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(54) Braided stranded rope forming machine.

(57) This machine for forming metal ropes in the form of braided strands or filaments comprises at least one lower (9) and at least one upper (34) spool assembly, the assemblies undergoing mutually opposing revolution about a vertical axis (36) containing the point of formation of the rope generated by the filaments or strands (24, 34T) originating from said spools, the spools of the lower assembly (9) and those of the upper assembly (34) being driven with rotary motion about the torsion axis (D', 35) of the respective filaments or strands in opposite directions (D, Y), each filament or strand (24, 34T) being presented to the point (25) of formation of the rope (42) alternately on opposite sides with respect to the other.

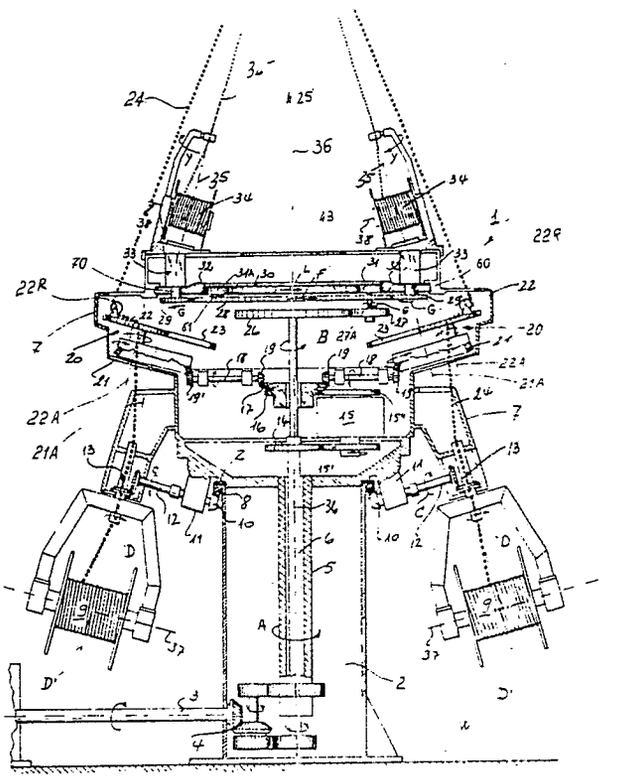

Fig. 1

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BRAIDED STRANDED ROPE FORMING MACHINE

This invention relates to a machine for forming ropes in the form of braided filaments or strands.

Machines for forming braided stranded ropes having the characteristic of not undergoing torsion when subjected to tension are already known. Such a machine is that described in Italian patent application No. 2934A/79 in the name of WABING S.p.A., to which reference should be made for completion of documentation.

Although said machine is considerably faster than previous machine types, it produces a rope having a strength less than that predicted.

In said machine, several filaments or strands unwind from their supporting spools by the effect of the circular trajectory with which these latter are driven, and interlace with second filaments or strands undergoing reciprocating translational movement and unwinding from several spools rigid with the ground.

It has been noted that in a rope produced in this manner, for each unit of filament or strand which unwinds from one of the spools rigid with the ground, a greater quantity of filament or strand unwinds from one of the spools which undergo rotary motion.

This it has been ascertained is due to the fact that two strands undergo combination by two different types of movement.

Because of this, when such a rope is subjected to traction, the strands originating from the fixed spool are more stressed than those originating from the rotating spools, with the result that these latter begin to have an effect only after the former have stretched.

As the strands do not uniformly respond to the stresses, the rope performance obviously suffers.

An object of the present invention is to provide a machine for forming ropes in the form of braided strands or wires which is able to obviate the aforesaid drawbacks, while maintaining the operating speed of the original machine unaltered.

This and further objects of the invention will be apparent to experts of the art on reading the detailed description given hereinafter.

This machine for forming ropes in the form of braided strands or filaments is characterised by comprising at least one lower (9) and one upper (34) spool assembly, the assemblies undergoing mutually opposing revolution about a vertical axis (36) containing the point (35) of formation of the rope (42) generated by filaments or strands (24, 34T) originating from said spools, the spools of the lower assembly (9) and those of the upper assembly (34) being driven with rotary motion about the torsion axis (D', 35) of the respective filaments or strands (24, 34T) in opposite directions (D, Y), each filament or strand being presented to the point (25) of formation of the rope (42) alternatively on opposite sides with respect to the other.

The invention is illustrated by way of non-limiting example in the figures of the accompanying drawings, in which:

Figure 1 is a diagrammatic section through part of the machine according to the invention;

Figure 1A is a perspective detailed view of some elements of the upper part of the machine, showing the means for allowing movement of the strands of lower origin;

Figure 2 is an overall side view of the machine, with some parts omitted for representational clarity;

Figure 3 is a side view of one type of rope produced by the machine;

Figure 4 is a cross-section through another type of rope produced by the machine.

In the aforesaid figures, the braider according to the invention, indicated overall by the reference numeral 1, consists of a base 2 into which there extends a drive shaft 3 terminating in a bevel gear pair 4. This bevel gear pair drives a first shaft 5 and a second shaft 6 which rotate in the same direction and both having their axis coinciding with the machine vertical axis 36.

The first shaft 5 rotates (in a direction which for clarity is referred to hereinafter as clockwise) an upper machine structure or carousel 7 which rests on the base 2, in correspondence with a thrust bearing Z disposed at the top thereof.

Six lower equidistant spools 9 (only two of which are shown in the figures) are directly rigid with the rotatable structure 7. They are linked to a fixed ring gear 8 of the machine by means of a bevel gear 10, a reduction gear 11, a shaft 12 deriving from the reduction gear 11, and a bevel gear pair 13. Said spools 9 of said assembly therefore rotate about said vertical axis 36, about an unwinding axis 37, and about the axis of torsion D' of the strand 24 unwinding from the spool 9. The strand path is indicated by a series of dots. The larger dots (24) indicate the strands originating from the lower spools 9 and the smaller dots (34T) indicate the strands originating from the upper spools 34 (and which will be described hereinafter).

The shaft 6 is connected to a gear 14 which transmits movement to a gear wheel 15', which operates a further gear 16 by way of a gear wheel 15". If constructional requirements (determined by the machine dimensions) demand it, a conventional intermediate gear unit can be disposed between the gear wheels 15' and 15" to increase the radial acceleration required for rope braiding, as de-

scribed hereinafter.

The gear 16 is rigid with a bevel ring gear 17, which transmits motion to a series of radial shafts 18 by means of bevel gears 19 keyed onto one end of them. The radial shafts 18 carry at their other end further bevel gears 19' for driving six thread guide devices, indicated overall by 20. For simplicity of illustration, only two diametrically opposite devices 20 are shown in the figures.

Each thread guide 20 consists of a first base bevel gear 21 of axis 21A, which causes a second gear 22 to revolve about said axis 21A so that it derives its own rotation about its axis 22A by virtue of its engagement with a fixed internally toothed ring gear 23, the axis of which coincides with said axis 21A. Said fixed ring gear 23 comprises a number of teeth which is twice that of its orbiting gear wheel 22, with the result that a deviation pulley 22R fixed eccentrically on this latter for the purpose of guiding the strand 24 of its particular spool 9, is subjected to essentially radial rectilinear movement.

The strands 24, which originate from the lower spools 9 and are to be directed towards the point 25 for formation of the rope 42, therefore pass along the axes D' and 22A and then around the deviation pulley 22R.

The shaft 6, which passes freely through the gear assembly 16-17, extends to terminate in a gear wheel 26 which transmits movement to at least one gear wheel 27.

The pin 27A of the gear wheel 27 is fixed eccentrically, in the manner of a crankpin, on a gear wheel 28 rigid with the carousel 7 and thus rotates with it. By virtue of this, the pin 27A is moved in orbital motion about the main central vertical axis 36 of the machine, while at the same time causing its gear wheel 27 to engage and rotate on the drive gear wheel 26 at a speed determined by the engagement ratios used "upstream" at 4. The pin 27A carries a gear wheel 31 which engages the inner toothing of six spaced-apart coplanar annular segments 32 mounted rotatable in an annular guide 60 which is also formed from spaced-apart annular segments, and is fixed to the carousel 7.

A series of gear wheels 31A which are coplanar with each other and with the gear wheel 31 also engage said annular toothed segments 32, and are idly supported on the upper end of pins 61 rigid with the gear wheel 28. The assembly formed by the gear wheel 31 and 31A is therefore distributed along a circle, and the annular segments define a ring 36 which is discontinuous by virtue of the presence of the spaces 32S between the segments (see Figure 1A).

The discontinuous ring 30 formed from the segments 32 rotates in a direction P opposite to the direction F of the gear wheel 28 (ie of the carousel 7), and its axis coincides with the axis 36. The gear wheel 31 therefore behaves as a motion-inverting idle gear wheel. It should be noted that the arrow L does not pertain to the ring 30, but to an externally toothed gear wheel 43 which links together the motion of the numerous pinions 31A disposed circumferentially on the gear wheel 28 in such a number that at least one is always engaged with the segments 32 of the ring 30, independently of the gaps 32S present therein. The ring 30 therefore moves in a direction P the reverse of the direction L indicated in Figure 1, by virtue of its internal toothing, whereas the gear wheel 43 comprises external toothing.

Each annular segment 32 of the ring 30 carries a support structure 33. Internal to this support structure there cooperates a shaft 70 which, below the relative segment 32, comprises a gear wheel 29 engaged with the gear wheel 28. Above the segment, the shaft 70 comprises an internally toothed bevel gear 18 engaging with a bevel gear 81 keyed on a shaft 82 inclined to the shaft 70. The shaft 82 is also supported by the annular segment 32 by way of the structure 33, and carries the upper spool 34. The strand 34T unwinds from the spool 34 and passes through the guide 36 associated with the spool, which rotates about its axis 38 and about the geometrical axis 35 of the shaft 82. By virtue of the described arrangement, the upper spools 34 are compelled to remain at a constant distance apart, as if they were joined together, or as if the ring 30 were formed in a single piece (instead of six segments 32).

The need for the gap 32S between the toothed segments 32 derives from the radial movement to which the strands 24 (originating from the spools 9) are subjected by the effect of the orbiting of their deviation pulley 22R (Figure 1). In this respect, the strands 24 must wind about a pair of successive strands 34T originating from the group of six upper spools 34, so that during the complex rotation of the machine parts, the strands 24 must lie alternatively in an inner and then an outer position with respect to the upper spool 34, ie with respect to the axis of rotation 35 of this latter.

The amplitude of this travel of the strands 24 from the spools 9 in order to wind about a pair of strands 34T originating from two consecutive upper spools 34 is such as to "cut" at 32S the ring gear 30 and the relative guide 60, which are therefore formed from various segments. These segments are shown as six in number, on the assumption that the machine 1 is provided for forming ropes comprising twelve strands, namely six strands 34T and six strands 24.

The spools 9 and 34 rotate not only about their respective unwinding axes 37 and 38 but also

about the torsion axes orthogonal to these, the spool 9 rotating about itself on the torsion axis D', and the spool 34 rotating about itself by orbiting torsionally in the direction Y about the axis 35, to cooperate with the other braiding movements.

During operation, the power from the shaft 3 is divided between the shafts 5 and 6, which rotate in the same direction shown by the arrows A and B. The base 2 and relative gear wheel 8 remain rigid with the ground W, while the upper structure or carousel 7 rotates clockwise, resting on the thrust bearing Z, to thus impress on the lower spools 9 a revolving movement about the vertical machine axis 36 in the same direction A.

The bevel gear 10 is driven in the direction indicated by the arrow C, and motion is transmitted by the elements 11, 12, 13 to the spools 9 to cause them to rotate in an anticlockwise direction in accordance with the arrow D.

The gear wheel 22 of the thread guide 20 rolls along the interior of the internally toothed ring gear 23 to drag its traversing strand 24 with hypocycloidal motion from one end to the other of the diameter of the gear 23, at a rate established such that each of the strands 24 originating from their spool 9 approaches strands 34T, unwinding from the spools 34, in a common confluence region 25 (Figure 2). This approach, or grouping, takes place on opposite sides alternately, to give rise to the consequent formation of the rope 42, one example of which is shown in side view in Figure 3. Figure 4 shows a section through a further type of rope comprising twelve strands (each of which is the product of braiding ten thick filaments and nine thin filaments) which can be formed in the manner illustrated by the said machine.

With reference to Figure 2, the movements of the various machine parts can be summarised as follows. A drawing unit 40 pulls all the strands 34T and 24 (six plus six) towards itself, to cause them to group together within a guide bore or point 25. The bore 25 feeds the product to the race of a pulley 41 while the specific strands 24, 34T unwind from the respective spools 9 and 34. The rotation of these spools about their unwinding axes 37, 38 is resisted by the usual brakes, provided to keep the various strands taut.

The base 2 is rigid with the ground W, whereas the upper structure 7 rotates (in a clockwise direction) in the manner of a carousel, so that its spools 9 revolve about the machine axis 36.

Simultaneously, the spools 9 rotate about themselves on the axis D' (equivalent to that of the strand 24), and about the unwinding axis 37.

For each complete revolution of the upper carousel structure 7 there is one complete revolution of a spool 9 about the axis D'.

The upper spools 34 revolve about the machine axis 36 in an anticlockwise direction (when observing the machine from above), and rotate clockwise about the axes 35 (identical with the axes of the strands 34T) so that for each revolution they also undergo approximately one rotation, in addition to their unwinding motion about the axis 38.

The final product is the rope 42, which comprises an extremely uniform braiding of the strands 34T and 24, as shown in Figures 3 and 4, and such as to allow correct distribution of the tensile loads between the two types of strands originating from the lower spools 9 and upper spools 34 respectively, to thus attain the said objects.

Claims

1. A braided stranded rope forming machine, characterised by comprising at least one lower (9) and one upper (34) spool assembly, the assemblies undergoing mutually opposing revolution about a vertical axis (36) containing the point (35) of formation of the rope (42) generated by filaments or strands (24 and 34T) originating from said spools, the spools of the lower assembly (9) and those of the upper assembly (34) being driven with rotary motion about the torsion axis (D', 35) of the respective filaments or strands (24 and 34T) in opposite directions (D, Y), each filament or strand being presented to the point (25) of formation of the rope (42) alternatively on opposite sides with respect to the other filament or strand.

2. A machine as claimed in the preceding claim, characterised in that the upper spools (34) are six in number, and cooperate in the formation of the rope (42) with a like number of lower spools (9), the strand or filament (24) of which is alternately moved to opposite sides of the strands or filaments (34T) of the upper spools (34) by thread guide devices (20) moving with essentially centrifugal-centripetal motion relative to the central axis (36).

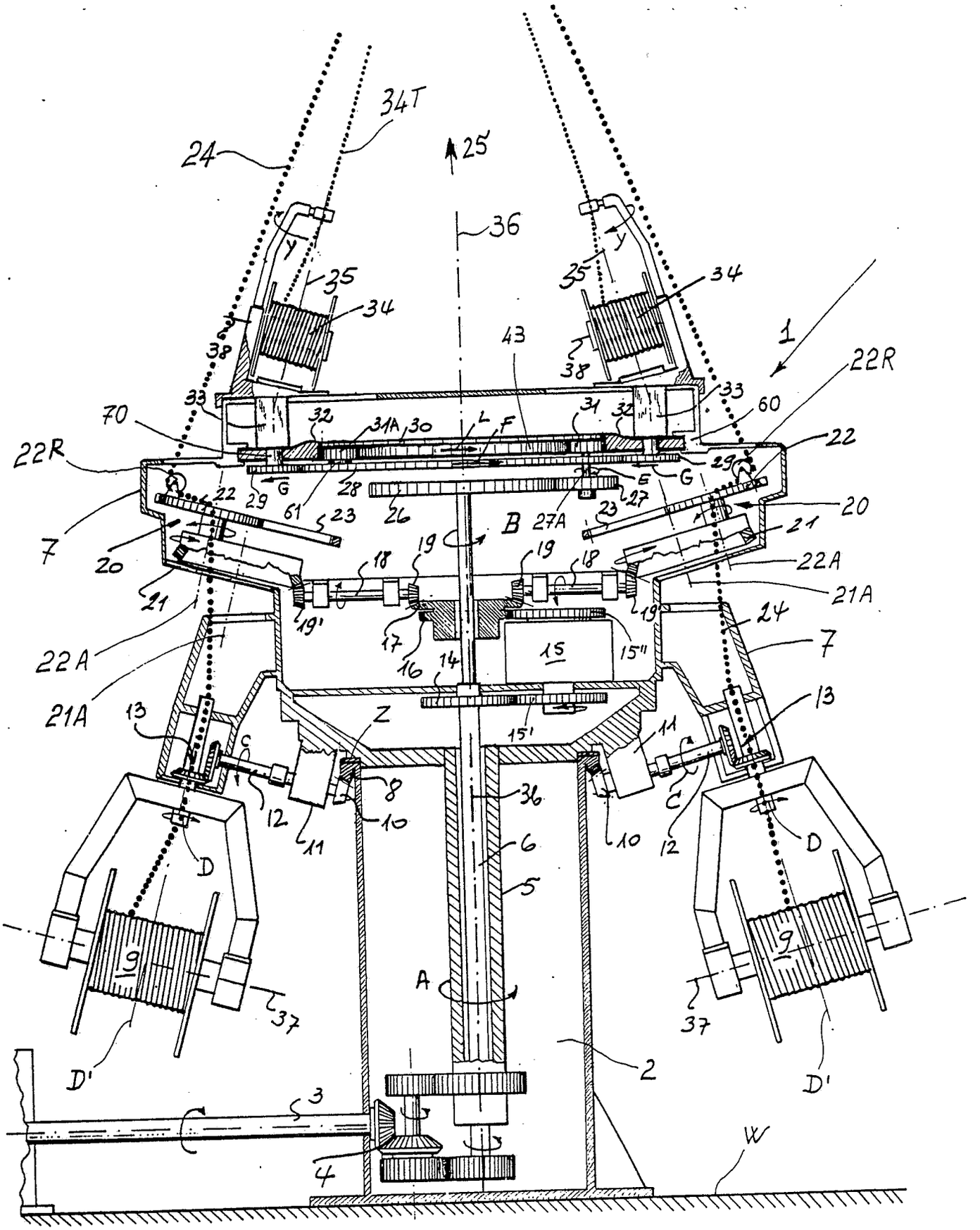
3. A machine as claimed in the preceding claims, characterised in that the thread guide devices (20) consist of a gear wheel (22) rotating within an internally toothed ring gear (23) and traversed by the strand (24) which is guided by it by means of an eccentric deviator (22R).

4. A machine as claimed in the preceding claims, characterised in that the strands (24) which unwind from the lower spools (9) undergo hypocycloidal motion (20) which can be assisted by an auxiliary intermediate gear unit (15), whereas the strands (34T) unwinding from the lower spools (34) undergo circular motion (Y), both said movements

being combined with their revolutionary movement in mutually opposing directions about the vertical axis (36) of the machine (1).

5. A machine as claimed in the preceding claims, characterised in that the synchronised movements of the thread guide (22R) generally enable any number of strands to be braided, by making the strands (24) originating from the lower spools (9) traverse the space (32S) between the toothed segments (32) carrying the supports (33) for the spools (34), with sudden radial movements in order to cause the strands (24) from the lower spools (9) to wind about a predetermined number of upper strands (34T).

6. A machine as claimed in the preceding claims, characterised by the addition of a drawing unit (40) for unwinding the strands (24, 34T) or filaments from the lower spools (9) and upper spools (34), in cooperation with the braking action exerted by usual means on the shafts (37, 38) of the various spools.


34T
24
25
36
35
34
38
43
1
22R
33
60
70
32
31A
30
L
F
31
22
29
G
E
61
28
26
23
27
B
27A
20
21
7
18
19
22A
21A
19'
17
16
14
15
15''
15'
24
13
Z
C
11
8
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12
D
6
5
A
9
37
D'
2
3
4
W

Fig. 1

Fig. 4

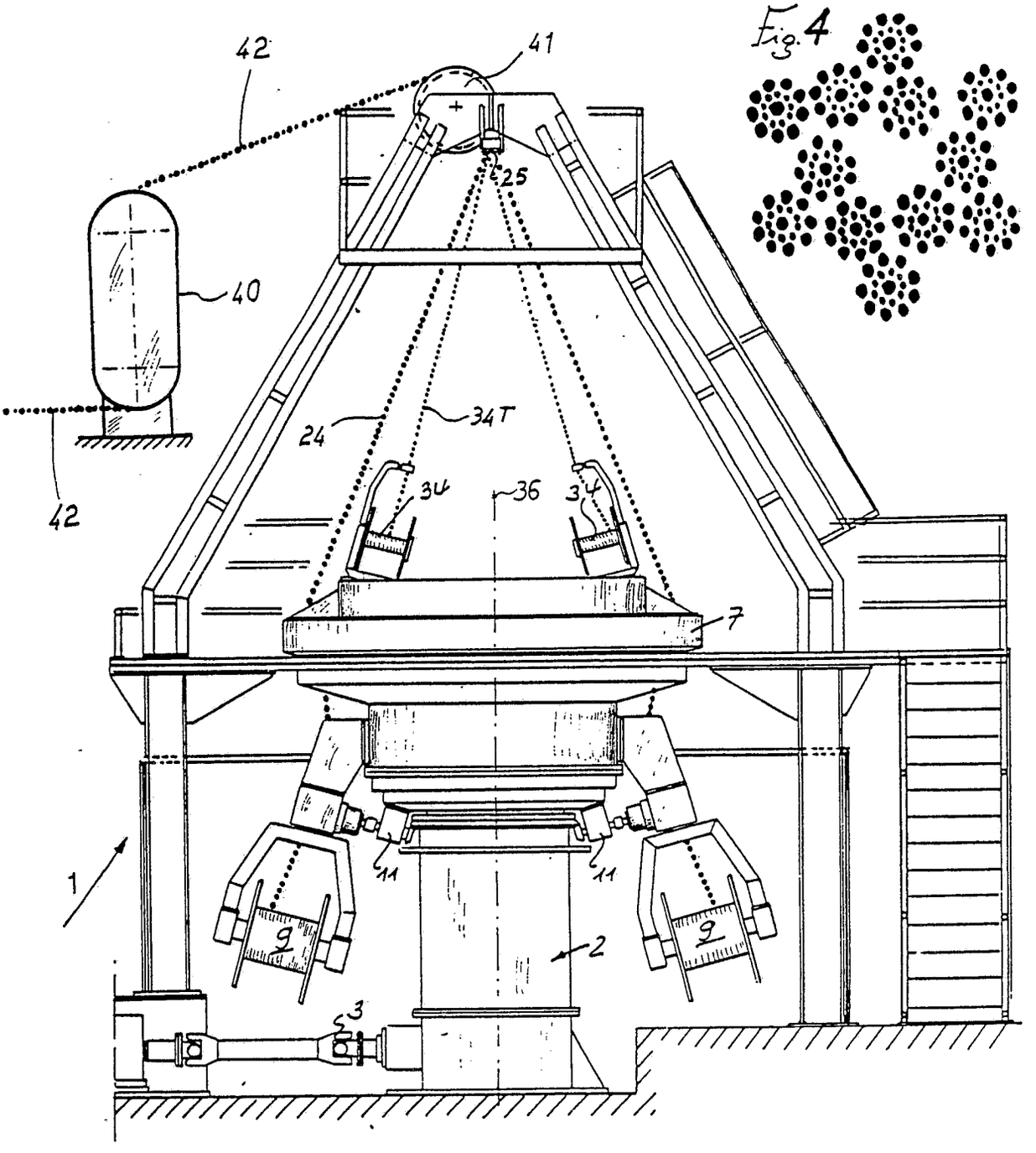

Fig. 2

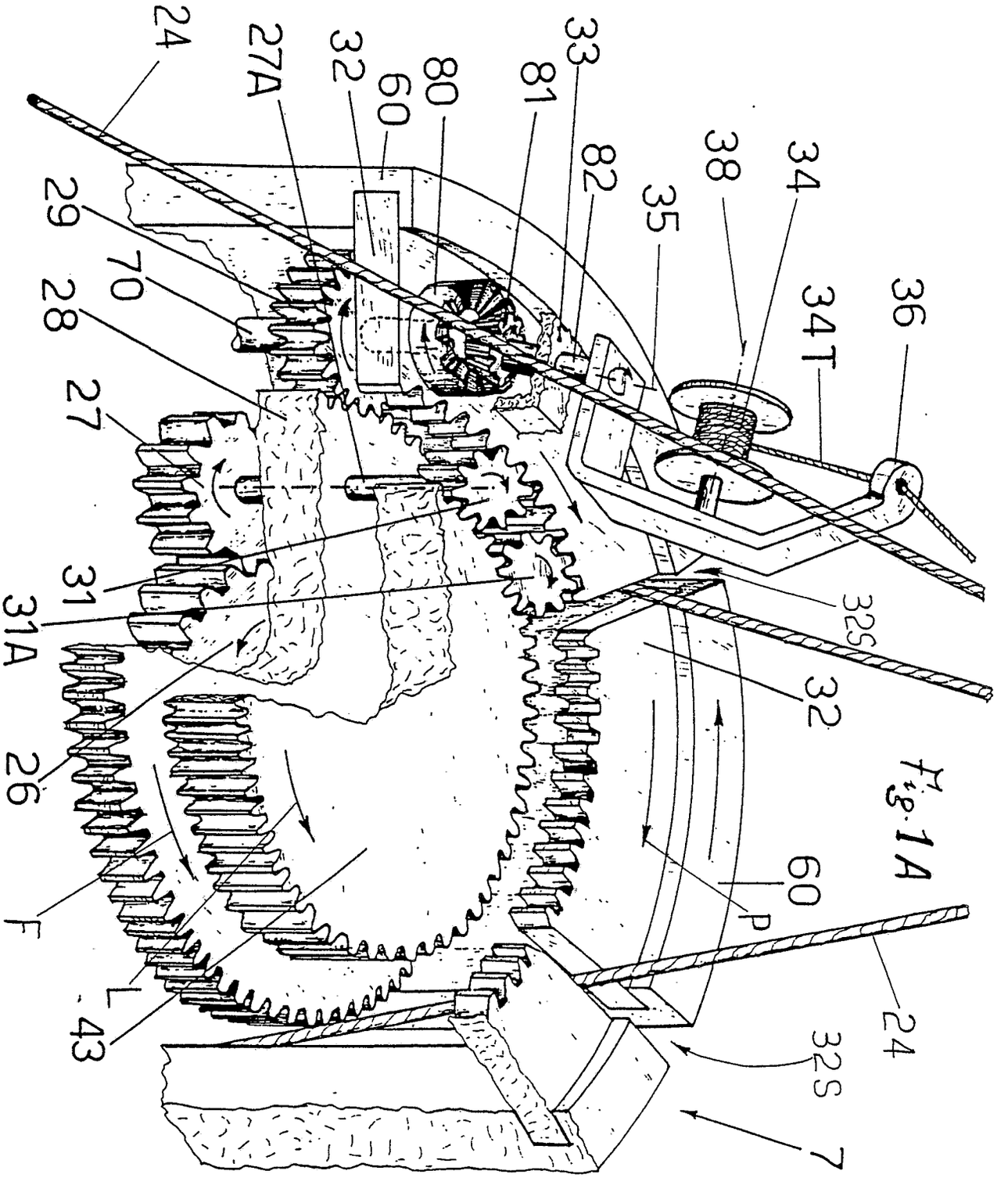
24
27A
32
60
80
81
33
82
38
34
35
29
70
28
27
34T
36
31
31A
32S
32
26
60
P
F
L
43
24
32S
7

Fig. 1A

Fig. 3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 87 11 0855

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.4)
X	GB-A-1 034 991 (C.R.F. OFFICINE MECCANICHE DE PRECISIONE) * Claim 1; page 3, lines 28-37,77-91; figures 4-6 *	1	D 04 C 3/42
A	GB-A-1 075 038 (TSENTRALNOE PROEKTNO-KONSTRUKTORSKOE BJURO KABELNOGO OBORUDOVANIA) * Claims 1,2,5; page 2, lines 61-87; figure 3 *	1,2,4,5,6	
A,D	GB-A-2 062 022 (WABING) * Page 2, lines 7-23; figures 1-4 *	2,3,5	
A	GB-A-2 076 435 (BICC LTD)		
A	US-A-3 892 161 (SOKOL)		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)
D 04 C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	07-04-1988	VAN GELDER P.A.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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