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(54) **IMPROVED EXPANDER FOR EXPANDING METAL PIPES**

(57) An improved expander for expanding metal pipes is described. The expander comprises a plurality of flexible rods (3), which are fed in parallel manner towards a corresponding plurality of parallel pipes (5) to axially insert respective expander mandrels (4) placed at the front end of the flexible rods (3) therein. The aforesaid flexible rods (3) are made in form of a harmonic steel stem with round section and smooth outer surface. (Fig. 2)

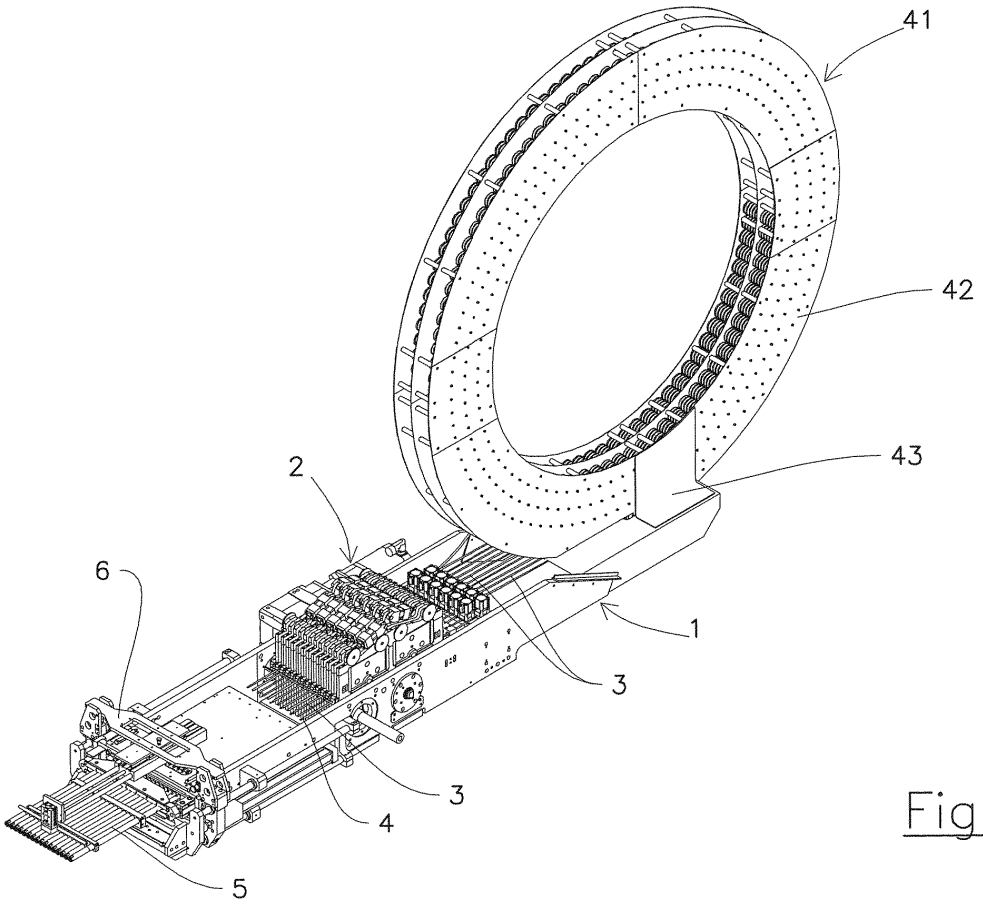

Fig. 1

EP 3 666 412 A1

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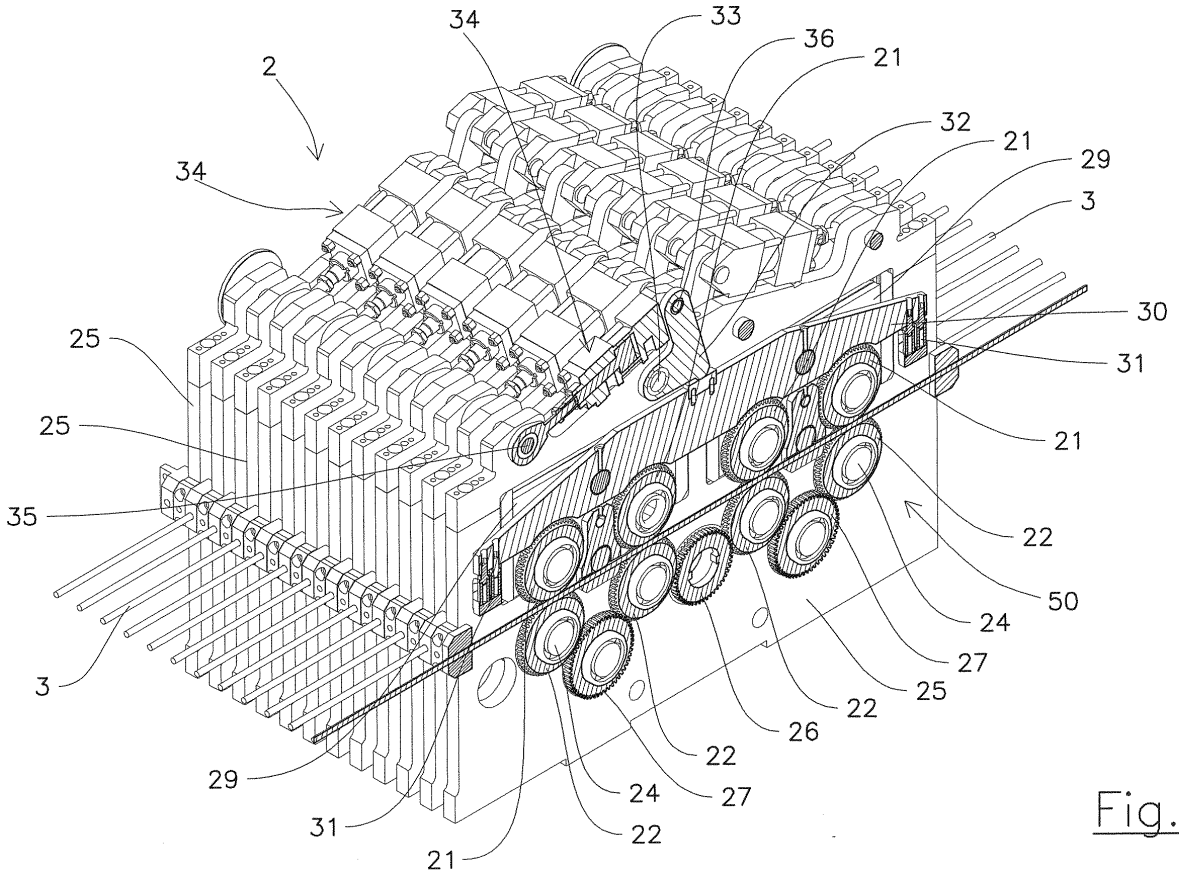
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Fig.10

Description

[0001] The present invention relates to an improved expander for expanding metal pipes.

[0002] The term "expander" means a machine capable of performing transversal expansion or widening of the inner space of metal pipes used for various purposes, particularly but not exclusively for suppling refrigerant or heating fluid inside the fins of finned pack heat exchangers.

[0003] An expander of this type is described in Italian patent No. 1426936 by the Applicant and comprises a plurality of flexible rods, which are fed in parallel towards a corresponding plurality of parallel pipes to axially engage therein the respective expander mandrels placed at the front end of the flexible rods.

[0004] The flexible rods consist of a metal wire spring wound in a cylindrical helix in which a braided steel wire cord axially extends, the front end of which is fixed to the rear end of the expander mandrel.

[0005] There may be two types of expander mandrels, one capable of expanding the pipe by means of axial pushing of a larger diameter mandrel head into the inner cavity of the pipe (push mandrel), the other capable of expanding by inserting a smaller diameter head into the inner cavity of the pipe, which head is then expanded and pulled back from its initial position (pull mandrel).

[0006] The first type of mandrel has a rigid body with a rear end fixed to the front end of the braided wire cord, as mentioned, and a front end to which said larger diameter head is fixed.

[0007] The second type of mandrel consists of two axially consecutive portions with an interposed spring, the rear portion of which is fixed to the front end of the braided wire cord and extends frontally with a further braided steel wire cord which ends in a flared front end towards a terminal head, while the front end can slide axially over said further cord and said flared front end and frontally carries an expandable nose which can abut axially against said terminal head. The terminal head of the mandrel can thus be inserted with compressed spring and non-expanded nose into the pipe to be expanded and then be pulled back to determine, by exploiting the extension of the spring, the sliding of the flared front end of the mandrel inside the nose with consequent expansion of the latter, and the progressive extraction of the nose itself for the desired expansion of the inner cavity of the pipe.

[0008] In the expanders thus formed, there may be a problem related to the conformation of the helical spring of the flexible rods, which does not ensure a correct and constant movement of the mandrel head and thus the desired expansion dimension.

[0009] WO 2010/115427 A1 describes a metal pipe expansion device which, similarly to that defined in the preamble of claim 1 of the present application, comprises a plurality of flexible rods which are fed in parallel towards a corresponding plurality of parallel pipes to axially insert therein respective expanding mandrels placed at the front end of the flexible rods. The type of flexible rods used is not defined.

[0010] JP 2015 085383 A describes a pipe expansion unit, which has the same features as WO 2010/115427 A1.

[0011] It is the object of the present invention to provide an improvement of the expander described above which solves the aforesaid problem, ensuring maximum expanding precision both in the case of a pushed mandrel and in the case of a pulled mandrel.

[0012] The aforesaid object is achieved by means of an expander for expanding metal pipes, which further comprises the features defined in the characterizing part of claim 1 of the present application.

[0013] In this manner, both in the case of push expansion and pull expansion, a correct and constant movement of the mandrel head, and thus the maximum precision of the desired expansion dimension, is ensured.

[0014] These and other features of the expander according to the present invention will be apparent in the following detailed description of a practical embodiment example thereof which is illustrated in the attached drawings:

figure 1 shows an overall perspective view of an example of expander according to the present invention;
figure 2 shows the enlarged detail of a push mandrel which can be used in the expander shown in figure 1 before it is inserted into the pipe to be expanded;
figure 3 shows a cross-section view of the aforesaid push mandrel taken along line III-III in figure 2;
figure 4 shows the enlarged detail of a pull mandrel which can be used in the expander shown in figure 1, before it is inserted into the pipe to be expanded;
figure 5 shows a cross-section view of the aforesaid mandrel taken along line IV-IV in figure 4;
figure 6 shows the aforesaid pull mandrel in a step of inserting into the pipe to be expanded;
figure 7 shows a cross-section view of the mandrel taken along line VII-VII in figure 6;
figure 8 shows the same pull mandrel in a position suited for the pulling expansion movement of the pipe;
figure 9 shows a cross-section view of the mandrel taken along line IX-IX in figure 8;
figure 10 shows a first, partially section perspective view, of a flexible rod moving assembly in the expander shown in figure 1;
figure 11 is a second exploded view of the moving assembly in figure 10;
figure 12 shows a top plan view of the same moving assembly;
figure 13 shows a longitudinal section of said moving assembly taken along line XIII-XIII in figure 12;
figure 14 shows a section view of said moving assembly taken along line XIV-XIV in figure 13;
figure 15 shows a top plan view of an unwinding and

rewinding drum of the flexible rods in the expander shown in figure 1;
figure 16 shows a section view of said drum taken along line XVI-XVI in figure 15;
figure 17 shows a partial section view of said drum taken along line XVII-XVII in figure 16.

[0015] The expander shown as a whole in figure 1 comprises a supporting frame 1 which supports a moving assembly 2 of flexible rods 3 from which expander mandrels 4 extend, which can be inserted into the axial cavities of the respective pipes 5 the transversal expansion of which is desired. The aforesaid pipes 5 are kept in position aligned with the expander mandrels 4 by a support 6 fixed to a front end of the frame 1.

[0016] The expander mandrels 4 can be of two types, shown in figures 2-3 and 4-9, respectively.

[0017] The expander mandrel in figures 2-3 is of the push type, i.e. is able to operate the transverse expansion of pipe 5 by means of axial pushing. For such a purpose, the mandrel comprises a rigid body 7 with a rear end fixed to the front end of a respective flexible rod 3 and a front end ending in a substantially truncated-cone-shaped expansion head 8 with a terminal front 9 of diameter smaller than that of the inner cavity of pipe 5 and a section 10 behind of a larger diameter than that of the aforesaid cavity.

[0018] As a result, while processing, the mandrel in figures 2-3, initially outside the inner cavity of the pipe, may be inserted into the cavity itself and carry out the transverse expansion of the inner cavity of the pipe by means of the enlarged section 10 of the head 8.

[0019] The expander mandrel in figures 4-9 is of the pulling type, instead, i.e. it is able to operate the transversal expansion of the inner cavity of pipe 5 by means of unforced insertion into the aforesaid cavity and subsequent expansion and extraction in an expanded state of the terminal head of the mandrel outside the cavity of the pipe. For this purpose, the mandrel is made of two axially aligned parts 11 and 12 with the interposition of a helical metal spring 13. The rear part 11 is fixed to the front end of a respective flexible rod 3 and has a front extension 14 ending with a truncated-cone-shaped flare 15 and finally with a terminal head 16. The front part 12 is mounted axially sliding on the aforesaid front extension 14 and ends in front with an expandable nose 17 with radial petals, which in non-expanded position has outer transverse dimensions smaller than the transverse dimensions of the inner cavity of the pipe 5, while in expanded position it may assume outer transverse dimensions larger than the transverse dimensions of said cavity.

[0020] As a result, while processing, the mandrel in figures 4-9, initially outside the inner cavity of the pipe with the spring 13 in resting position, the front part 12 retracted with respect to the truncated-cone-shaped flare of the extension 14 and the non-expanded nose 17 (figure 4), may be inserted with the terminal head 16 into the cavity of the pipe 5 and then pushed with the front part 12 along the extension 14 and its truncated-cone-shaped flare 15 (figure 6) with consequent compression of the spring 13 and progressive expansion of the nose 17 up to a transversal dimension greater than the transversal dimension of the inner cavity of pipe 5. At this point, by pulling the flexible rod 3 backwards and exploiting the expansion of the spring 13, it is possible to completely extract the mandrel from the inner cavity of the pipe, which is expanded transversely by virtue of the action of the enlarged nose 17, abutting frontally against a rear stop front 18 of the terminal head 16.

[0021] Whatever the mandrels 4 used, the corresponding flexible rods 3 consist of respective solid stems or harmonic steel cables with circular cross-section and smooth outer wall. Their movement for the insertion of the mandrels 4 in the cavities of the pipes 5 and their extraction from the pipes themselves is provided by the movement assembly 2, the details of which are shown in figures 10-14.

[0022] The movement assembly 2 comprises a plurality of driving elements (50) arranged side-by-side, one for each flexible rod 3 to be moved, each of which is formed by a set of pairs of slotted gears 21-22 superimposed in pairs (figures 10, 11 and 13), which define grooves 23 intended for the passage and driving of a flexible rod 3 (figures 10, 13 and 14).

[0023] The lower gears 22 are rotationally supported fixed pins 24 taken to a fixed position by intermediate plates 25 placed between the various gear sets (figures 10, 11, 12 and 14) and are motorized by means of a drive shaft (not shown) on which a drive gear 26 and an idle gear 27 are mounted (figures 10, 11 and 13), while the upper gears 21 are rotationally supported by pins 28 mounted on rectangular plates 29 (figures 10, 11 and 13), which are integral with trapezoidal plates 30 supported in vertically movable manner by the intermediate plates 25.

[0024] The trapezoidal plates 30 are biased or in any case can be controlled to move upwards by elastic or hydraulic means 31 placed at the two ends (figures 10 and 13) but can be kept in a lowered position, suited for the engagement of the upper gears 21 with the lower gears 22, by means of L-shaped levers 32 pivoted in 33 on the intermediate plates 25 and which can be actuated between engagement and disengagement positions with respect to the trapezoidal plates 30 by means of hydraulic cylinder-piston units 34 with rotating ends on pins 35 and 36 carried by the intermediate plates 25 and by the levers 32, respectively (figures 10, 11 and 13).

[0025] With the trapezoidal plates 30 in position lowered by the levers 32, as in figures 10 and 13, the upper gears 21 are, in turn, lowered and mesh with the lower gears 22 and may receive motion from the latter and thus cause the movement (either forward or backward) of the flexible rods inserted in the grooves 23, while with the trapezoidal plates raised following the disengagement of the levers 32 by means of the cylinder-piston assemblies

34, the upper gears 21 are, in turn, raised and disengaged by the lower gears 22 with consequent cessation of movement of the flexible rods 3. By independently controlling the cylinder-piston assemblies 34, it is thus possible to control the advancement or retraction movement of the flexible rods 3 and the corresponding mandrels 4 in equally independent manner.

[0026] The movement assembly 2 takes the flexible rods 3 from a coil wrapped in a large drum 41 and then returns them to the drum itself after expanding. Of course, the taking and the returning depend on the direction of rotation imparted to the slotted gears 21 and 22.

[0027] The drum 41 is shown in more detail in figures 15-17, where it is seen to comprise three circular perforated plates 42 which form the two sides and a middle separating wall of the drum itself. The lower parts of the two sides are fixed to frame 1 by means of brackets 43, as also shown in figure 1.

[0028] Between each side plate and the middle plate there are two spiral-shaped sequences of idle rolls 44 (figure 16), each of which is provided with parallel radial fins 45 which form grooves 46 for the housing of respective flexible rods 3 which extend longitudinally along all or part of the overall extension of the sequences of rolls.

[0029] As a result of all the above, the expander assembly 2, with the levers 32 in the operating position of figures 10 and 13, progressively takes suitable lengths of the rods 3 from the drum 41 until the mandrel 4 is inserted into the pipes to be expanded. If the number of pipes to be expanded is lower than that of the available mandrels, by appropriately choosing the position of the levers 32 by virtue of the cylinder-piston assemblies 34, the engagement of only one part of the gear pairs 21-22 is determined and therefore the advancement of only one part of the flexible rods 3, more precisely of those the mandrels of which must engage the inner cavities of pipes 5 for their radial expansion.

[0030] If the mandrel is of the push type in figures 2 and 3, the forced advancement of the rods, and thus of the mandrels, is sufficient to perform the expansion of pipe 5, after which the motion of the grooved gears 21-22 is reversed and the withdrawn lengths of rods are rewound on the drum 41.

[0031] Instead, if the mandrel is of the pull type in figures 4-9, the advancement of the flexible rods 3 is only used to insert the terminal head of the mandrel, with the nose 13 still not expanded, into pipe 5 in which then the expansion of the nose 13, determined by the further advancement of the rod 3, determines the expansion of the pipe. The successive retraction of the rods under the control of movement assembly 2 determines the radial expansion of the inner cavity of pipe 5 by virtue of the enlarged nose until the mandrel exits from the pipe, which is the end of the expansion operation. The rod lengths previously taken from drum 4 and the rod lengths previously taken from drum 41 are finally rewound into the drum itself.

Claims

1. An expander for expanding metal pipes, comprising a plurality of flexible rods (3), which are fed in parallel towards a corresponding plurality of parallel pipes (5) to axially insert respective expander mandrels (4) placed at the front end of the flexible rods (3) therein, **characterized in that** said flexible rods (3) are made in form of a harmonic steel stem with round section and smooth outer surface and wherein a moving assembly (2) for said flexible rods (3) is provided, which assembly comprises a plurality of driving elements (50) arranged side-by-side, one for each flexible rod (3), each of which is formed by a set of pairs of superimposed slotted gears (21-22) which define grooves (23) for the passage and driving of a flexible rod (3).

2. An expander according to claim 1, **characterized in that** each driving element (50) comprises means (34, 32, 28, 29) for controlling the mutual movement of the coupled slotted gears (21-22) towards mutual engagement and disengagement positions with the rods (3) interposed.

3. An expander according to claim 2, **characterized in that** said means (34, 32, 28, 29) present in each driving element (50) for controlling the mutual movement of the coupled slotted gears (21-22) towards mutual engagement and disengagement positions comprise a cylinder-piston assembly (34) which controls the rotation of a lever (32) which acts on movable supporting plates (28, 29) of said upper and lower slotted gears (21-22).

4. An expander according to any one of claims 1-3, **characterized in that** said moving assembly (2) takes lengths of flexible rods (3) from a rod winding drum (41) during a step of executing of a pipe expansion operation and reinserts said lengths into the drum at the end of the expansion operation.

5. An expander according to claim 4, **characterized in that** said drum (41) comprises circular-shaped perforated metal sheets (42) which form two sides and at least one intermediate separating wall of the drum itself, spiral-shaped successions of idle rolls (44) being placed between said metal sheets (42), each of which is provided with parallel radial fins (45) which form grooves (46) for housing respective flexible rods (3), which grooves extend longitudinally along all or a part of the total extension of the successions of rolls (44).

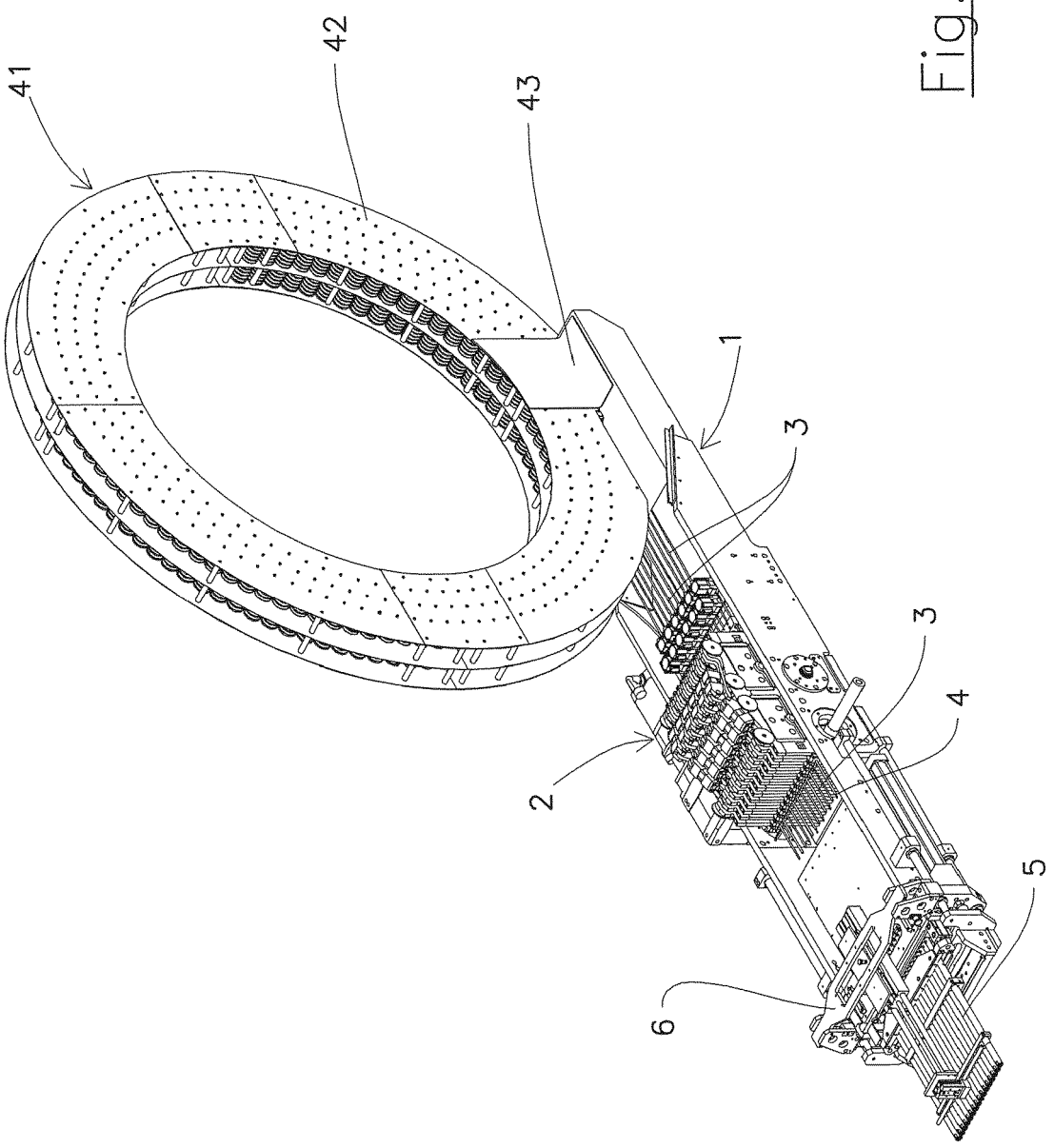

Fig. 1

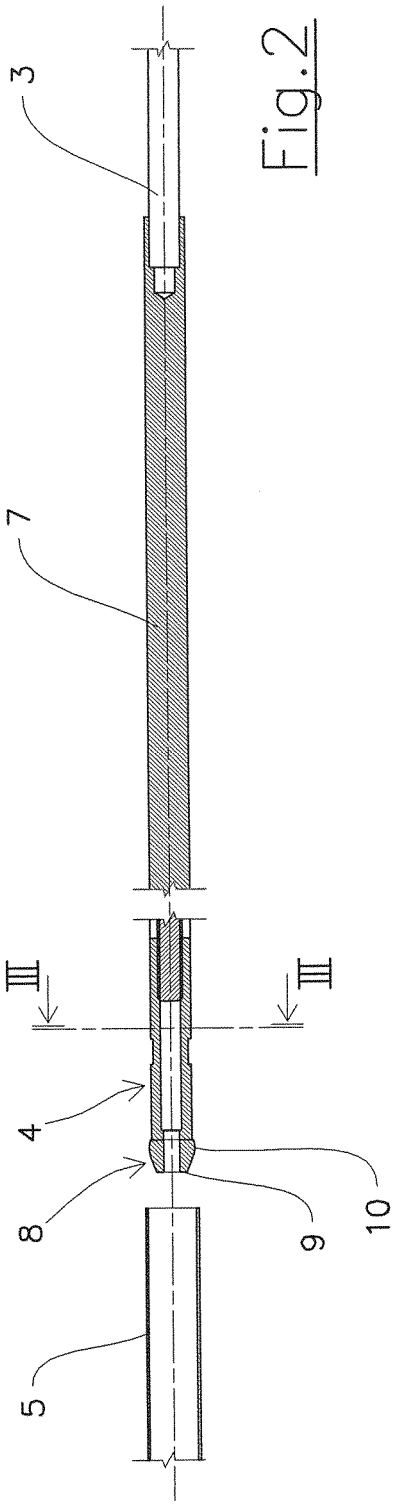

Fig.2

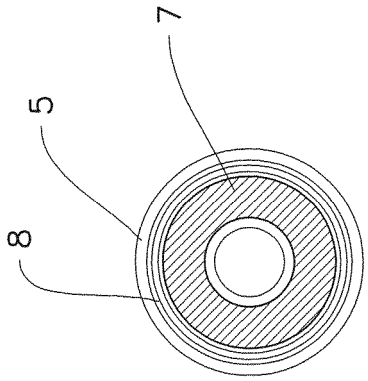

Fig.3

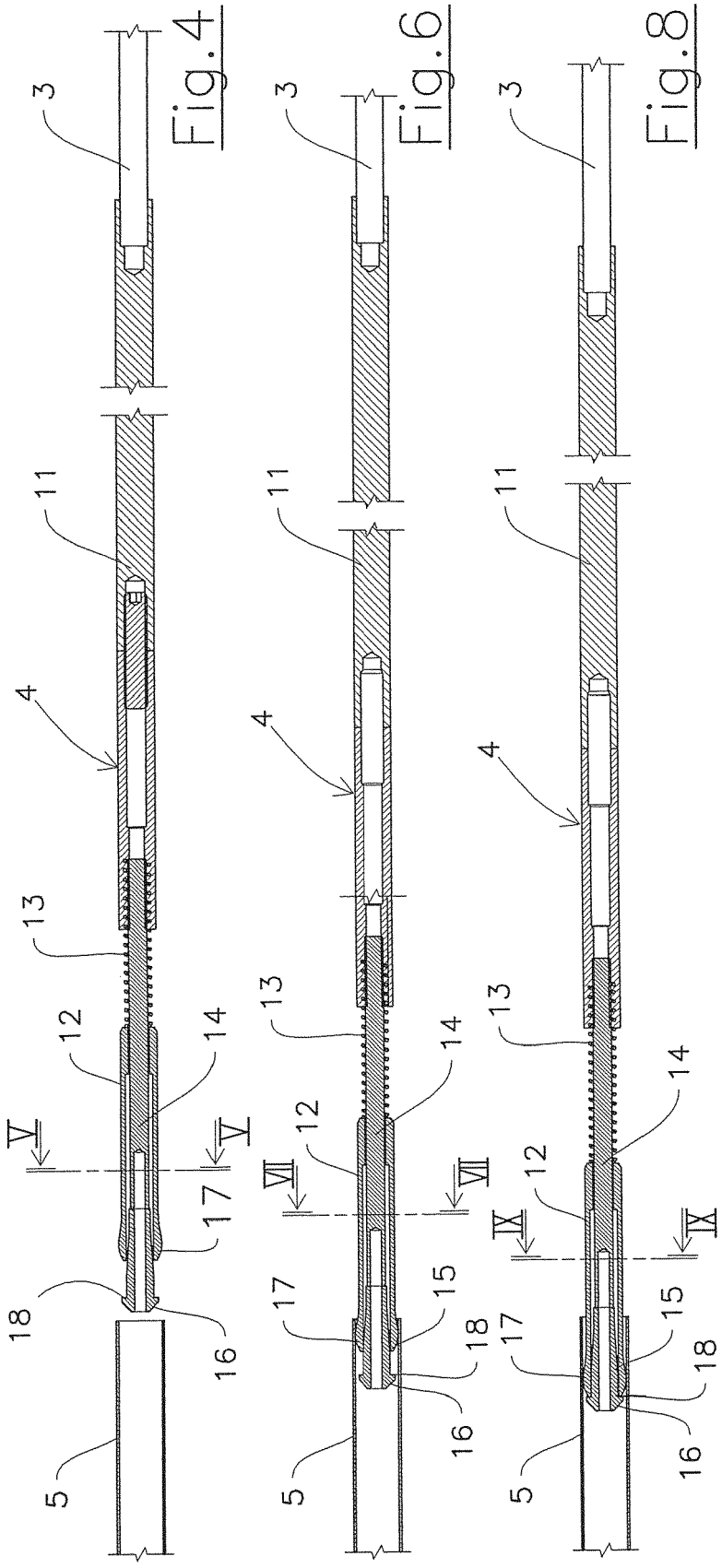

Fig.4

Fig.6

Fig.8

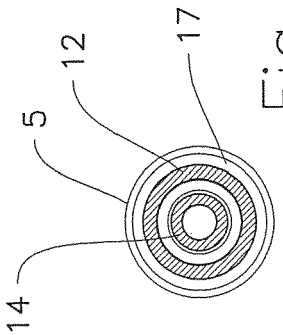

Fig.9

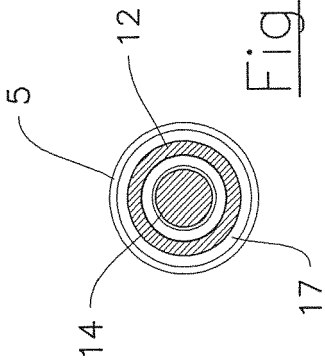

Fig.7

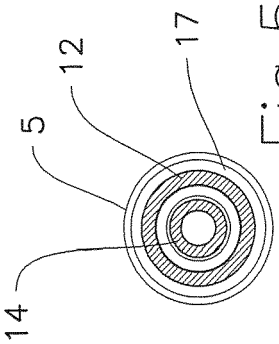

Fig.5

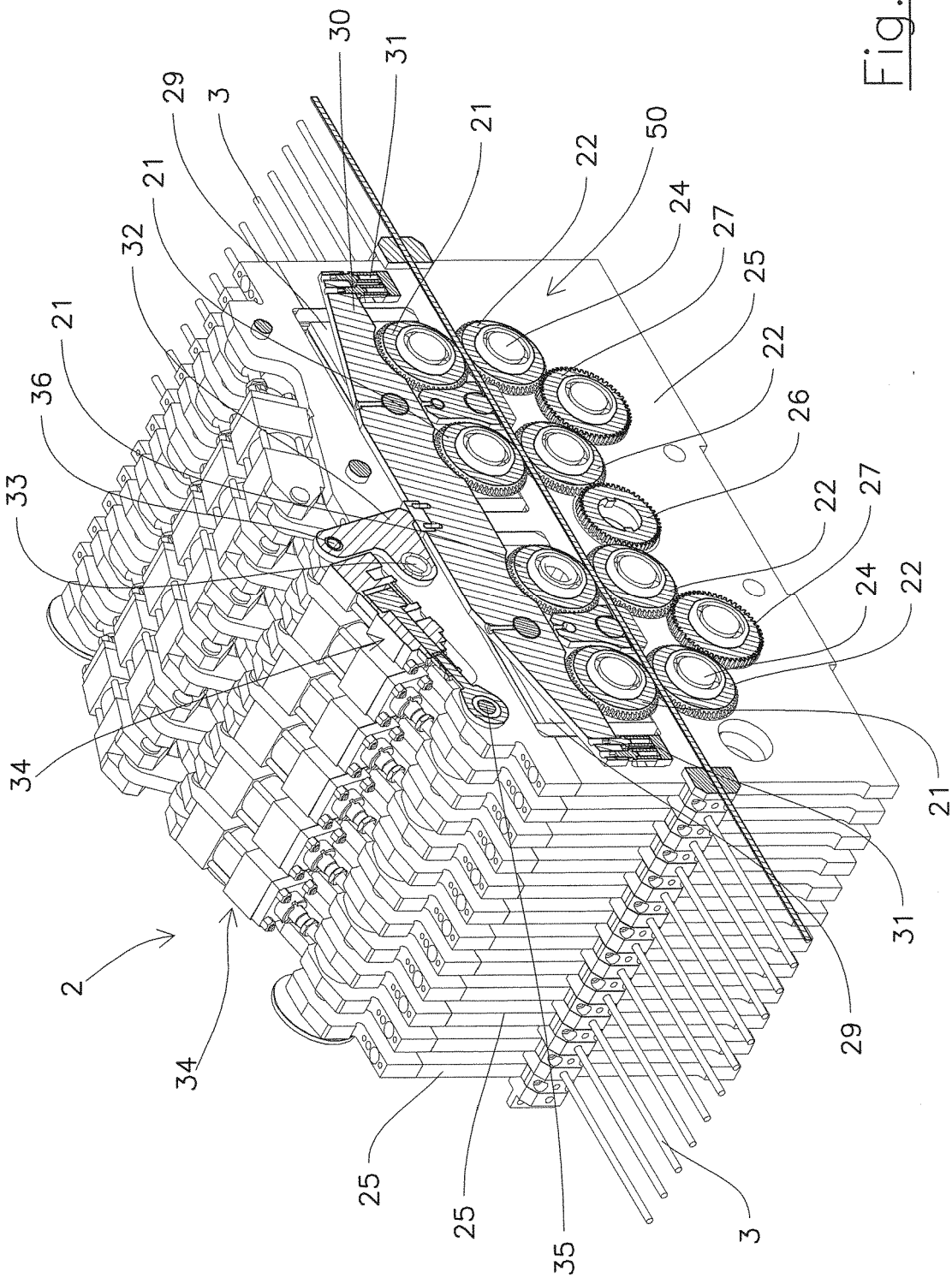
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Fig.10

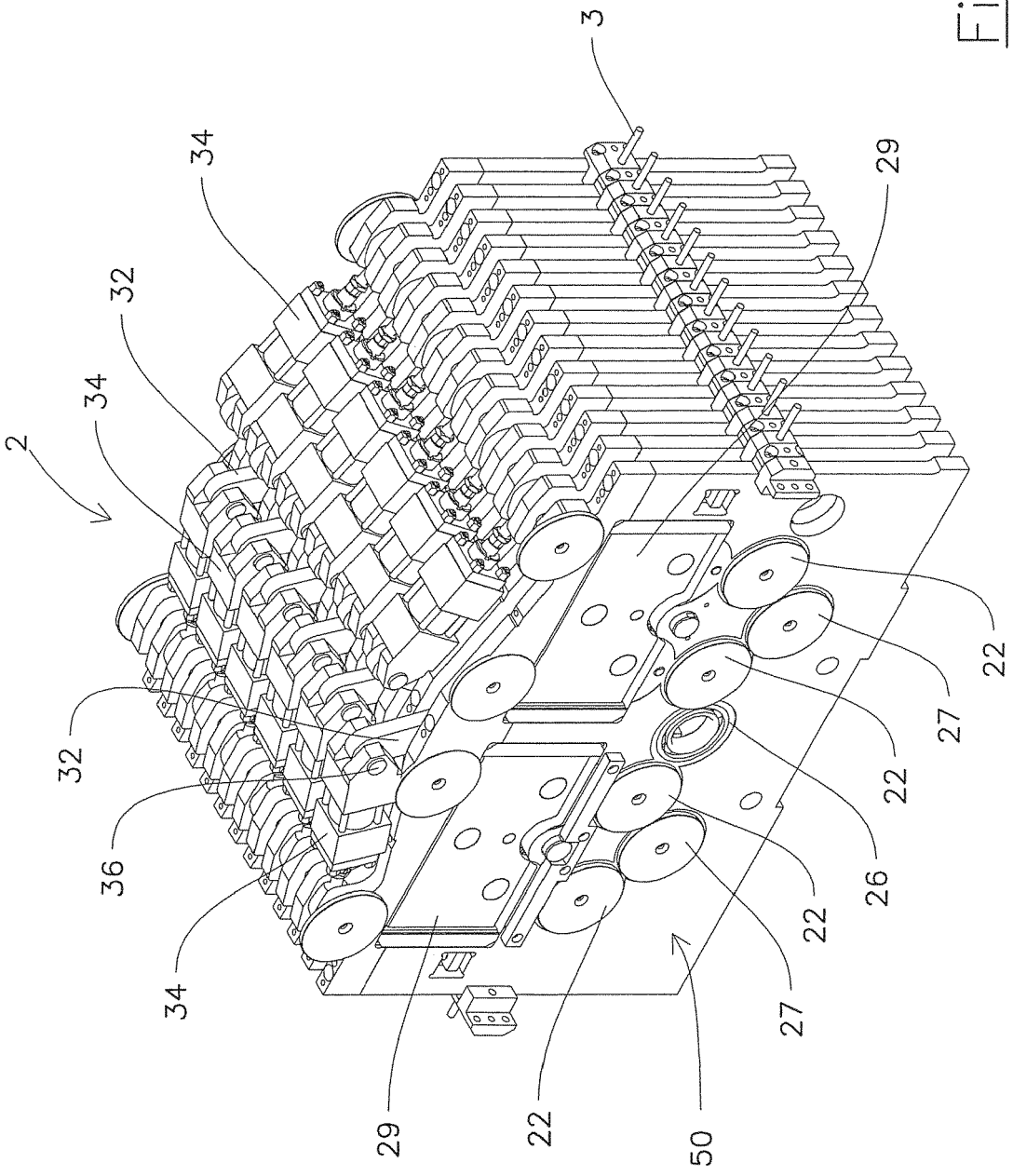

Fig. 11

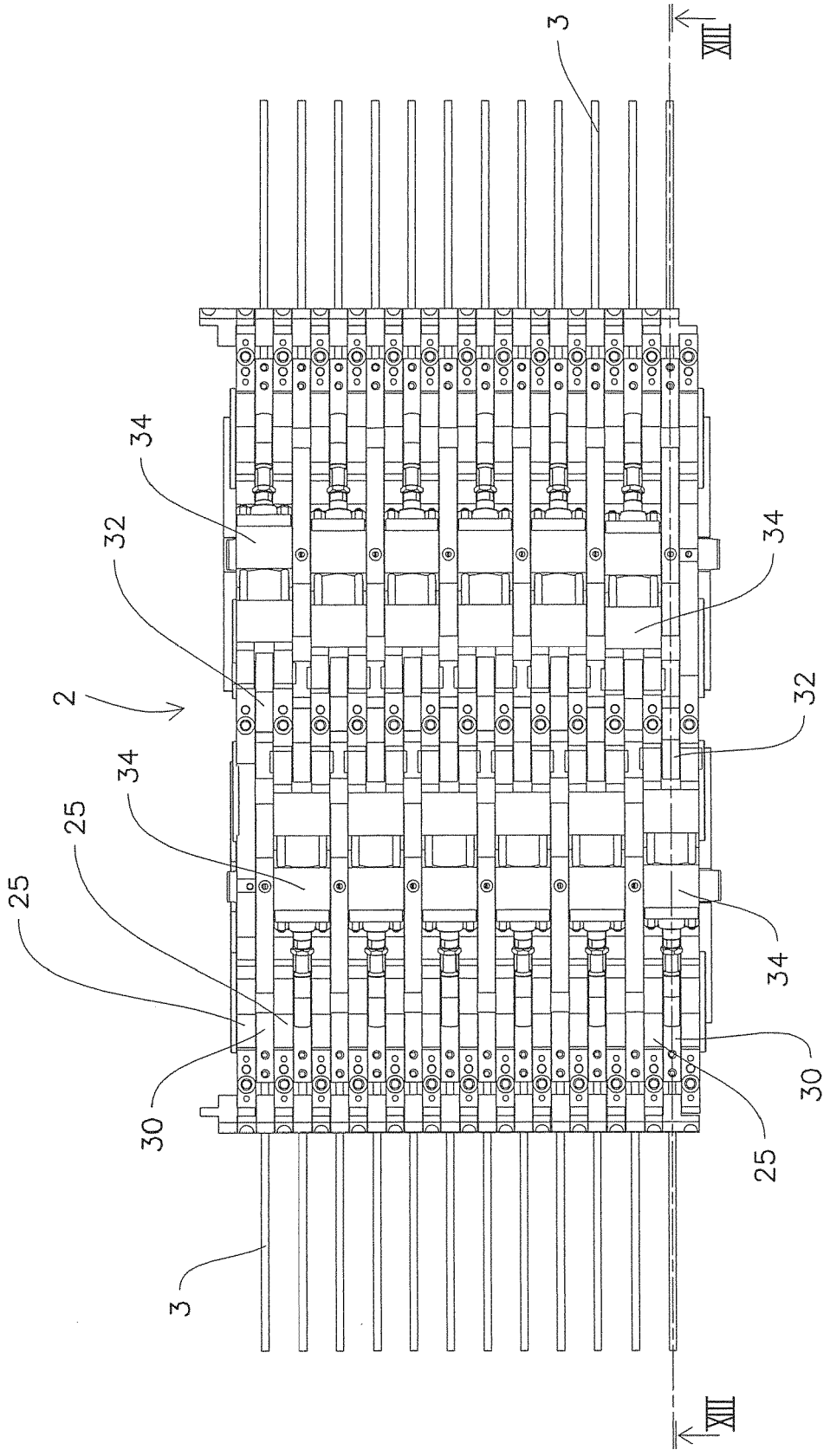

Fig.12

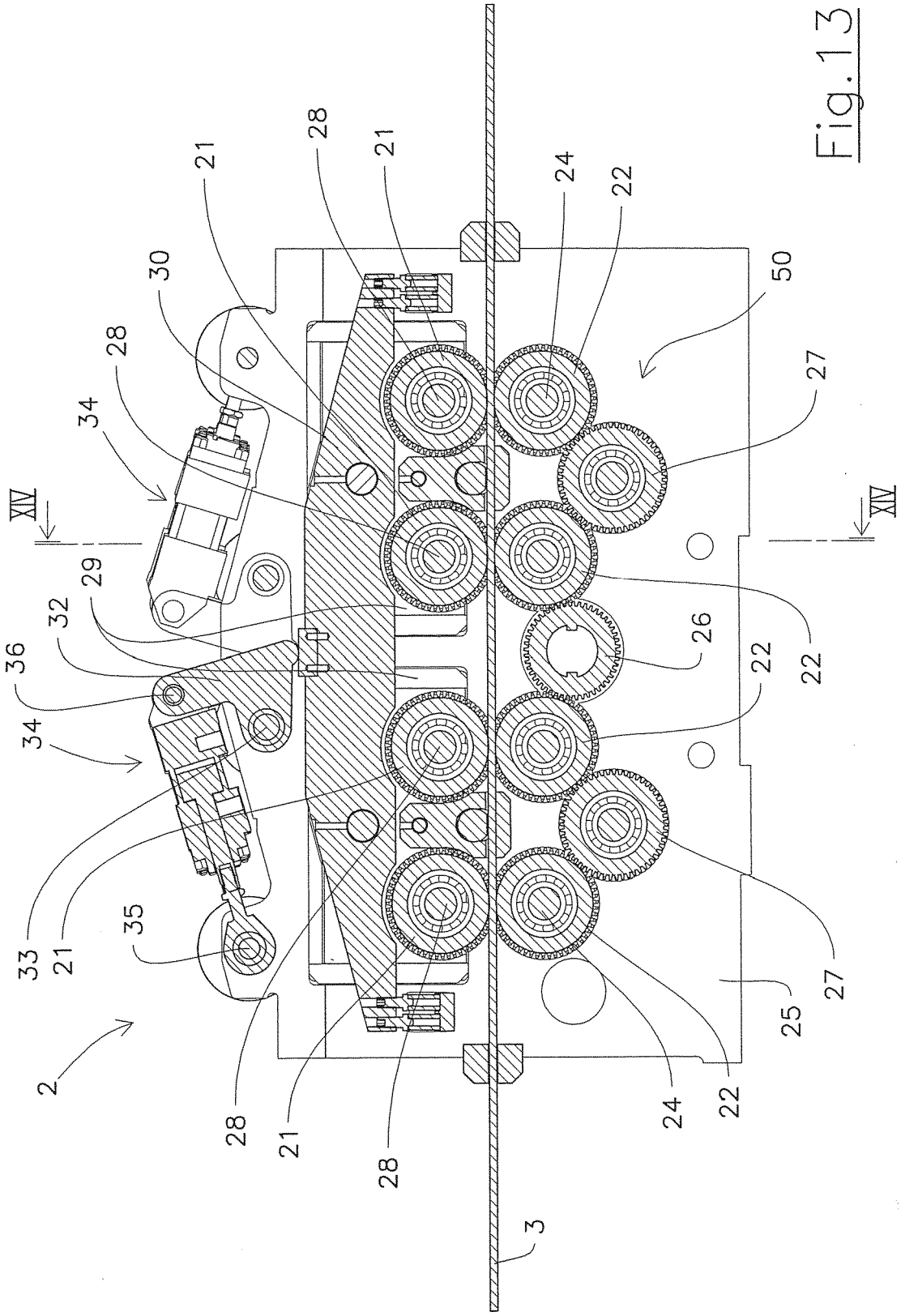
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Fig.13

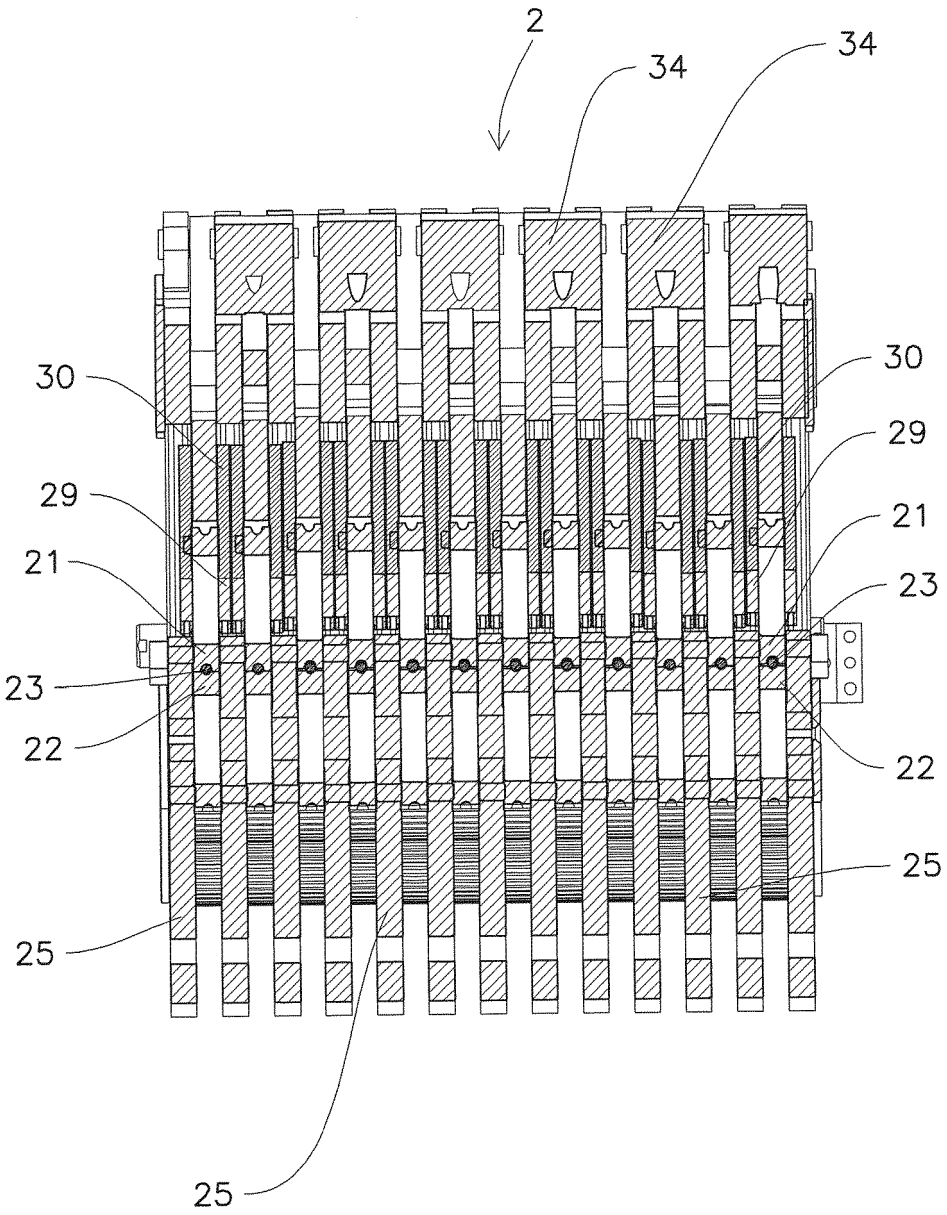

Fig.14

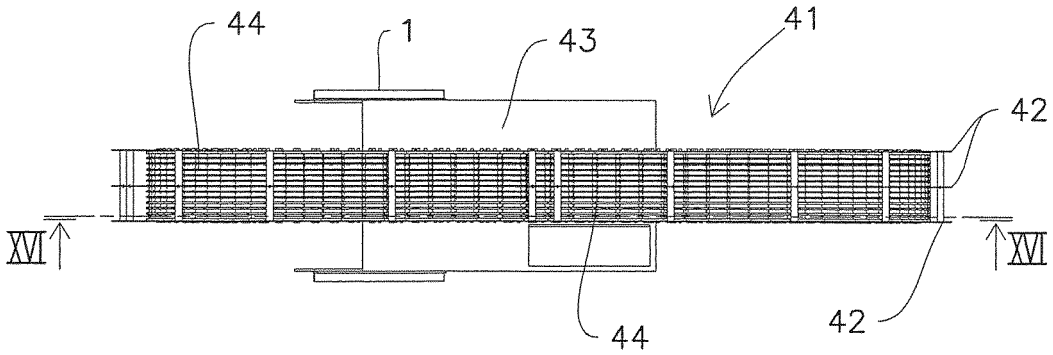

Fig.15

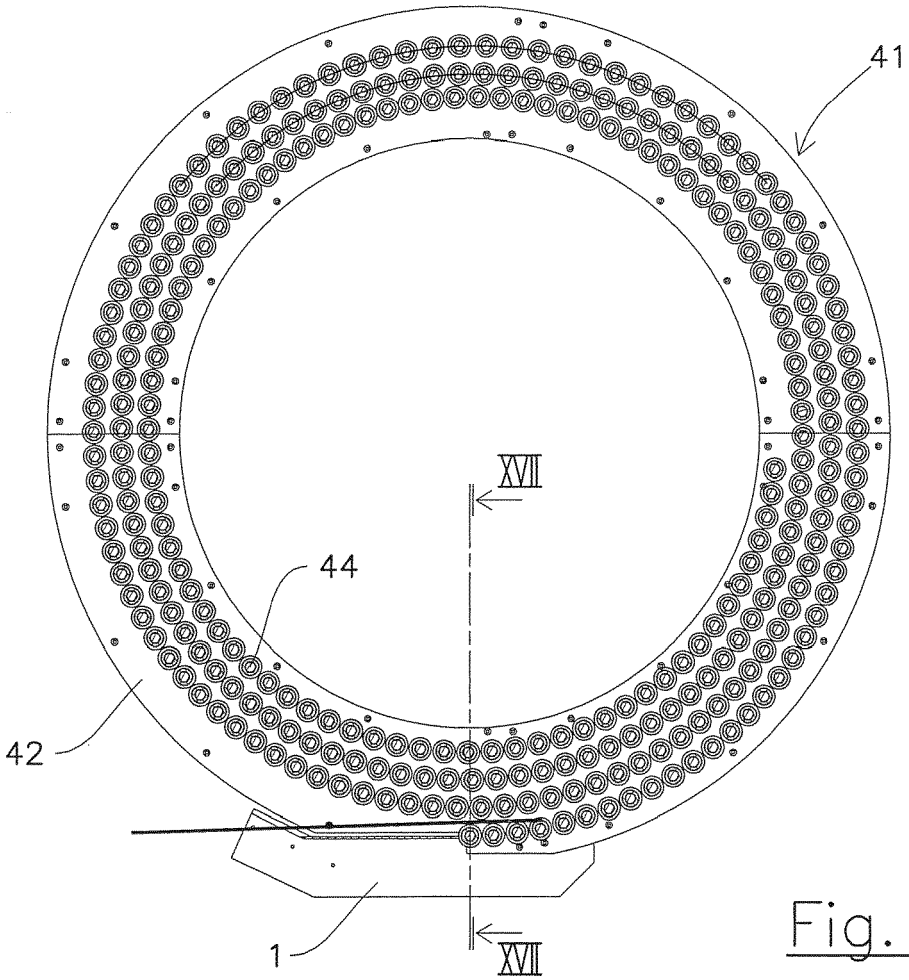

Fig.16

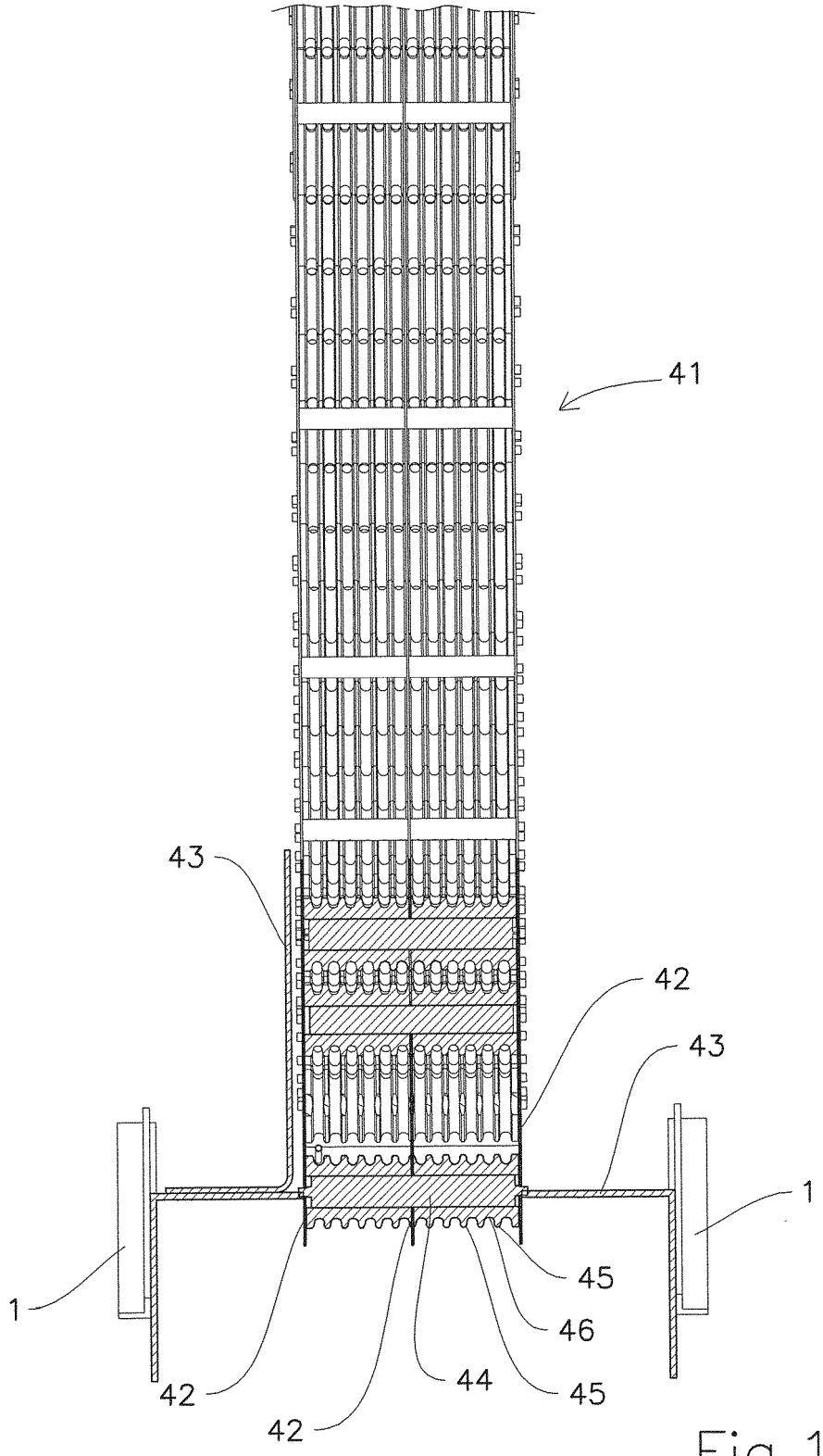

Fig.17

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EUROPEAN SEARCH REPORT

Application Number
EP 19 20 4024

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	EP 2 786 816 A1 (CMS COSTRUZIONE MACCHINE SPECIALI S R L [IT]) 8 October 2014 (2014-10-08) * paragraph [0063]; figures 1-12 *	1-5	TECHNICAL FIELDS SEARCHED (IPC) B21D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	24 March 2020	Vassoille, Philippe

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 20 4024

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