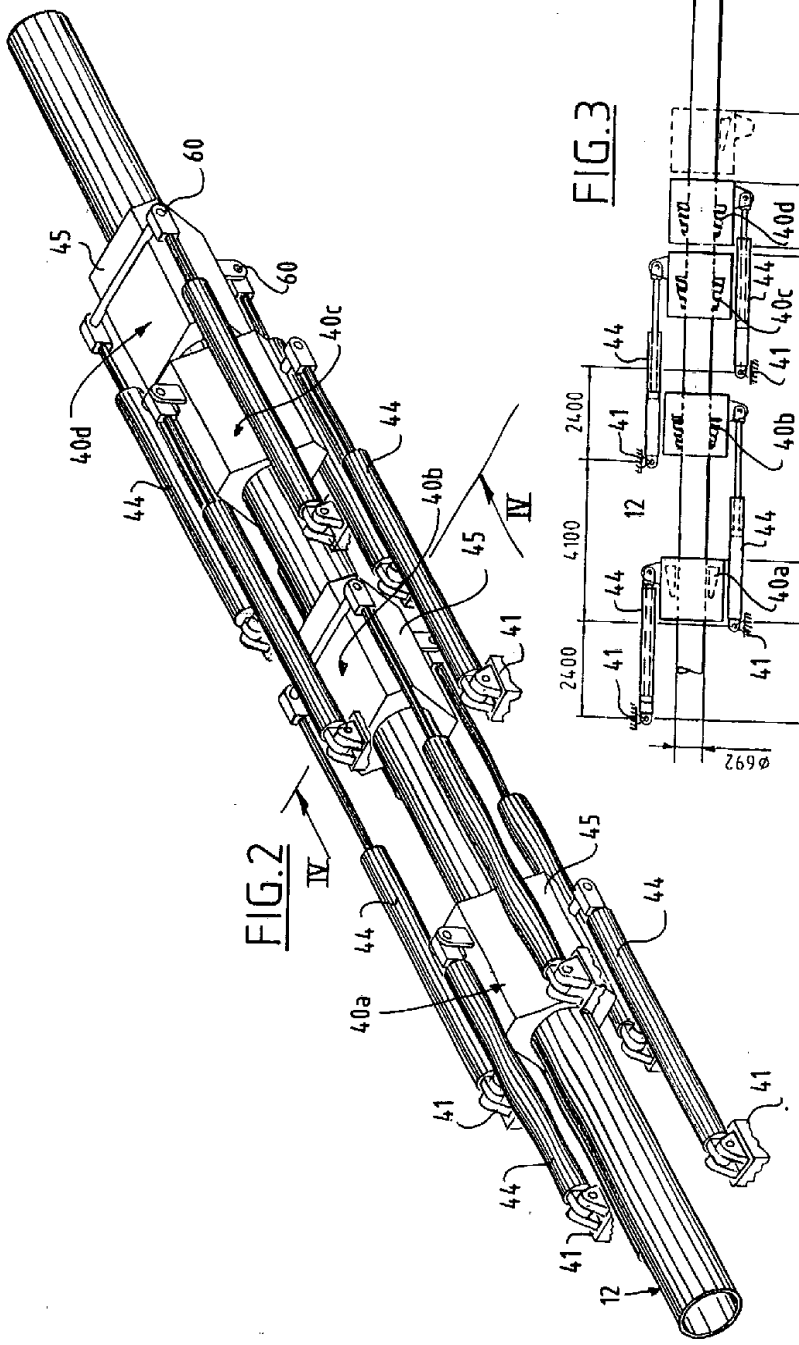

FIG.2

FIG.3

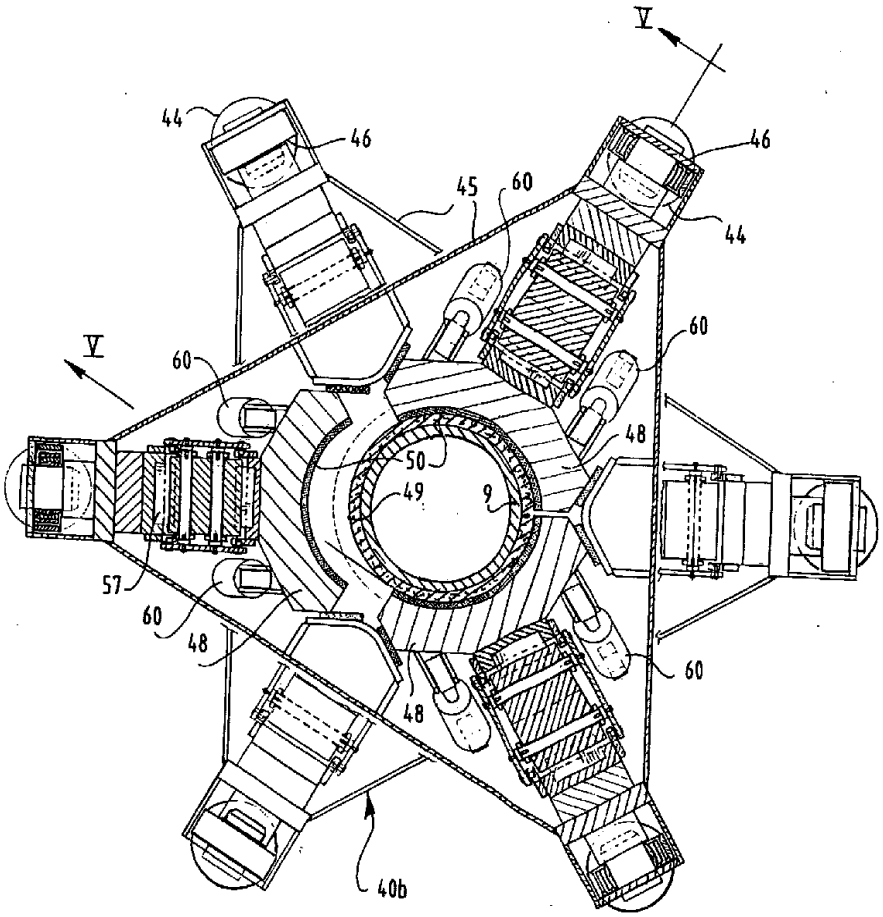

FIG.4

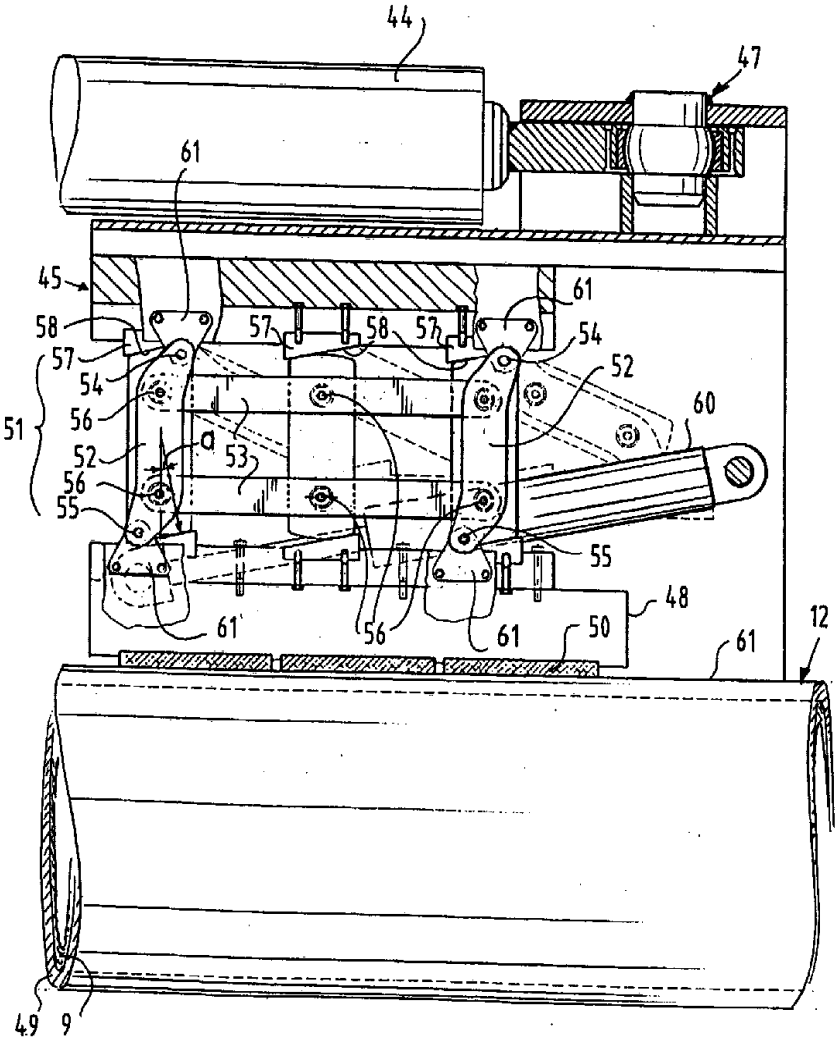
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FIG.5

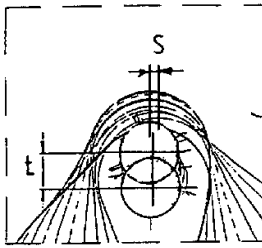

FIG.6a

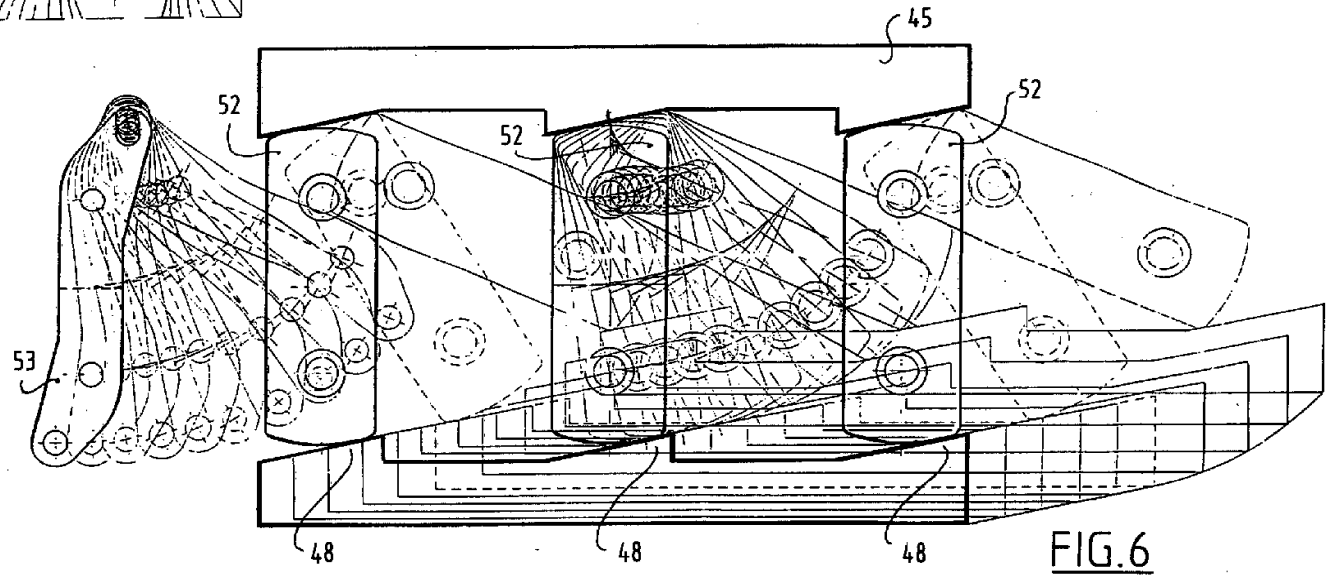

FIG.6

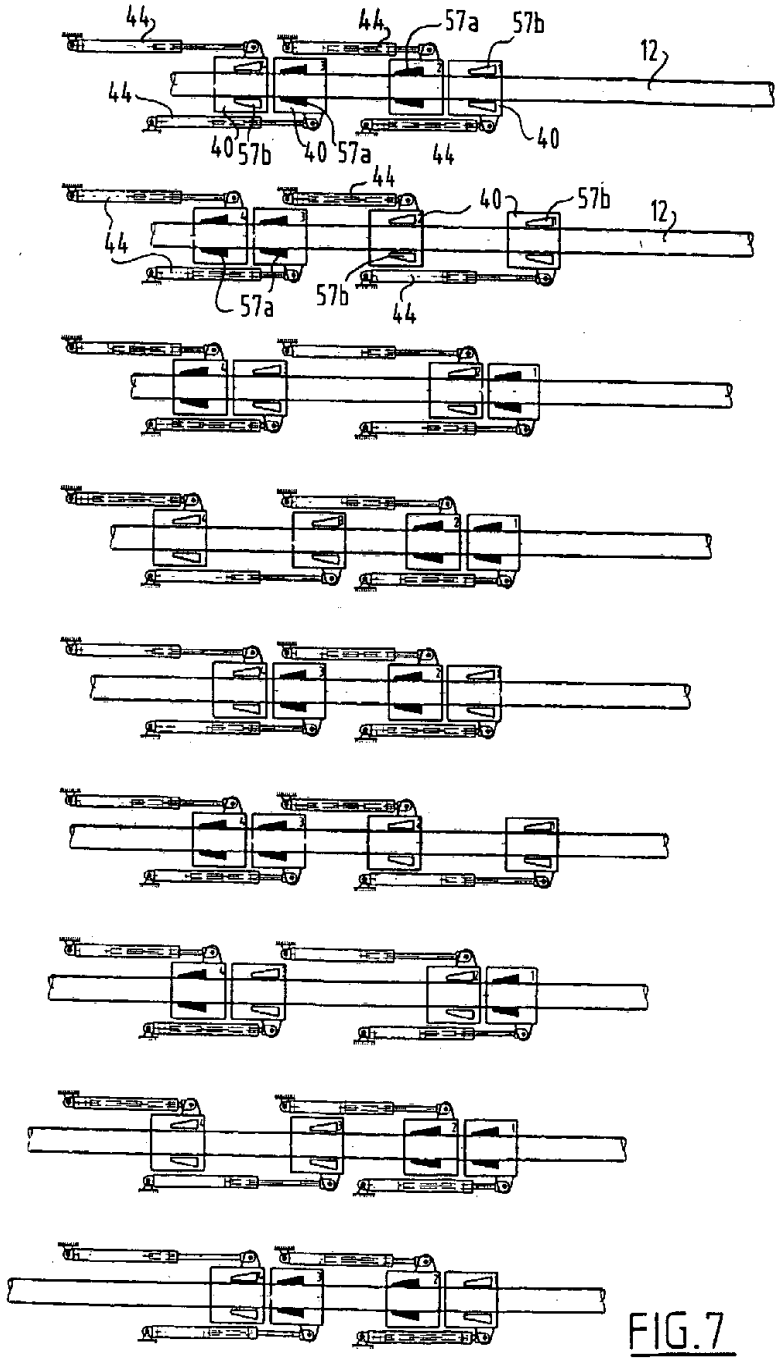

FIG.7

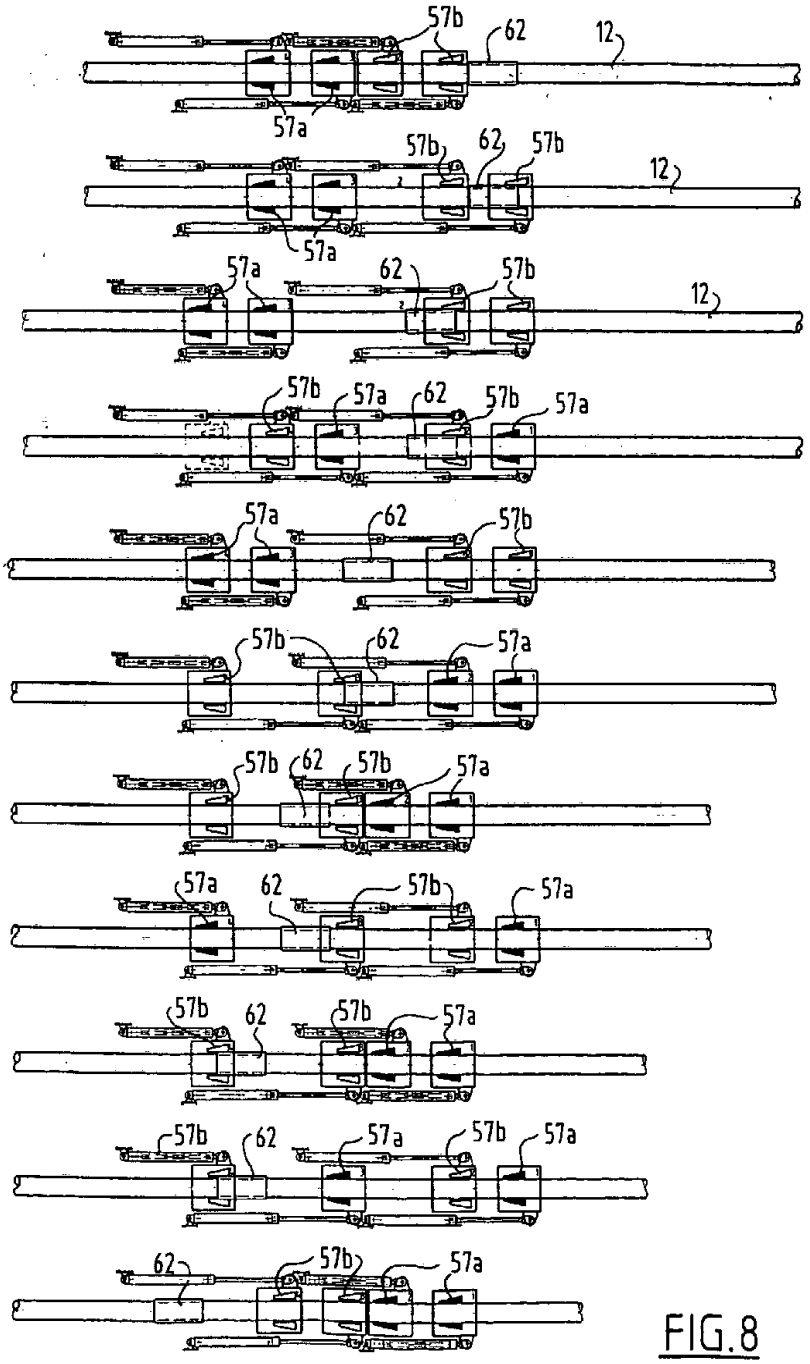
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FIG.8

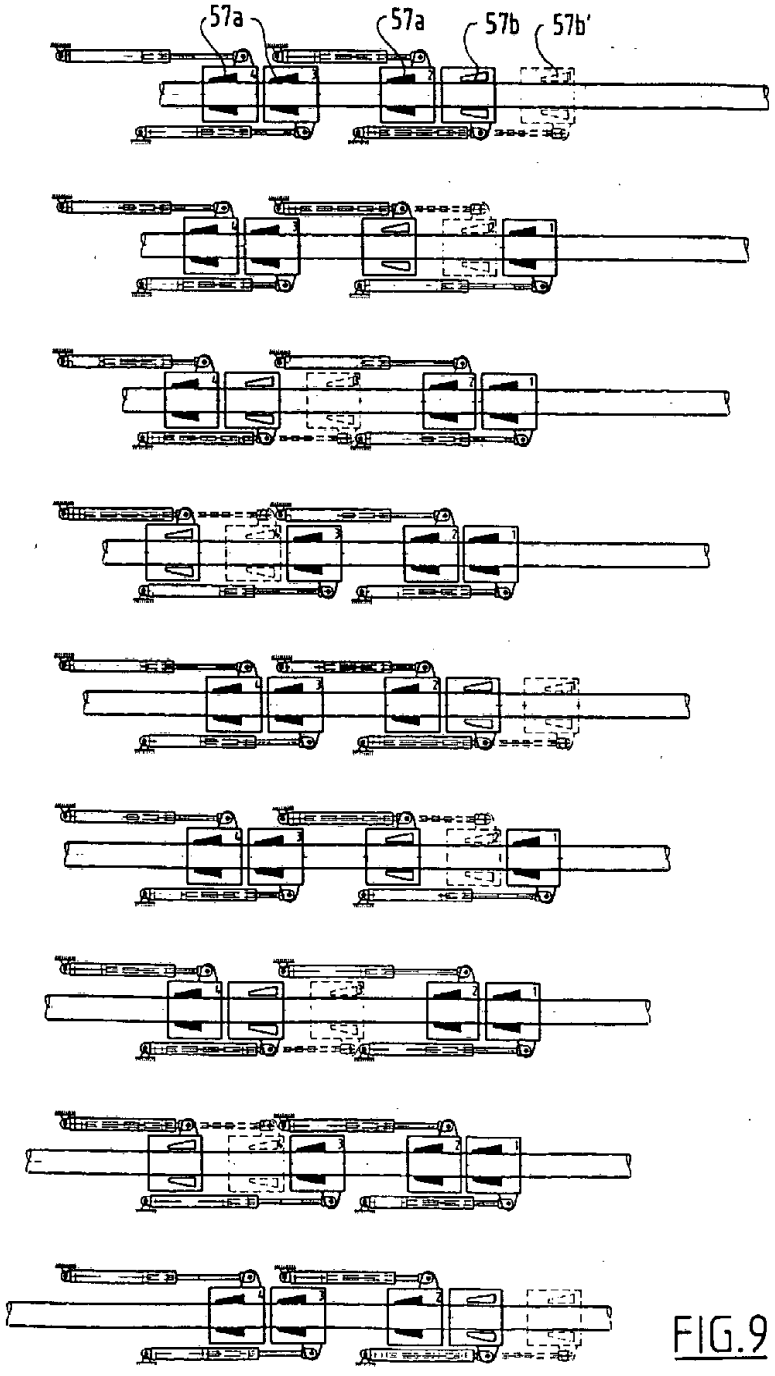

FIG.9

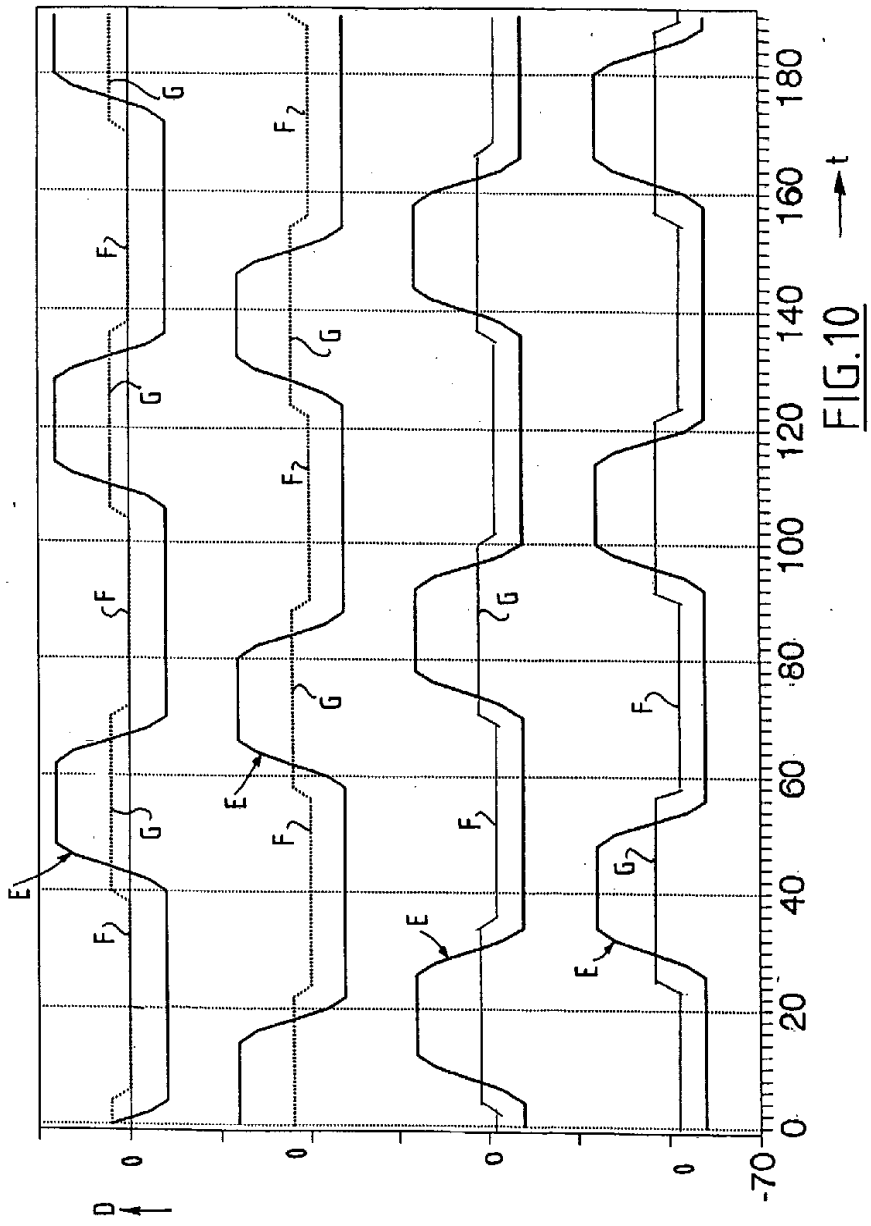

FIG.10

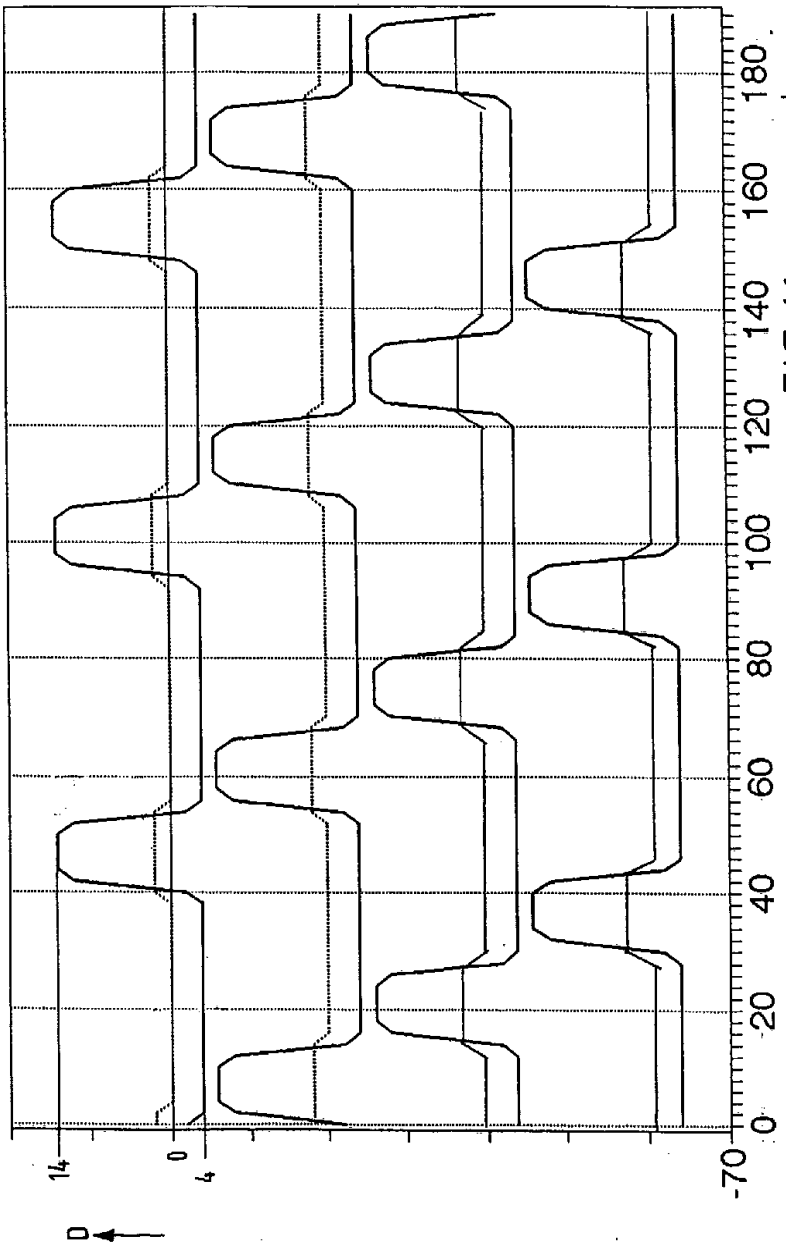

FIG.11

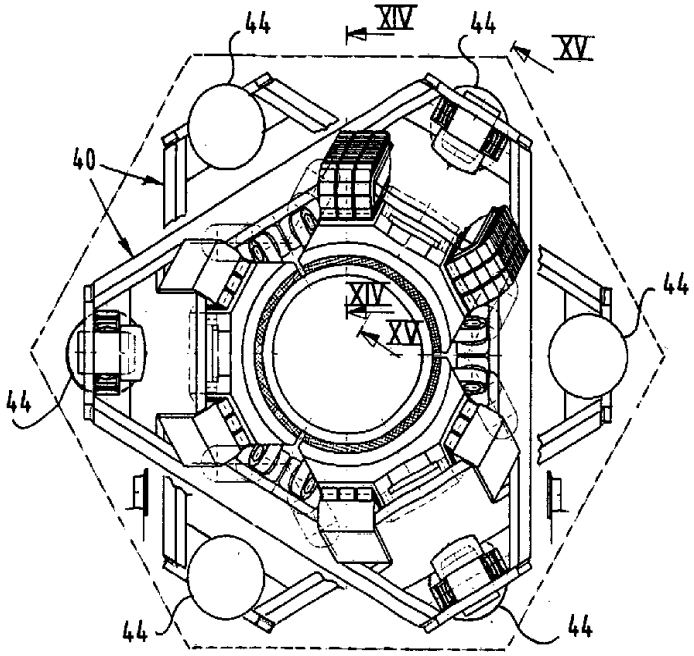

FIG.12

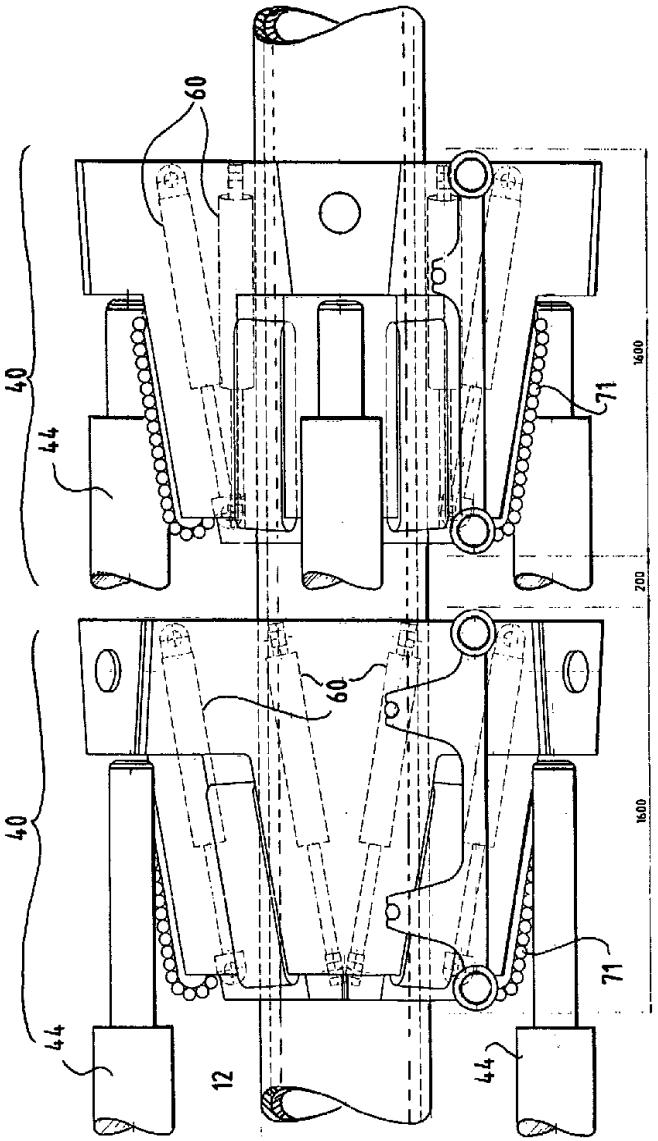

FIG.13

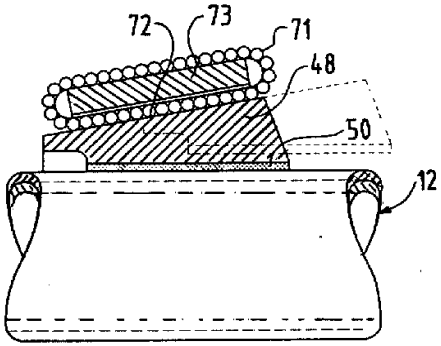

FIG.14

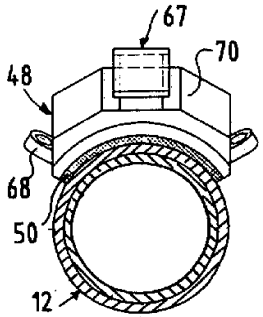

FIG.16

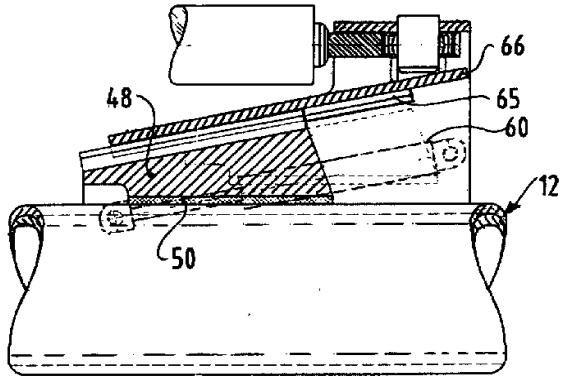

FIG.15

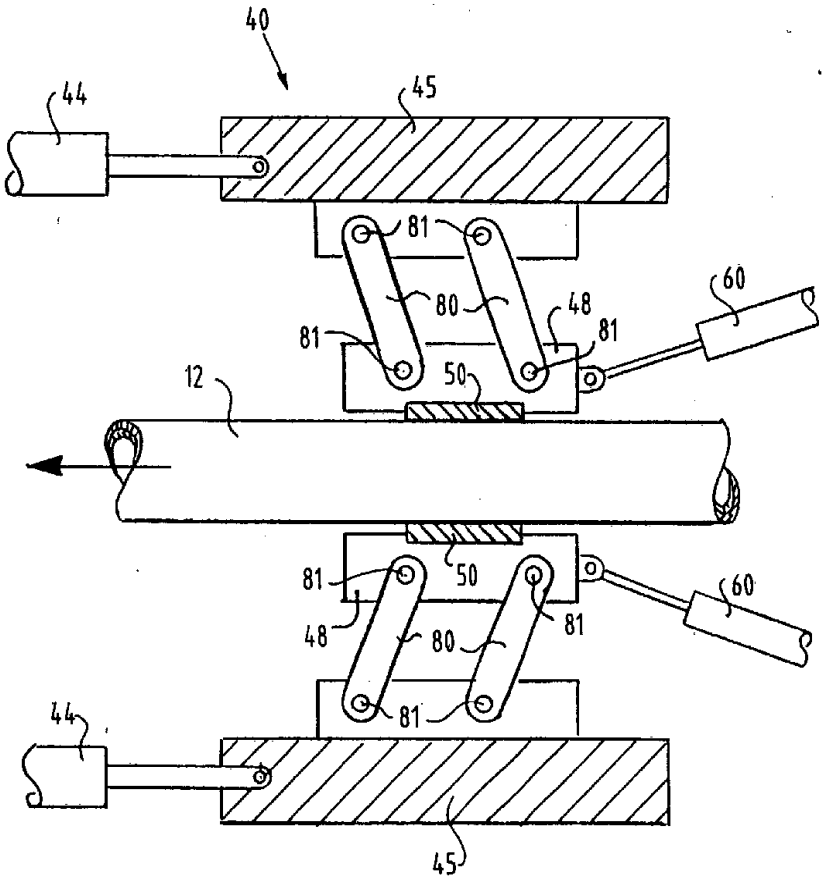

FIG.17

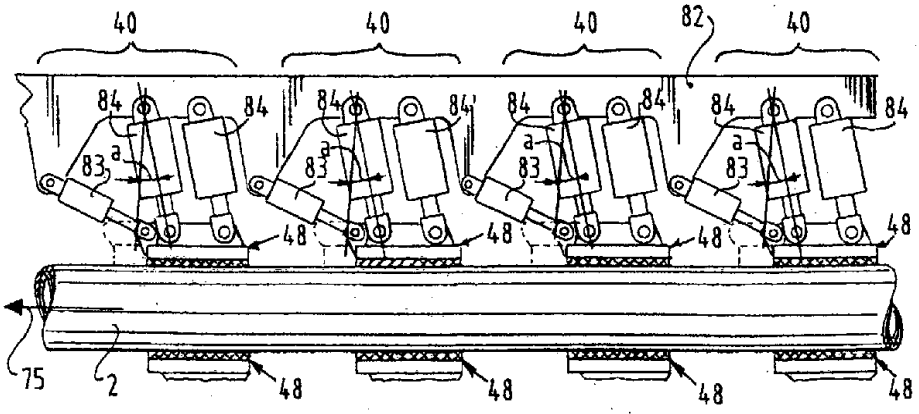

FIG. 18