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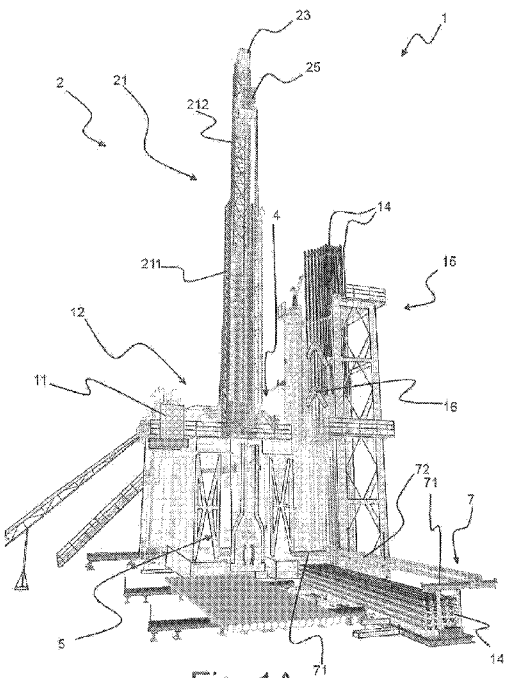

Fig. 1A

(57) Abstract: Drilling rig (1) for creating wells for extracting hydrocarbons, comprising a rig floor (12) raised off the ground; a mast (2), located on the rig floor (12), along which slides a drilling head (25); a mud circulation circuit (3) for circulating drilling mud (M), comprising a main circuit (31) and a secondary circuit (32) for introducing mud, a recovery circuit for the mud (33) and a collector circuit (34); an automated connection clamp (4) for connecting the secondary circuit (32) to a drilling rod (14), comprising a radial aperture (142) for continuously circulating the mud, comprising a movement arm (41), a central body (42), a gripping system (44); a first manipulator (5), capable of assembling at least two drilling rods (14) together, comprising a linear movement device (52); a locking tong (54) capable of generating a torque over these rods to ensure that they are locked, and a lifting device (56). Said mast (2) is telescopic, comprising a movement system (22) in turn comprising a supply chamber (226) and two hydraulic pistons (222,224) aligned in a single direction, parallel to the vertical axis (Z), and acting in opposite senses to each other.

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TITLE: HIGH EFFICIENCY AND HIGH SAFETY AUTOMATED DRILLING RIG FOR SINKING WELLS FOR EXTRACTING HYDROCARBONS

The present invention refers to an improved rig, in particular a second-generation automated rig for creating wells for extracting hydrocarbons.

In particular the rig according to the present invention is highly automated, with the aim of keeping personnel at a distance from the rig floor during operating phases.

The strong demand for energy and the continuous depletion of petroliferous reserves in production have pushed the search for petroleum into increasingly deep environments. This new situation leads operators to drill more complex and hostile geological formations. At the same time there is a growing need to improve standards of HSEQ (health, safety, environment and quality) as well as operative performance.

In the perspective of an improvement in HSEQ and a reduction in drilling times and especially a reduction in “Non Productive Time”, indicated in the technological sector by the acronym NPT, technological innovation is focused, by the various operators, on drilling rigs with a high degree of automation, with the object of optimising the entire process of drilling a well.

In general the drilling process is made up of two macro-phases:

- preparation, in which for example the assembly or dismantling of the rig is carried out (known by the terms “rig up” and “rig down”), at the drilling site;

- drilling, during which the process of drilling the soil is carried out, in which a series of drilling rods of drilling length are added or removed, where the term 'length' means, as is known to a technician skilled in the field, one or more connected drilling rods.

Reliability, automation and high performance indicate the direction in which the present technological sector for creating new drilling rigs will develop. One request made by operators is therefore to have drilling rigs easily movable to the various locations. A second request, which is not always successfully satisfied simultaneously with the first, is the creation of high-performance rigs.

Drilling rigs which are easily movable need to be easily assembled and dismantled, reducing as far as possible the space occupied during the stages of moving between drilling sites.

In the known art there are substantially two rig construction technologies, one concerning masts dismantlable into a plurality of sections, and another using telescopic masts.

The first solution makes it possible to obtain numerous segments of small dimensions, easily transportable, but requiring more effort at the assembly and dismantling stages.

In the known art, the solution with telescopic masts proves to be much faster in the assembly and dismantling stages, but, being substantially monolithic in order to be easily transportable, does not make it possible to have large sizes of mast usable during the operational phases of drilling, thus limiting the length of the series of

drilling rods which can be used during the drilling phase, as is known to a technician skilled in the field.

The use of the telescopic mast in the field of drilling rigs is a technological solution which is by now well-established in the sphere of oil and gas drilling. This solution, as mentioned above, makes it possible to have fairly compact drilling rigs in terms both of height and of space occupied on plan, with undoubted advantages with regard to movement between one drilling site and another.

The limitation of rigs with a telescopic mast lies in the fact that the length of the series of drilling rods which can be used is less than the length which can be used on a rig with a traditional fixed mast. This limitation is due essentially to the travel achievable by the telescopic mast.

In rigs with telescopic masts of the known art, this translates into rigs of small dimensions, capable of operating with rod lengths at the most of 20 m.

Furthermore, in the solutions according to the known art being used for drilling to shallow depths, systems for monitoring pressures in the well are not always demanded. For example, in such rigs there is no provision for an integrated system for continuously circulating the drilling mud.

Furthermore, where the rig does include a system for continuously circulating the mud, the stage of attaching and detaching the secondary circuit (for forcing the mud through the radial aperture in the drilling rods) is still carried out manually.

Furthermore, since it is not possible to use drilling lengths greater than 20 m, these rigs cannot provide automated systems for assembling the lengths of drilling rods, operating in parallel with the rig's drilling phase, in order to automatically prepare a new series of rods of the desired length for the next drilling stage, so as to reduce the rig's non-productive times.

The principal technical problem which it is desired to resolve is to create a movable drilling rig capable of using drilling lengths (length of the series of rods) greater than 20 m, with high rapidity in adding and removing rods while maintaining high standards of HSEQ, translating into rigs with high automation.

In particular the individual devices comprised in a rig must be automated and controllable by a single operator located in a control cabin, reducing to a minimum the number of operating personnel present on the rig floor during the operating stages of the drilling rig.

The present invention proposes to resolve the above technical problems by creating a movable drilling rig or "fast moving rig", of hydraulic type, which makes it possible to use drilling lengths greater than 20 m, for example 27 m.

One aspect of the present invention concerns a rig with the characteristics of the attached Claim 1.

The accessory characteristics are stated in the attached dependent claims.

The characteristics and advantages of the rig according to the present invention will be clear and evident from the following description of an exemplary and

non-limiting embodiment of the rig and from the attached drawings which illustrate respectively:

- figures 1A, 1B and 1C show various views of the complete rig; in particular: figure 1A shows the rig in an axonometric view; figure 1B shows the rig in a view from above; figure 1C shows the rig in a frontal view;
- figures 2A, 2B show a possible embodiment of the mast according to the present invention in two operating configurations: respectively figure 2A shows the mast in a contracted condition, while figure 2B shows the mast in an extended condition;
- figures 3A, 3B, 3C and 3D show in various views an automated connection clamp for connecting a secondary circuit to the drilling rods for continuously circulating the drilling mud, in particular figure 3A in a perspective view of the clamp gripping a drilling rod on a rig floor; figures 3B and 3C, in a lateral view of just the clamp in two different configurations of the movement arm, respectively contracted and extended; figure 3D shows the end part of the clamp in a view from above, and figure 3E the detail, in a perspective view, of the clamp gripping a drilling rod;
- figures 4A-4D show details of a possible embodiment of the connection clamp of figures 3D and 3E in a section B-B in various operating configurations of the devices comprised in the clamp; in particular figure 4A shows the clamp connected to the drilling rod where the coupling device and the opening device are both in a non-operating condition; figure 4B where the clamp is in an operating condition, connecting the connecting element of the clamp to the gripping element of the first shutter,

figure 4C in which the first actuator is in an operating condition, rotating said first shutter while the second opening actuator is in a non-operating configuration; figure 4D shows both the opening actuators in an operating condition allowing the start of the transfer of the drilling fluid through said radial aperture;

- figures 5A-5E show the mud circulation circuit; in particular figure 5A is a schematic illustration of the complete mud circulation circuit; figure 5B shows part of the mud circulation circuit where the collector circuit is visible in the configuration in which the mud is directed towards the main intake circuit; figure 5C shows part of the circuit where the collector circuit is visible in the operating configuration in which the mud is directed towards the secondary intake circuit, and the simultaneous depressurisation of the main circuit is also visible; figure 5D shows the detail of the collector circuit; figure 5E illustrates the collector circuit located on the rig drilling floor;

- figures 6A-6E show the manipulator for achieving the desired length of rods in various operating configurations, in particular: figure 6A shows the rig comprising the manipulator in a lateral view, in which the manipulator itself is in a horizontal position; figures 6B-6E show the manipulator raised into a vertical position seen from a plane A-A, at various moments in joining two drilling rods;

- figure 7 shows a view of the rig from above in which can be seen the path traced by the second manipulator for picking up or arranging a series of rods of known length in the rod rack;

- figures 8A and 8B show details of the first manipulator, excluding from the view the remaining parts of the drilling rig, particularly figure 8A in a lateral view and figure 8B in an axonometric view.

With reference to the above-mentioned drawings, the drilling rig for creating wells for extracting hydrocarbons is indicated with reference number 1. Said rig is preferably movable, being easily assemblable and dismantlable. Figures 1A-1C show a preferred but not limiting embodiment of the rig 1 according to the present invention.

The rig according to the present invention comprises: a rig floor 12 raised off the ground; a mast 2, located on the rig floor 12, comprising a trellised structure 21, along which can slide a drilling head 25, as is known to a technician skilled in the field.

The rig floor 12, once assembled, is lifted off the ground by means of a lifting mechanism. In the preferred embodiment, the rig floor 12 is raised, for example by means of a pantographic lifting mechanism, when the mast 2 is in a vertical position. An alternative embodiment for raising the rig floor 12 requires stabilisers, as is known to a technician skilled in the field, as for example illustrated in figure 6A.

The rig floor 12 according to the present invention comprises a principal hole 122, in which the drilling to create the extraction well is carried out, and preferably an auxiliary hole 124, in order to automate the rig and reduce the downtime, as is known to a technician skilled in the field.

Rig 1 further comprises a mud circulation circuit 3 for circulating drilling mud "M", comprising a principal circuit 31 and a secondary circuit 32, for forcing the drilling mud "M" into the well, a mud recovery circuit 33 and a collector circuit 34, suitable for monitoring the flow of mud "M", towards the principal circuit 31 and the secondary circuit 32. The mud circulation circuit 3 attached to the rig 1, according to the present invention, is capable of circulating the drilling mud, particularly towards the bottom of the drilling well, continuously during all the operative phases of the rig, for example even during the addition or removal of one or more rods 14 of known length, inserted into the drilling well.

The rig 1 according to the present invention further comprises an automated connection clamp 4 for connecting the secondary circuit 32 to a drilling rod 14, comprising a radial aperture 142 for continuous mud circulation. Said automated connection clamp 4 comprises a movement arm 41, a central body 42 and a gripping system 44, connected to said central body 42. Said gripping system 44 is capable of ensuring the connection of the connection clamp 4 to the drilling rod 14. Said movement arm 41, connected to said central body 42, is capable of moving said connection clamp 4 in order for it to be attached to or disengaged from the drilling rod 14.

The automated connection clamp 4, by virtue of its high level of automation, ensures that the connection between the secondary circuit 32 and the drilling rod 14 is made rapidly and securely, without the need to manually operate on the connection of the clamp 4 or the removal of

safety plugs connected to the radial aperture 142 in the rod 14, as happens in the known art.

The mud circulation circuit 3 comprises a monitoring system for the flow of drilling mud "M" in the mud circulation circuit 3 itself, in order to detect any losses or the possible generation of undesired flows, known by the term "blowout". In particular, the monitoring system is capable of detecting the presence of gas or strata fluids in the return drilling mud "M" from the well being drilled, which are typical indicators of the start of a blowout; furthermore, it is capable of detecting losses of mud "M" into the well, caused by the absorption of the well itself.

The mud circulation circuit 3, as (for example) illustrated in figure 5A, in addition to said principal circuit 31 and said secondary circuit 32, comprises a mud intake tank 312 and a mud recovery tank 332. Said mud intake tank 312 is comprised in the intake circuit of the mud “M” into the well being drilled. In this tank 312 the drilling mud “M” is prepared, depending on the geological formation which is being drilled.

Said mud recovery tank 332 is where the recovery circuit 33 discharges, in which the drilling mud “M” is cleaned of excavation detritus and reintroduced into the mud circulation circuit 3 to be reused, for example by reintroducing it into the mud intake tank 312.

Rig 1, according to the present invention, further comprises a first manipulator 5, suitable for assembling at least two drilling rods 14, comprising a linear movement device 52, for moving the rods 14. Said first manipulator 5 comprises a locking tong 54 suitable for generating a torque on the rods 14 to be connected to each other, so as

to ensure that they are tight. Said manipulator 5 is automated, allowing it to assemble/disassemble two or more drilling rods 14 when the rig is in the drilling phase or in the phase of removing the drilling rods 14, phases known to a technician skilled in the field, for the purpose of speeding up these operations, reducing the downtimes for adding/removing drilling rods 14.

In a preferred but not limiting embodiment, the rig 1, furthermore, comprises a rod rack 15, in which are arranged a plurality of rods 14 assembled together in a series of defined length and a second manipulator 16 to move said rods 14. Said second manipulator 16 is preferably of pantograph type, and is suitable for preparing said rods 14, for example contained in the rod rack 15, making them available to the drilling head 25 and vice versa, for example placing said series of rods 14 in the auxiliary hole 124, from which the drilling head 25, for example by means of a pantograph structure 26, can be extended and pick up the rod 14, or the series of rods, placed in said auxiliary hole 124. Said pantograph structure is partially visible in a retracted configuration in figure 3A. Said rod rack makes it possible to keep in a vertical position a series of rods, previously packed, which can be used during the drilling phases.

Going into the details of the rig 1, according to the present invention, said mast 2 is telescopic and comprises: a trellised structure 21 comprising in turn a first structure 211 suitable for being fixed to the rig floor 12; at least one second structure 212, movable with respect to the first structure 211, so as to obtain a telescopic mast 2. The mast 2 comprises a movement system 22 suitable at

least for extending and retracting the longitudinal extension of said telescopic mast 2, in particular by moving said at least one second structure 212. Preferably, said movement system 22 is able to move said at least one second structure 212 in a vertical direction, parallel to the axis "Z", particularly when the mast 2 itself is located on said rig floor 12, in a vertical position.

Said mast 2 is capable at least of assuming an extended operating configuration, in which the mast 2 is completely extended, assuming its maximum longitudinal extension, as for example illustrated in figure 2B, and a retracted operating configuration, in which the mast 2 is completely retracted, assuming its minimum longitudinal extension, as for example illustrated in figure 2A.

In the embodiment illustrated, said trellised structure 21 comprises a single second structure 212 at whose end is comprised at least one fixed length 23. Said drilling head 25 is preferably mounted on a movable length 24 suitable for sliding along guides comprised on said mast 2. In an exemplary but not limiting embodiment, the movement of the second portion 212, by means of the movement system 22, moves the fixed length 23 which, using a system of ropes and pulleys, moves the movable length 24 and consequently the drilling head 25.

Furthermore, said movement system 22 in turn comprises a supply chamber 226 and two hydraulic pistons (222,224) aligned in a single direction, parallel to the vertical axis "Z", and acting in opposite senses to each other. Said telescopic mast 2, comprising two pistons opposed to each other, makes it possible to reach an extension of the trellised structure 21 such as to enable use of drilling

rods assembled in series greater than 20 m in length, for example up to 27 m.

Said first piston 222, at a first end thereof is fixed to said rig floor 21, by means of a fixing portion 221, and at its second end to the supply chamber 226. Said second piston 224, on the other hand, at a first end thereof is fixed to said second structure 212, and at its second end to the supply chamber 226.

In general, said movement system 22 is situated inside the mast 2, in particular inside said first structure 211 and said second structure 212.

Going further into constructional detail, preferably said at least one supply chamber 226 is fixed to one end of a first hydraulic piston 222 and to one end of a second hydraulic piston 224, being arranged between the two hydraulic pistons (222, 224) and moving integrally with them. These characteristics are clearly visible in figures 2A-2B. All the parts illustrated in the above drawings are clearly distinguishable for a technician skilled in the field.

Said movement system 22 comprises at least one pressurisation chamber 228 for supplying the two pistons (222,224), located in the fixing portion 221 of the movement system 22 on said rig floor 12. Fuller details on the construction of the mast 2 just described are for example comprised in patent application ITTO2013000850A.

Said first manipulator 5 is automatic. Said manipulator 5 comprising a lifting device 56 is suitable for assembling said drilling rods in a vertical position. Said first manipulator 5 is suitable for assembling together at least two drilling rods for the purpose of

obtaining a series of rods with a length greater than 20 m, for example up to 27 m, in particular when said rods are in a vertical position, i.e. substantially parallel to the vertical axis “Z”.

The high automation of the rig 1 according to the present invention makes it possible to use series of rods 14 of greater length than the series of rods usable in the rigs with telescopic mast comprised in the state of the art, reducing the non-productive time of the rig.

In a preferred embodiment, said first manipulator 5 comprises a support structure 51, two linear movement devices (52A, 52B), a closing device 54, comprising in turn a screwing device 541 capable of rapidly screwing two rods between the two rods. As mentioned above, the first manipulator 5 comprises a hydraulic lifting device 56 capable of rotating at least part of the first manipulator 5 itself around a first axis “X”. In particular said lifting device 56 is capable of moving at least part of the first manipulator 5 itself from a horizontal to a vertical position and vice versa.

In particular, in said first manipulator 5 according to the present invention, a first linear movement device 52A is fixed to a support structure 54, at one end thereof. At the opposite end, said support structure 51 is hinged, in such a way as to be able to rotate around said axis “X”. Said lifting device 56 acts on said support structure 51 for the purpose of making said support structure 51 complete the arc described in figure 6A. In particular, in the non-limiting embodiment illustrated, said lifting device 56, to make the support structure 51 pass from a

horizontal position to a vertical position, pulls the structure 51 itself.

A second linear movement device 52B is placed in proximity to the auxiliary hole 124, arranged vertically in such a way as to be able to move the drilling rods 14 in the direction of the longitudinal extension of the auxiliary hole 124, i.e. parallel to the vertical axis “Z”. Said second auxiliary movement device 52B is independent of the support structure 51, remaining fixed in a position of its own in proximity to the auxiliary hole 124.

When the first manipulator 5 is in a vertical position, and in particular said support structure 51, said two linear movement devices (52A, 52B) are aligned in the direction of the longitudinal extension of the auxiliary hole 124.

In a preferred embodiment, said locking tong 54 is placed in proximity to the auxiliary hole 124, preferably above the second linear movement device 52B. In this embodiment, said locking tong 54 and said second linear movement device 52B are placed fixed in proximity to the auxiliary hole 124, not moving with the rest of the first manipulator 5, in particular in proximity to the support structure 51; while the first linear movement device 52A is movable with said support structure 51.

Said second linear movement device 52B in combination with the locking tong 54, perform the function of sealing element for the drilling rod 14 in position, particularly vertical position, in the auxiliary hole 124, in order to facilitate its connection with the next drilling rod 14, lifted by the support structure 51, by means of said lifting device 56. Furthermore, said first linear movement

device 52A also performs the function of element holding the drilling rod 14 during the movement from horizontal to vertical, and contributes to supporting the drilling rod inside the auxiliary hole 124.

Said second movement device 52B directs the drilling rods into the auxiliary hole 124, maintaining them in position to be assembled with the subsequent rods. Further on in the present description, a detailed description will be given of the operative phases undergone by the manipulator 5 for assembling at least two drilling rods together, for example during the performance of the drilling phase by the drilling head 25.

With reference to an exemplary and non-limiting embodiment, for example illustrated in figures 8A and 8B, said support structure 51 has a forked conformation, in which the arms are hinged in such a way as to rotate around said first axis “X”; at the opposite end, on the other hand, the support structure 51 is fixed to said first linear movement device 52A. Preferably, the distance between the arms of the support structure 51 is such as to create a housing which will surround said locking tong 54 and said second linear movement device 52B, as may be seen in figures 6B-6E. Said linear movement devices (52A,52B) are preferably roller systems. In the preferred embodiment said lifting device 56 is raised by at least one hydraulic piston, even more preferably by a pair of hydraulic pistons. Said at least one hydraulic piston is hinged at one end to the support structure 51 and at the opposite end to a base structure, located at ground level, or to the structure of the rig 1, for example the rig floor 12. In the embodiment illustrated said lifting device is a pair of

pistons, at one end respectively fixed to the arms of the support structure 51 and at the opposite end to the rig floor 12.

Said locking tong 54 and said screwing device 541, are preferably hydraulic devices.

Still in the logic of a highly automated rig, the collector circuit 34, comprised in the mud circulation circuit 3, is automated.

In particular, the collector circuit 34 is suitable for automatically intercepting and selectively diverting, at least partially, a flow of drilling mud "M". Said flow of mud "M" flows continuously in the mud circulation circuit 3. Said mud circulation circuit 3 is suitable for introducing a flow of mud "M" into the drilling well, the latter having been created by the drilling rig 1 itself, as is known to a technician skilled in the field.

The collector circuit 34, according to the present invention, comprises a first sub-circuit 342 and at least one second sub-circuit 344. Said at least one second sub-circuit 344 is fluidodynamically connected to said first sub-circuit 342 to receive at least one portion of flow of mud "M", diverted by said first sub-circuit 342, and convey it towards at least one first outlet 344B of the second sub-circuit 344.

Going into detail, said first sub-circuit 342 comprises at least one first duct, comprising at least one first valve 342A. The first sub-circuit 342 itself comprises at least one second duct which in turn comprises at least one second valve 342B, as may be seen, for example, in figure 5D.

Said first sub-circuit 342, depending on the operative configurations of said at least one first valve 342A and of said at least one second valve 342B, is capable of:

- allowing said mud flow "M" to pass in said at least one first duct, directed towards the principal circuit 31, in turn directed towards the drilling head 25 as illustrated in figure 5B; or

- selectively diverting at least one portion of said mud flow "M" towards said at least one second duct, directed towards said second sub-circuit 344, in turn directed towards said secondary circuit 32.

Said at least one second sub-circuit 344 is fluidodynamically connected to said first sub-circuit 342, in particular via said second duct, preferably directly. Said at least one second sub-circuit 344 is capable of receiving at least one portion of flow of mud "M", diverted by said first sub-circuit 342, and conveying it towards at least one first outlet 344B of the second sub-circuit 344.

Said at least one second sub-circuit 344 and said first sub-circuit 342 are independent of each other. Furthermore, said at least one second sub-circuit 344 is removable from the collector circuit 34.

The first sub-circuit 342, in addition to being able to be installed at the level of the rig floor 12 of the oil rig 1, can be installed at ground level, for example integrated directly into the circulation circuit 3.

Said at least one second sub-circuit 344 is connectable to the first sub-circuit 342 by means of a pipe, for example a flexible pipe such as for example may be seen from figures 5B-5D, or directly connected. The solution with flexible pipe makes it possible to arrange

said at least one second sub-circuit 344 on a different plane from the one on which the first sub-circuit 342 lies, for example at a different height from ground level.

Said at least one second sub-circuit 344 is the portion of collector circuit 34 facing towards the secondary circuit 32, as for example illustrated in figures 5B-5D, in particular towards the radial aperture 142, connected to drilling rod 14.

Said at least one second sub-circuit 344 is always excluded during the drilling phases of a drilling rig 1, as for example illustrated in figure 5A. In particular, said at least one second sub-circuit 344 is activated by means of said first sub-circuit 342, supplying it with at least part of the flow of mud "M", exclusively during the phases of addition/removal of a plurality of elements of drilling rods 14, of the desired drilling length. In particular said second sub-circuit 344 is activated when it is necessary to make the flow of mud "M" run through the secondary circuit 32 instead of the principal circuit 31, as for example illustrated in figure 5C.

Going into the constructional details of the collector circuit 34, said second sub-circuit 344 comprises an intake 344A, from which enters the flow of mud "M" diverted by said first sub-circuit 342. Said intake 344A is connected to the second outlet of the second duct of the first sub-circuit 342.

In general, said at least one sub-circuit 344 comprises at least one valve 344C suitable for regulating said at least one portion of flow of mud "M", said valve being directed towards said at least one first outlet 344B. Said first outlet 344B is connected to a secondary circuit

32 of the fluids circulation circuit 3. In particular said at least one first outlet 344B can be connected, preferably directly, to said secondary circuit 32.

In the preferred embodiment, the second sub-circuit 344 comprises two valves 344C, for example placed in parallel with each other, capable of controlling said at least one portion of the flow of mud "M" diverted by said first sub-circuit 342. The control performed by the two valves 344C is suitable for allowing the circulation of the flow of mud "M", continuously, towards the bottom of a drilling well.

All the valves (342A, 342B, 344C) comprised in the collector circuit 34 are automatic valves which are remotely activated, for example by means of the controls comprised in the control room 11.

In the embodiment illustrated in figures 5B-5D, said second sub-circuit 344 comprises at least one filtering device 345 suitable for filtering the flow of mud which runs in said second sub-circuit 344. Said filtering device 345 makes it possible to improve the efficiency of said sub-circuit 344 with evident functional and safety advantages, which are easily understood by a technician skilled in the field.

Said first sub-circuit 342 can be connected with said principal circuit 31 of the fluids circulation circuit 3 in any position in line with the principal circuit 31 itself.

In general, said sub-circuit 342 and said second sub-circuit 344, of the collector circuit 34, comprise respectively at least one depressurisation circuit 35.

Said depressurisation circuits 35 are distinct and activatable automatically and independently of each other.

Each one makes it possible to depressurise respectively at least part of the first sub-circuit 342 and at least part of the second sub-circuit 344. Said depressurisation circuits 35 are fluidodynamically connected to the recovery circuit 33 for drilling mud "M", comprised in the circulation circuit 3 of the drilling rig 1, according to the present invention.

Said depressurisation circuits 35, in addition to allowing the depressurisation of the various circuits, principal and secondary, are of fundamental importance because they regulate the opening and closing of the axial valves, comprised in the drilling rods 14, during the diversion of the flow of mud.

Figure 5E illustrates a possible arrangement of the collector circuit 34 on rig floor 12.

Equivalent embodiments of the collector circuit are for example described in patent application ITTO2014000024A.

The mud circulation circuit 3 comprises a monitoring system for the mud flow "M" which is automatic.

In general, as for example illustrated in figure 5A, said circulation circuit 3 comprises a principal circuit 31, in which flows said mud flow "M", comprising at least one principal pump 314. Said principal circuit 31 is capable of being connected to a drilling head 25 of the drilling rig 1. The same fluids circulation circuit 3 comprises at least one secondary circuit 32, in which said mud flow "M" can flow. Said at least one secondary circuit 32 is capable of being connected to a radial aperture 142 comprised in a drilling rod 14. Preferably, connected to this radial aperture 142 is comprised at least one valve

unit 144 fixed to the drilling rod 14 located in the drilling well, as is known to a technician skilled in the field. The drilling rod 14 itself comprises an axial safety valve, as is known to a technician skilled in the field. Said valve unit 144 preferably comprises a valve body 146 and two shutters, in particular a first shutter 145, constituting a first barrier or valve, and a second shutter 147, constituting a second barrier or valve. Said two shutters are not removable from the valve body. Said two shutters constitute a double protection for the radial aperture 142.

Said secondary circuit 32 is preferably realised by means of a duct, preferably at least in part flexible, and at its end is located said automated connection clamp 4, described in detail below.

The fixing of the connection clamp 4 to the automated circuit is effected preferably by means of a first connection portion capable of allowing a sealed connection to said secondary circuit, for example by means of hammer lug couplings, or with fixing means known to a technician skilled in the field.

Said automated connection clamp 4 is capable of automatically gripping the drilling rod 14 and opening the radial aperture 142 of the drilling rod 14 located in the drilling well, and in particular of opening a safety valve unit 144 connected to said radial aperture 142.

Said automated connection clamp 4 is furthermore capable of ensuring a mechanical fixing and a pressure-tight seal. The fixing of the automated connection clamp 4 to the radial aperture 142 makes it possible to introduce the mud flow “M” into the series of drilling rods 14

inserted into the drilling well, towards the drill bit located at the lower end of said series of drilling rods 14, as is known to a technician skilled in the field.

This automated connection clamp 4 is capable of opening and closing said valve unit 144, which represents a safety feature. Said safety valve unit 144 is capable of avoiding the leakage of drilling mud through said radial aperture 142 when a drilling mud flow “M” runs into the axial hole in the drilling rod, as is known to a technician skilled in the field.

The secondary circuit 32 is preferably realised with a flexible pipe, in order to allow maximum mobility to the secondary circuit 32 so as to be easily movable by means of said movement arm 41 comprised in the connection clamp 4.

The connection between connection clamp 4 and drilling rod 14 enables the circulation of a flow of drilling mud “M” towards the bottom of a drilling well during the phases of connection and/or removal of drilling rods 14, i.e. when it is not possible to make the drilling mud “M” flow via the principal circuit 31 through the axial hole in the drilling rod 14, as is known to a technician skilled in the field.

For simplicity during the description, the single term 'drilling rod' has been used, but said radial aperture and valve unit associated therewith can be comprised in a joint or a coupling, known to a technician skilled in the field, without for this reason departing from the inventive concept of the present invention.

As mentioned above, said connection clamp 4 comprises a movement arm 41 capable of moving said connection clamp 4. In particular said movement arm 41 is capable of

bringing into proximity and retracting said connection clamp 4 with respect to said drilling arm 14. In the embodiment illustrated in figures 3B and 3C, said movement arm 41 is an articulated parallelogram structure, whose operation is clearly understandable from the drawings for a technician skilled in the field. Said movement arm 41 is fixed to the rig floor 12 by means of a fixing base 411.

The movement of the connection clamp 4 for connecting and releasing said drilling rod 14 contributes to the automation of the drilling rig 1, according to the present invention. Figures 3B and 3C illustrate said movement arm 41 by way of non-limiting example, in particular figure 3B illustrates the movement arm 41 in a compact or retracted configuration. Figure 3C, on the other hand, illustrates the same movement arm 41 in an extended configuration. Other equivalent shapes of the movement arm 41, capable of moving the connection clamp 4, must be considered comprised in the present patent description, without for this reason departing from the content of the present application.

Figures 3D and 3E show an exemplary embodiment of the end part of the connection clamp 4, in which may be seen the central body 42 and the locking system 44. In the exemplary embodiment illustrated, the gripping system 44 comprises two arms 442 to each of which is attached a tightening actuator 444. Preferably, each tightening actuator 444 is rotatably constrained to said arm 442. In particular, said tightening actuator 444 is constrained to one end of said arm 442, which is hinged and capable of rotating. This technical solution makes it possible simply to ensure the grip of the connection clamp 4 to the drilling rod 14. The present solution contributes,

furthermore, to the automation of the connection to the drilling rod 14.

Going into the details of construction, the automated connection clamp 4, comprised in rig 1 according to the present invention, comprises a single opening device 46 which is capable of selective opening and closing of the radial aperture 142 by acting on said valve unit 144. Furthermore, within the connection clamp 4 there is comprised a single coupling device 48 for connecting said opening device 46 to said valve unit 144, as in the example illustrated in figures 4A and 4B.

Going further into the details of construction, the opening device 46 is capable of selectively opening and closing said radial aperture 142 by acting on a first shutter 145 in the valve unit 144, performing at least one movement, at least rotatory. Furthermore, the coupling device 48 is capable of attaching itself to a gripping element 145A comprised in the first shutter 145 itself, in such a way that said at least one movement, at least rotatory, of the opening device 46 is transferred onto said first shutter 145 to selectively open and close, at least in part, said radial aperture 142, in a safe manner.

In the exemplary embodiment illustrated, said coupling device 48 comprises: a connecting element 482 capable of being coupled with a corresponding gripping element 145A, comprised on said first shutter 145, and a connecting actuator 484 capable of moving said connecting element 482, to enable its attachment to or detachment from said gripping element 145A.

Said opening device 46, however, comprises at least one first opening actuator 462 which is capable of making said

connecting element 482 perform at least one rotatory movement; and at least one second opening actuator 464 which is capable of making said connecting element 482 perform a translatory movement.

Figures 4A-4D show a preferred embodiment of the connection clamp 4, according to the present invention. Equivalent embodiments are for example described in patent application ITTO2014000030A.

In the embodiment illustrated by way of non-limiting example of the clamp 4, the opening device 46 is capable at least in part of selectively opening and closing said radial aperture 142 by acting on said first shutter 145 of the valve unit 144, performing a roto-translatory movement. In order to have the roto-translatory movement performed, there are comprised two distinct actuators, one for the rotatory movement and one for the translatory movement. In particular said opening device 46 comprises a first opening actuator 462, for the rotatory movement around a second axis “Y”, an axis normal to said valve unit 144. Said first opening actuator 462 is able to cause a rotation to be made of between 10° and 120°, for example 90°. Said second opening actuator 464 is capable of making said connecting element 482 perform a translatory movement, for a finite length.

In the present embodiment, said coupling device 48 and said opening device 46 are located inside the central body 42, in particular inside the intake duct, as for example may be seen in the attached figures 4A-4D. Preferably, the actuators are incorporated in an ordinary external casing 49, fixed by means of a support element 491 to the walls of the intake duct of the central body 42.

The operative sequence will be briefly described below for the connection and subsequent disconnection of the connection clamp 4 to the drilling rod 14. The embodiment illustrated and described below represents one possible embodiment, non-limiting, for exemplary purposes.

The step of bringing the connection clamp 4 closer is activated by moving said movement arm 41. Once the connection clamp 4 has reached proximity with the drilling rod 14, thanks to the gripping system 44, it grips onto the drilling rod 14 itself, keeping the connection energised, compressing a gasket, ensuring the hydraulic seal, as for example may be seen in figure 4A. A sealing flange 422 is capable of being inserted into a housing for the sealing flange comprised in the drilling rod 14.

Subsequently to the tightening of the gripping system 44 onto the drilling rod 14, the coupling of the coupling device 48 to the valve unit 144 is carried out, passing from a non-operative condition to an operative condition, as, for example, may be seen in figure 4B.

In the present embodiment, the connecting element 482 has a discoidal shape comprising housings suitable for hosting prominences, shaped to be complementary, extending from the gripping element 145A of the first shutter 145. Said coupling actuator 484 is a linear actuator, preferably pneumatic. Said connecting element 482 is maintained in contact with the first shutter 145 by an elastic means, for example a spring as illustrated in the drawings.

Subsequently to the attachment of the connecting element 482 to the gripping element 145A, the opening device 46 is activated, in particular the first opening actuator 462, passing from a non-operative configuration to

an operative configuration. The transition of the first opening actuator 462 to the operative configuration causes the first shutter 145 to perform a rotatory movement, as for example illustrated in figure 4C, at least partly moving said coupling device 48, in particular said connecting element 482.

To transmit the movement from the first opening actuator 462 to the coupling device 48, there is a joint, visible in figure 4C.

To oppose the force exerted by the elastic means and allow the movement of the first shutter 145, and the consequent definitive opening of the valve to which the first shutter 145 is connected, the second opening actuator 464 is activated. Said second opening actuator 464, passing from a non-operative to an operative condition, acts on at least one cam 145B; in particular it presses on a plurality of cams 145B, as for example shown in figure 4D, at least partly moving said coupling device 48, in particular said connecting element 482.

Said pressure exerted by the second opening actuator 464 on said plurality of cams 145B makes the first shutter 145, and consequently the connecting element 482 connected to it, translate along the second axis “Y”, carrying said first shutter 145 in the second operative configuration, opening the valve connected to it, as for example shown in figure 4D. Equivalent embodiments of the first shutter, in which said cams and associated elastic elements have been removed, are however comprised within the scope of the present invention.

Said second opening actuator 464 is preferably a linear actuator, preferably hydraulic.

Following the rotational and translational movement of the first shutter 145, at least one gap is opened, for example three gaps, preferably equidistant, for example located at 120° from each other, through which the drilling mud "M" can pass.

The operation and technical characteristics of valve unit 144, illustrated in the present embodiment, are described in detail in Italian patent application ITTO20130722A.

Subsequently to the opening of the first valve connected to the first shutter 145, the drilling mud "M", diverted from the secondary circuit 32 can overcome the barrier constituted by the first shutter 145; since it is the first shutter 145 it reaches the second operative configuration, eliminating the first barrier for the circulation of fluids through the radial aperture 142. The last barrier, before it is possible definitively to establish the circulation of the drilling mud "M" through the radial aperture 142, consists of the second shutter 147, for example a butterfly shutter, as for example illustrated in figure 4D. The difference in pressure at the ends of the second shutter 147 allows said second shutter 147 to move, opening the second valve in the valve unit 144, and establishing the circulation of mud "M" via the radial aperture 142. In this configuration, not illustrated in detail but easily understandable from the description and the attached drawings, both the shutters (145, 147) are in the second operative configuration which renders the two respective valves or barriers open. In this phase the mud flow passes through said radial aperture 142 of the drilling rod 14 towards the bottom of the drilling well.

The phase of introducing drilling mud “M” via the radial aperture 142 being terminated, by appropriately operating the collector circuit 34, described above, the flow of mud “M” towards the secondary circuit 32 is interrupted to simultaneously re-establish the circulation towards the principal circuit 31. This variation in pressure in proximity to the radial aperture 142 makes the second shutter 147 pass once more into the first operative configuration, closing the valve connected to it and preventing the circulation of the fluid via said radial aperture 142.

Following this, the second opening actuator 464 is activated, terminating the action on the cams 145B; in particular said second opening actuator 464 is retracted, allowing the cams 145B to return to an initial position of rest. Contributing to the movement of the cams 145B in addition to the elastic means comprised in the attachment actuator 484 which presses on the first shutter 145, the cams themselves comprise return means such as springs, partially visible in the attached drawings, bringing the shutter 145 back to the initial operating condition, performing a translation along axis “Y”. The movement of the second opening aperture 464 leads to a configuration similar to that shown in figure 4C.

This translatory movement of the first shutter 145 at least partially closes the valve to which it is connected, bringing the shutter itself only partially into the first configuration.

Subsequently, the first opening actuator 462 is activated once more, performing a rotation, preferably contrary to the direction of rotation performed for the

opening of the first valve to which is connected the first shutter 145. The closure of the first valve has the effect that said first shutter 145 once again reaches the first operative configuration, definitively closing the radial aperture 142.

In the situation under examination the devices (46, 48) comprised in the connection clamp 4 have reached an operative condition substantially equivalent to that illustrated in figure 4B.

Once the barrier constituted by the first shutter 145 is closed, the coupling actuator 484 can be activated in order to retract the connecting element 482 of the gripping element 145A, returning to the initial configuration, for example illustrated in figure 4A. Subsequently the gripping system 44 is activated, in order to release the drilling rod 14, in particular by opening.

Subsequently, by means of said movement arm 41, the connection clamp 4 is moved away from the drilling rod 14.

Said gripping system 44, said coupling device 48 and said opening device 46 are activated and monitored by an automated control unit, by means of a plurality of sensors, for the purpose of executing the operative sequence described above. The entire connection clamp 4 is highly automated and is totally controllable remotely by an operator located in the control room or control cabin or dog house 11.

Said valve unit 144, associated with a radial aperture 142 in a drilling rod 14, and the connection clamp 4 can constitute a system or an assembly capable at least of contributing to the control of the circulation of drilling mud “M” towards the bottom of the well, particularly

through said radial aperture 142, in a safe manner, in order to reduce the risks to personnel present on the drilling rig 1 according to the present invention.

The drilling rig 1 according to the present invention is particularly innovative by virtue of said first manipulator 5 which constitutes an automatic assembly system for a series of rods capable of making up a desired drilling length, for example of 27 m. Said first manipulator 5 associated with the rig 1, according to the present invention, makes it possible to obtain the following advantages: packaging/assembly of a series of drilling rods of a desired length, performed completely automatically and controllably from the control room or dog house or cabin of the drilling rig 11; not engaging the rig floor 12, the drilling head or top drive 25 and the power tong (hydraulic wrench) for assembly operations or adding a rod string, it thus being possible to perform the assembly phase in parallel to the drilling phase: the series of rods is assembled away from the rig floor 12 and thus in parallel, in background time. All the operations of packaging and moving the rods are performed in parallel to the actual drilling and do not interfere with its execution.

The drilling rig 1, and in particular the telescopic mast 2 makes it possible to operate with series of rods with a reference length of 27 m, which is achievable indifferently by making it up from three rods of length 9 m, known in the jargon as range 2, or from two rods of length 13.5 m, known as range 3.

Rig 1 according to the present invention makes it possible to operate either with drilling rods or with casings for lining the well.

Below is a list of the steps executed by the first manipulator 5 for creating a series of rods.

If a 27 m series of rods is being created, in particular made up of two range 3 rods, it will be sufficient to carry out the proposed steps only once. In the case of a drilling length made up of three range 2 rods, the steps from b) to c) must be repeated several times in order to obtain the desired length.

The method of assembling a series of drilling rods 14 comprises the following consecutive steps:

a) moving a rod 14 from a container of rods 17 to the first manipulator 5, for example by means of a positioning device 7, where the rod is in a horizontal position;

b) raising the manipulator 5, thus lifting the rod from a horizontal to a vertical position, bringing it to the auxiliary hole 124;

c) sliding the rod 14 into the auxiliary hole 124 by means of at least one linear movement device (52A, 52B);

d) moving a new drilling rod 14 and consequently lowering the manipulator 5 to grip the rod;

e) repeating steps b) to c);

f) assembling the two drilling rods, where the two linear movement devices (52A, 52B) align the two rods, one of which is already present in the auxiliary hole 124 and the other lifted by manipulator 5, and the screwing device 541 screws the two aligned drilling rods together, and finally the locking tong 54 tightens the two rods;

g) repeating steps d)-f) until a series of rods of the desired length is created.

Step a) of moving a rod 14 from a container of rods 17 to the first manipulator 5, is executed by means of a positioning device 7. Said positioning device 7, constrained to said container 17, is capable of sliding on guides 71 for the purpose of picking up a rod 14 from said container 17 and positioning it on a support structure 73 to be picked up by the first manipulator and vice versa. Said positioning device 7 comprises a gripping element 72, for example a double tong mechanism. Subsequently to step a), step b) is executed, of raising the manipulator 5, thus lifting the rod from a horizontal to a vertical position. Said first manipulator, and in particular said support structure 51, through the pull of the lifting device 56, performs a movement illustrated in figure 6A. This rod 14 is carried to an auxiliary hole 124.

In said step the first linear movement device 52A aligns the lifted rod with the locking tong 54 and with the second linear movement device 52B.

As shown in figure 6B, in this step the locking tong 54 and the second linear movement device 52B grip the rod 14 restraining it, in such a way that if the first movement device 52A was disengaged from the rod, following the lifting, the rod itself would remain correctly in a vertical position.

Step b) is followed by step c) of sliding the rod 14 into the auxiliary hole 124 by means of at least one linear movement device (52A, 52B). In this step the two movement devices (52A, 52B) cooperate, at least in part, to lower

the drilling rod into the auxiliary well 124, in order to reach the configuration illustrated in figure 6C.

As soon as the first movement device 52A has disengaged from the rod, the lifting device 56 could move the support structure 51 in order to bring it to a horizontal configuration. Subsequently to step c), step d) is executed, of moving a new drilling rod 14 and consequently lowering the manipulator 5 to grip the rod. This step requires that, in order to increase the automation of the rig, the positioning device 7 should be activated in such a way as to prepare a new rod on said support structure 73, in such a way that simultaneously with the descent of the manipulator 5, it should already find a new rod to be gripped, so as to be able to lift it as soon as possible, in a similar way to what was done with the previous rod in step b).

Cyclical step e) has steps b) and c) repeated, in order to reach the configuration illustrated in figure 6D. The sliding step is performed until the two rods reach proximity with each other.

When the cyclical step e) is completed, it is followed by step f) of assembling the two drilling rods, where the two linear movement devices (52A, 52B) align the two rods, one of which is already present in the auxiliary hole 124 and the other lifted by manipulator 5, and the screwing device 541 screws the two aligned drilling rods together, and the locking tong 54 tightens the two rods. Figure 6E shows the two rods assembled together.

When this step is completed a series of rods is created consisting of two rods joined together which could be used in rig 1 according to the present invention, thus reducing

the number of interruptions for the addition of drilling rods.

When step f) is completed, step g) is executed, of repeating steps d)-f) until a series of rods of the desired length is created.

Preferably the length of the series of rods assembled by means of the first manipulator, usable correctly by the rig according to the present invention, is 27 m.

For exemplary and non-limiting purposes, following stage g) another stage is comprised between:

- moving the series of packed/assembled rods from secondary hole 124 to rod rack 15 by means of said second manipulator 16; or
- moving the series of packed/assembled rods from auxiliary hole 124 to the principal hole 122 by direct pick-up by the drilling head 25.

Depending on needs, the series of rods packed by the first manipulator 5 can be immediately used for drilling and therefore picked up from the auxiliary hole 124 to position the series in the principal well 122; alternatively, it is possible to decide to store more than one series of already packed rods, of the desired length, for example 27 m, in the rod rack 15, to be used in subsequent drilling phases.

During the use of the rig 1 according to the present invention it is particularly advisable to use at least one anti-friction device associated with a drilling element, such as a drilling rod 14 or a joint, of substantially cylindrical form, as is known to a technician skilled in the field, and having a first outer diameter and a longitudinal extension. Preferably said anti-friction

device is associated with a drilling element at regular intervals in the series of rods used during drilling.

The drilling element used in the rig below preferably comprises at least one housing suitable for accommodating this anti-friction device.

The anti-friction device is preferably of hollow cylindrical form having an internal diameter less than said first diameter of the drilling element, and an outer diameter larger than said first diameter of the same drilling element.

The anti-friction device is suitable for rotating around the longitudinal axis of the drilling element, in said housing, independently of the drilling element itself.

The device makes it possible to reduce irregular wear on the drilling elements, since the drilling rods 14 themselves are less subject to frictional action against the walls of the lining pipe and of the uncovered hole of the well. Equivalent embodiments are for example described in patent application ITTO20140778A.

The anti-friction device considerably reduces breakages of drilling rods, and this fact considerably increases the safety of operations. The anti-friction device, besides reducing periods of non-productive time, known as NPT, and increasing safety, makes it possible by reducing friction to increase the speed of drilling, reducing operating costs and bringing forward the possible date of putting the well into production.

In the overall view of the rig illustrated in figures 1A-1C, a horizontal rack is visible for the linings or casings to be inserted into the well once the drilling

stage is completed, as is known to a technician skilled in the field.

The parts illustrated in the attached drawings but not described in detail in the present description are to be considered comprised in the present description since they are clearly distinguishable by a technician skilled in the field.

The rig 1, according to the present invention, is particularly suited to creating wells of medium-large depth and critical wells by reducing the number of interruptions in drilling due to the addition or removal of the series of rods of the length desired, and eliminating interruptions in the mud flowing towards the well precisely during the addition or removal of the series of rods, with evident operative, economic and safety advantages.

The automated connection clamp 4, together with the collector circuit 34, constitute the fixed equipment of the system for the prevention of operating problems connected with the drilling of petroliferous wells, in particular high pressure and high temperature (or HP/HT) wells, even in deep water, in which the operating conditions are more critical.

The clamp 4 performs the function of controlling the opening and closure of the valve unit 144 associated with the radial aperture 142 of the rod 14, and of ensuring the introduction of drilling mud “M”, coming from the collector circuit 34, into the battery of rods during the connection/disconnection of each series of rods of the desired length, safely and automatically.

The flow monitoring system serves to implement and increase the safety of the mud circulation circuit 3 for

the continuous circulation of the drilling mud “M”, which would lose many of its advantages if not coupled to the continuous circulation system. The system provides for a plurality of sensors, for example located in the mud intake tank, in the mud recovery tank and along the mud circulation circuit, particularly along the principal circuit, along the secondary circuit and along the recovery circuit, for the purpose of measuring various physical sizes, preparatory to monitoring flows in the mud circulation circuit.

The flow monitoring system comprises a processing device suitable for receiving the data from said sensors, processing it and returning at least one item of information on the flow of mud circulating in the mud circulation circuit.

The known art uses a system which makes it possible to perform pressure drilling of the annulus, i.e. the area comprised between the drilling rods and the walls of the well where the drilling mud “M” passes in its (monitored) rise towards the surface. The pressure is monitored through a leak prevention device or BOP (blowout preventer) of rotatory type, known to a technician skilled in the field, installed on the well head, and certain valves which are located downstream of the BOP and which make it possible to pressurise precisely the rising mud return line. The solution according to the present invention does not require pressurising the annulus of the well and furthermore does not require the use of rotatory BOP devices and a series of valves connected with the BOP.

The solution according to the present invention does not therefore require the pressurisation of the annulus of

the well by means of valves or systems of choking the outgoing flow from the well itself.

The monitoring system returns to the operator a fault signal which can be a sound, visual or sensory signal.

The peculiar characteristic of the connection clamp 4 is the high level of automation which allows it to be monitored and controlled remotely from the control room or dog-house 11.

The development of an automatic clamp 4 has in fact as its principal objective the achievement of a high level of safety which will allow its use even in areas where there are heavy restrictions on the use of personnel and their safety, for carrying out manual work in areas at risk on the rig floor.

This function of the collector circuit, performed in complete synergy with the connection clamp 4, is completely automated and can be monitored and controlled remotely from the control room or cabin of the drilling rig 11, with a consequent reduction in the personnel used and in operating risks.

The mud circulation circuit 3, comprising the collector circuit 34 described above, makes it possible to exclude completely said secondary circuit 32 during the circulation of the mud in the principal circuit 31. This property has the objective of allowing maintenance operations to the secondary circuit 32, and to the second sub-circuit 344 of the collector circuit 34, without interrupting drilling operations. This characteristic furthermore facilitates the operation of the automated connection clamp 4, safeguarding the aspects connected with safety.

The rig described and illustrated represents an exemplary embodiment. Equivalent embodiments must be considered comprised within the present description.

NUMERICAL REFERENCES	
Drilling rig	1
Control room	11
Rig floor	12
Main hole	122
Auxiliary hole	124
Drilling rod	14
Radial aperture	142
Valve unit	144
First shutter	145
Gripping element	145A
Cams	145B
Valve body	146
Second shutter	147
Rod rack	15
Second manipulator	16
Rod container	17
Mast	2
Trellised structure	21
First structure	211
Second structure	212
Movement system	22
Fixing portion	221
First piston	222
Second piston	224
Supply chamber	226
Pressurisation chamber	228
Fixed length	23
Movable length	24
Drilling head	25
Pantograph structure	26

Mud circulation circuit	3
Main circuit	31
Mud intake tank	312
Main pump	314
Secondary circuit	32
Recovery circuit	33
Mud recovery tank	332
Collector circuit	34
First sub-circuit	342
First valve	342A
Second valve	342B
Second sub-circuit	344
Intake	344A
First outlet	344B
Valve	344C
Filtering device	345
Depressurisation circuit	35
Automated connection clamp	4
Movement arm	41
Fixing base	411
Central body	42
Sealing flange	422
Gripping system	44
Arms	442
Tightening actuator	444
Opening device	46
First opening actuator	462
Second opening actuator	464
Coupling device	48
Connecting element	482
Coupling actuator	484

Outer casing	49
Support element	491
First manipulator	5
Support structure	51
First linear movement device	52A
Second linear movement device	52B
Locking tong	54
Screwing device	541
Lifting device	56
Positioning device	7
Guides	71
Gripping element	72
Support structure	73
Drilling mud	“M”
First axis	“X”
Second axis	“Y”
Vertical axis	“Z”

CLAIMS:

1. Drilling rig (1) for creating wells for extracting hydrocarbons,

said rig comprising:

- a rig floor (12) raised off the ground;
- a mast (2), located on the rig floor (12), along which a drilling head (25) can slide;
- a mud circulation circuit (3) for the circulation of drilling mud (M), comprising: a main circuit (31) and at least one secondary circuit (32) for mud intake; a mud recovery circuit (33) and a collector circuit (34);
- an automated connection clamp (4) for connecting the secondary circuit (32) to a drilling rod (14), comprising a radial aperture (142) for the continuous circulation of mud, comprising a movement arm (41), a central body (42), a gripping system (44) to ensure the connection of the connection clamp (4) to the drilling rod (14);

the rig (1) is characterised in that:

- it comprises a first manipulator (5), capable of assembling together at least two drilling rods (14), comprising a linear movement device (52); a locking tong (54) capable of generating a torque on these rods to ensure that they are locked, and a lifting device (56); and in that
- said mast (2) is telescopic, comprising a movement system (22) in turn comprising a supply chamber (226) and two hydraulic pistons (222,224) aligned in a single direction, parallel to the vertical axis (Z), and acting in opposite senses to each other.

2. Rig according to Claim 1, wherein said manipulator (5) is automatic, comprising said lifting device (56) for

assembling said drilling rods together in a vertical position.

3. Rig according to one of the preceding claims, wherein this at least one supply chamber (226) is fixed at one end of a first hydraulic piston (222) and at one end of a second hydraulic piston (224), being arranged between the two hydraulic pistons (222, 224) and moving integrally with them.

4. Rig according to one of the preceding claims, wherein this collector circuit (34) is automatic and comprises:
a first sub-circuit (342) and at least one second sub-circuit (344); said at least one second sub-circuit (344) is fluidodynamically connected to said first sub-circuit (342) to receive at least one portion of flow of mud (M), diverted from said first sub-circuit (342), and convey it towards at least one first outlet (344B) of the second sub-circuit (344);
said at least one second sub-circuit (344) and said first sub-circuit (342) are independent of each other and said at least one second sub-circuit (344) is removable from the collector circuit (34).

5. Rig according to one of the preceding claims, wherein the automated connection clamp (4) comprises one single opening device (46) capable of selective opening and closing of the radial aperture (142) acting on a valve unit (144); one single coupling device (48) for connecting said opening device (46) to said valve unit (144); wherein the opening device (46) is capable of selectively opening and closing said radial aperture (142) acting on a first shutter (145) of the valve unit (144), performing at least one movement at least rotatory and the coupling device (48)

is capable of being coupled to a gripping element (145A) comprised in the first shutter (145) itself, in such a way that said at least one movement at least rotatory of the opening device (46) is transferred to said first shutter (145) to selectively open and close at least in part said radial aperture (142), in a secure manner.

6. Rig according to one of the preceding claims, wherein this first manipulator (5) comprises two linear movement devices (52), a closing device (54) comprising in turn a screwing device (541) capable of rapidly screwing two rods to each other, and a hydraulic lifting device (56) capable of rotating at least a part of said manipulator around a first axis (X) from a horizontal position to a vertical position.

7. Rig according to one of the preceding claims, wherein said movement system (22) comprises at least one pressurisation chamber (228) for supplying the two pistons (222,224), located in a fixing portion (221) of the movement system (22) on said rig floor (12).

8. Rig according to one of the preceding claims, wherein said first manipulator (5) comprises a support structure (51), conformed as a fork, to which a first linear movement device (52A) is fixed at one end thereof, and at an opposite end thereof is hinged to rotate around said first axis (X).

9. Rig according to Claim 5, wherein:

- said coupling device (48) comprises: an attachment element (482) capable of being coupled with a corresponding gripping element (145A) comprised on said first shutter (145), and a coupling actuator (484) capable of moving said attachment element (482);

- said opening device (46) comprises: at least one first opening actuator (462) capable of making said attachment element (482) perform at least one rotatory movement; and at least one second opening actuator (464) capable of making said attachment element (482) perform a translatory movement.

10. Rig according to one of the preceding claims, wherein said rig comprises:

• a rod rack (15) wherein are arranged a plurality of rods (14) assembled together in a series of defined length;

• a second manipulator (16) for moving said rods (14), capable of preparing said rods (14) contained in the rod rack (15) at the disposal of the drilling head (25) and vice versa.

11. Method of assembling a series of drilling rods (14) for use in a rig according to Claims 1-10, wherein are comprised the following consecutive steps:

a) moving a rod (14) from a rod container (17) to the first manipulator (5), wherein the rod is in a horizontal position,

b) raising the manipulator (5) thus lifting the rod from a horizontal to a vertical position, bringing it to an auxiliary hole (124);

c) sliding the rod (14) into the auxiliary hole (124) by means of at least one linear movement device (52A, 52B);

d) moving a new drilling rod (14) and consequently lowering the manipulator (5) to grip the rod;

e) repeating steps b) to c);

f) assembling the two drilling rods, wherein the two linear movement devices (52A, 52B) align the two rods, and the screwing device (541) screws the two aligned drilling

rods together and the locking tong (54) tightens the two rods;

g) repeating steps d)-f) until a series of rods of the desired length is created.

12. Method according to Claim 11, wherein, following step g) a further step is comprised between:

- moving the series of packed rods from auxiliary hole (124) to rod rack (15) by means of said second manipulator (16); or

- moving the series of packed rods from secondary hole (124) to the main hole (122) by direct pick-up by the drilling head (25).

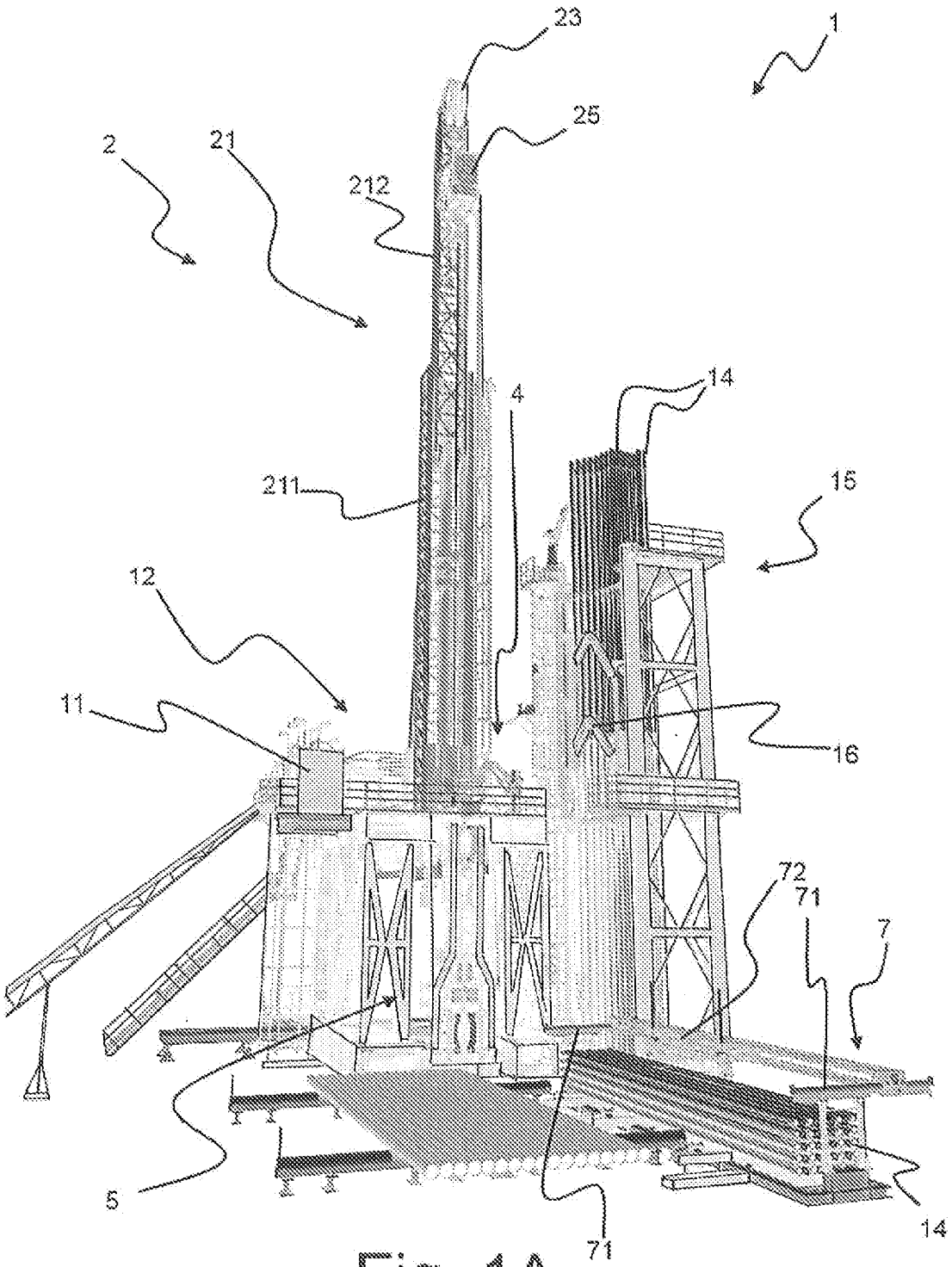


Fig. 1A

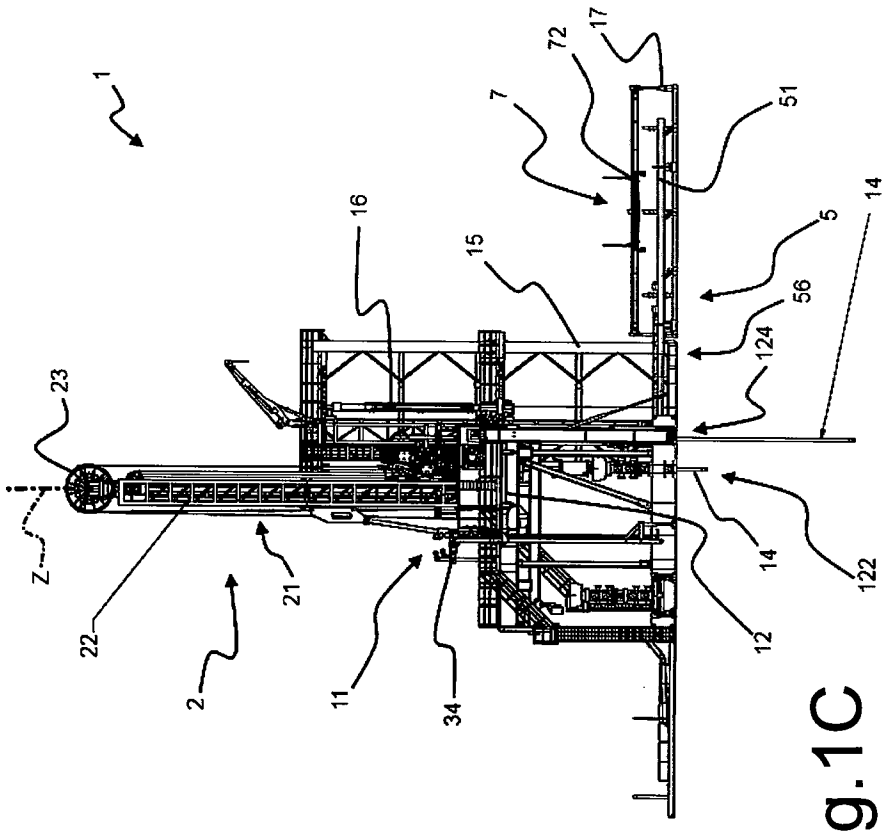

1
72
17
7
51
16
15
5
14
56
124
23
Z
22
21
2
11
34
12
14
122

Fig.1C

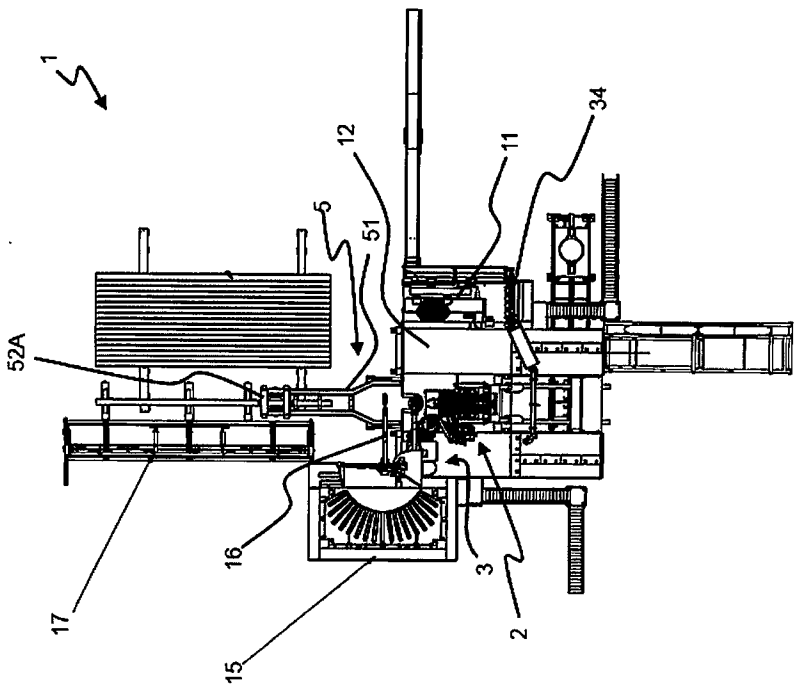

1
12
11
34
5
51
52A
16
3
17
2
15

Fig.1B

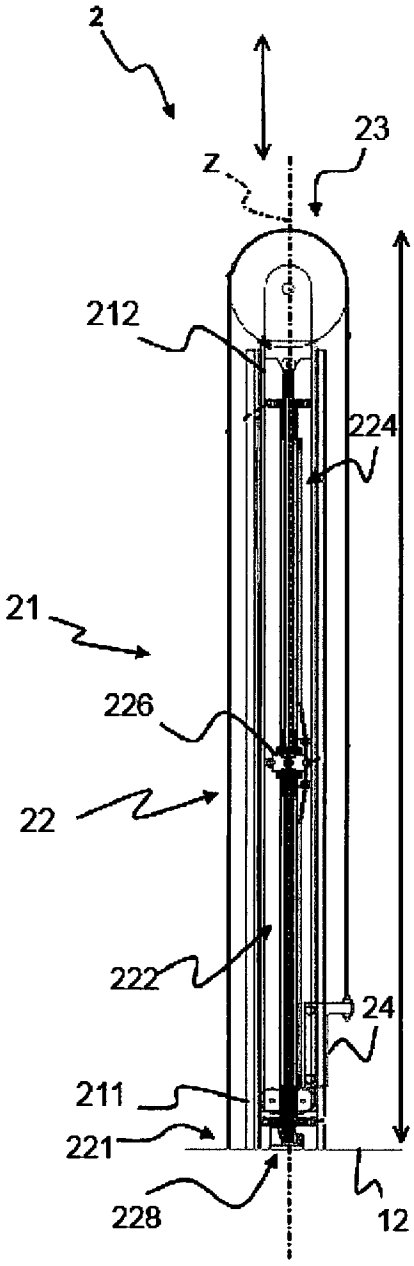
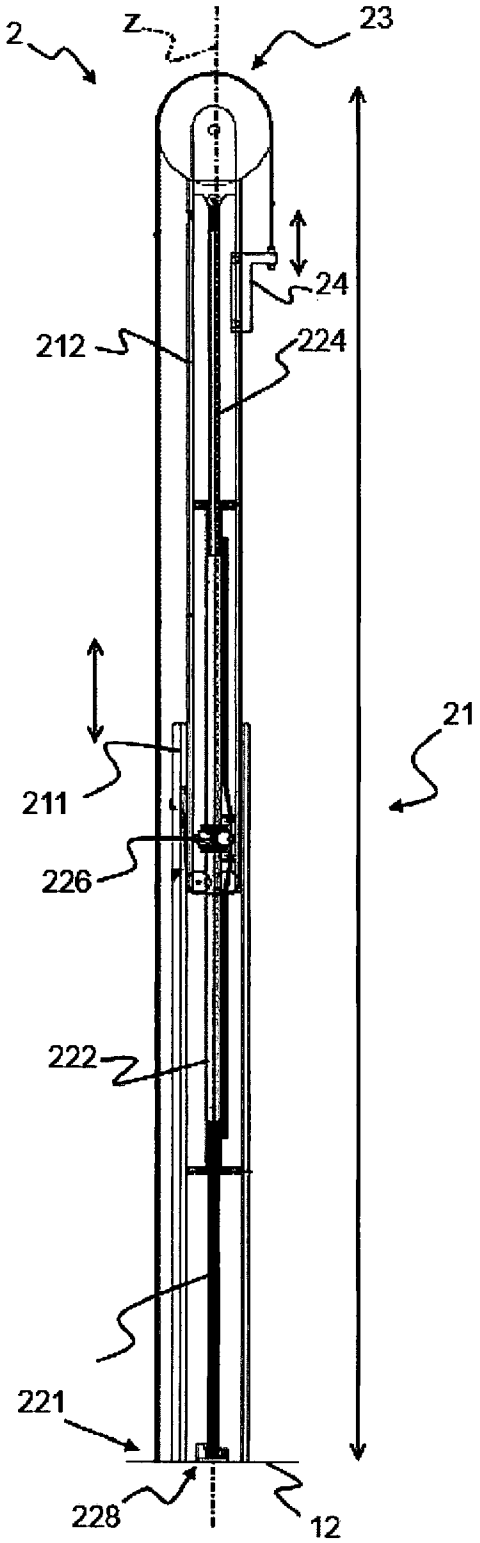

2
z
23
212
224
21
226
22
222
24
211
221
228
12

Fig.2A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z
23
24
212
224
21
211
226
222
221
228
12

Fig.2B

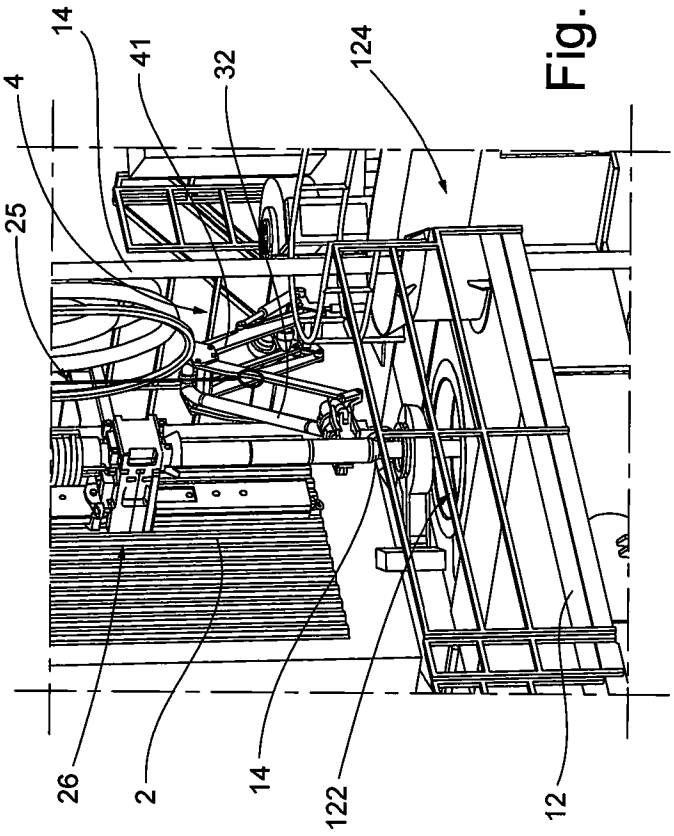


Fig. 3A

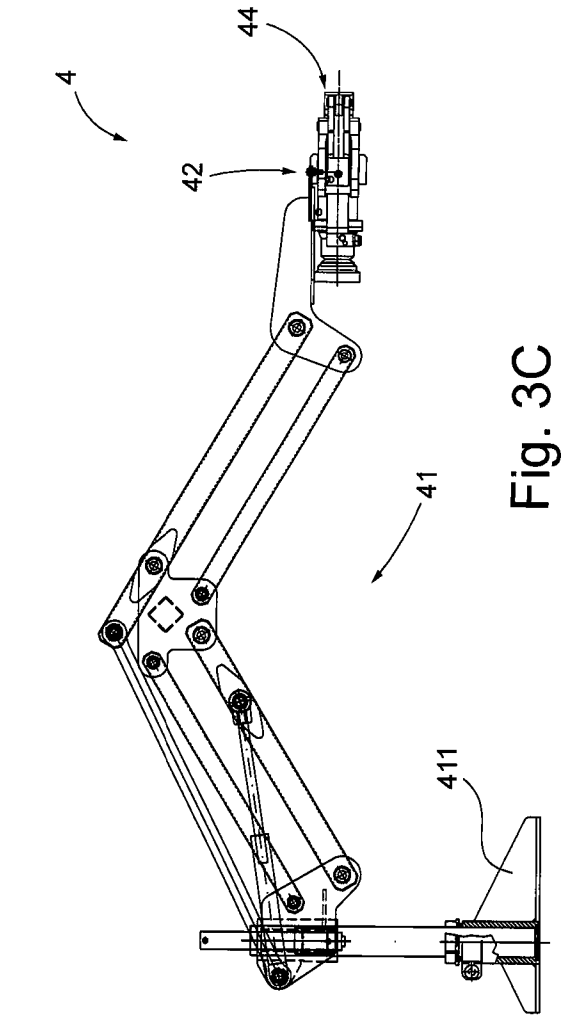


Fig. 3C

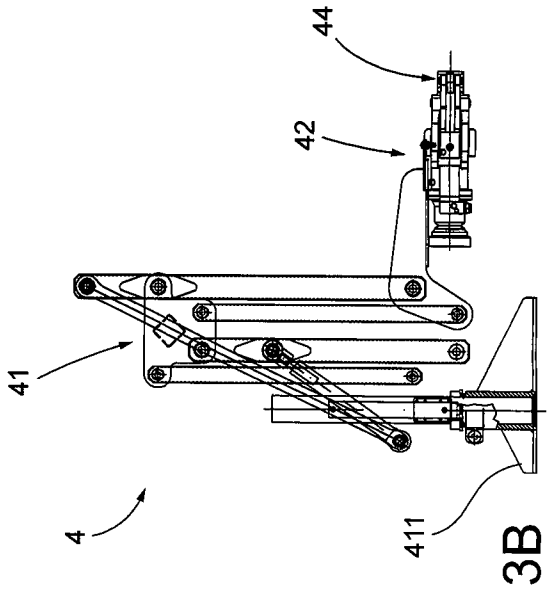


Fig. 3B

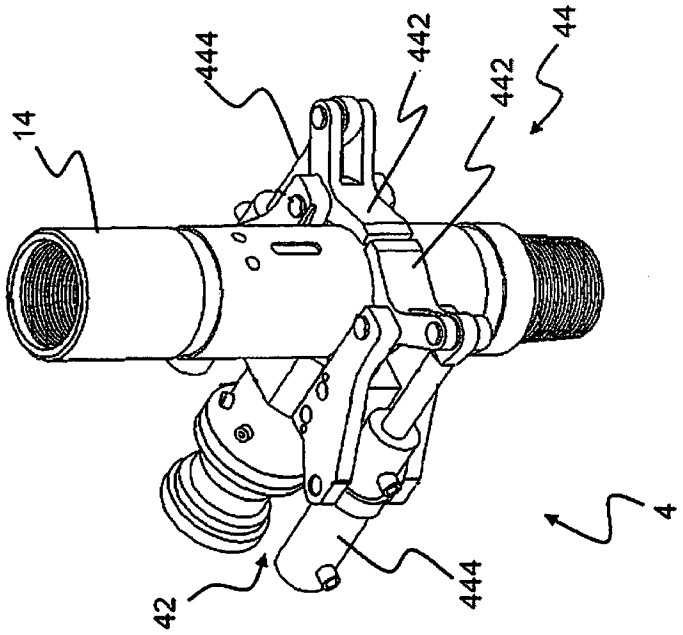


Fig.3E

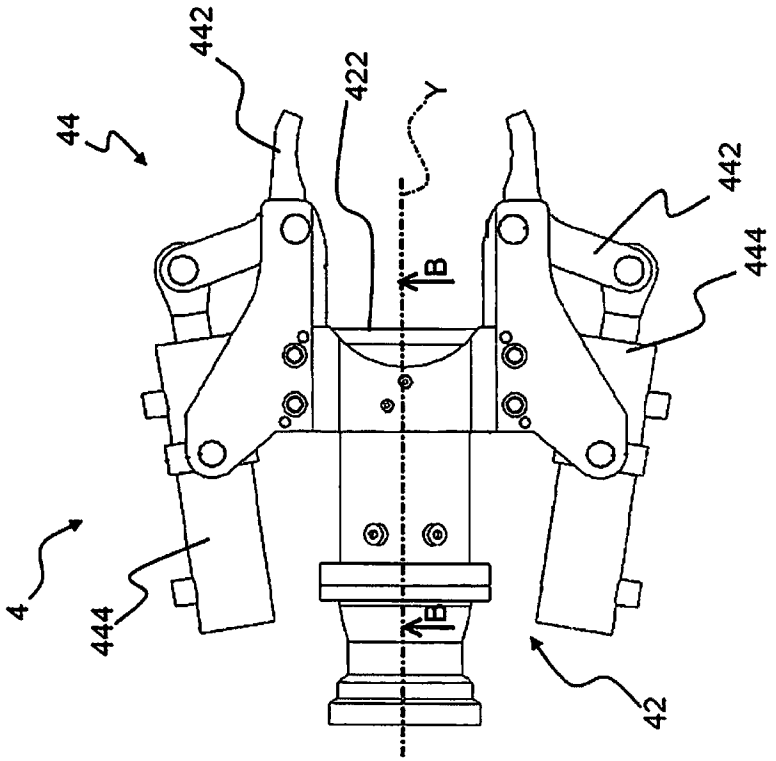


Fig.3D

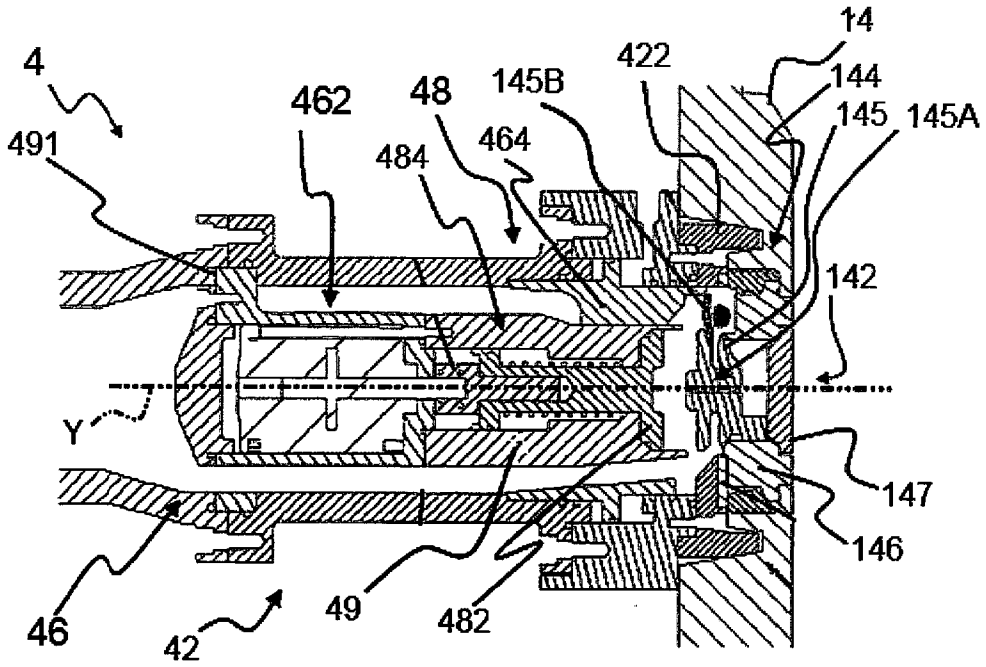
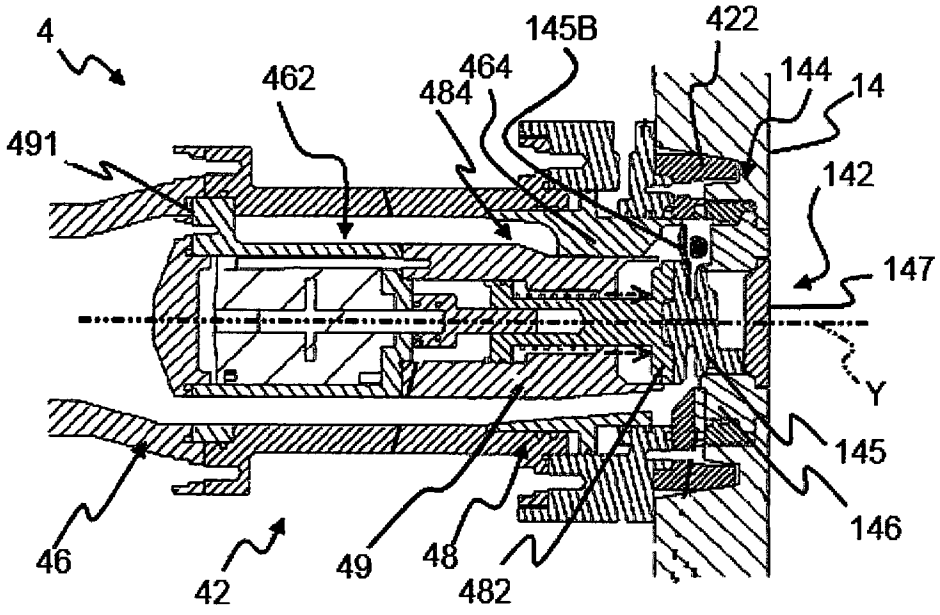

4
491
462
48
145B
422
14
144
145
145A
484
464
142
Y
147
146
46
42
49
482

Fig.4A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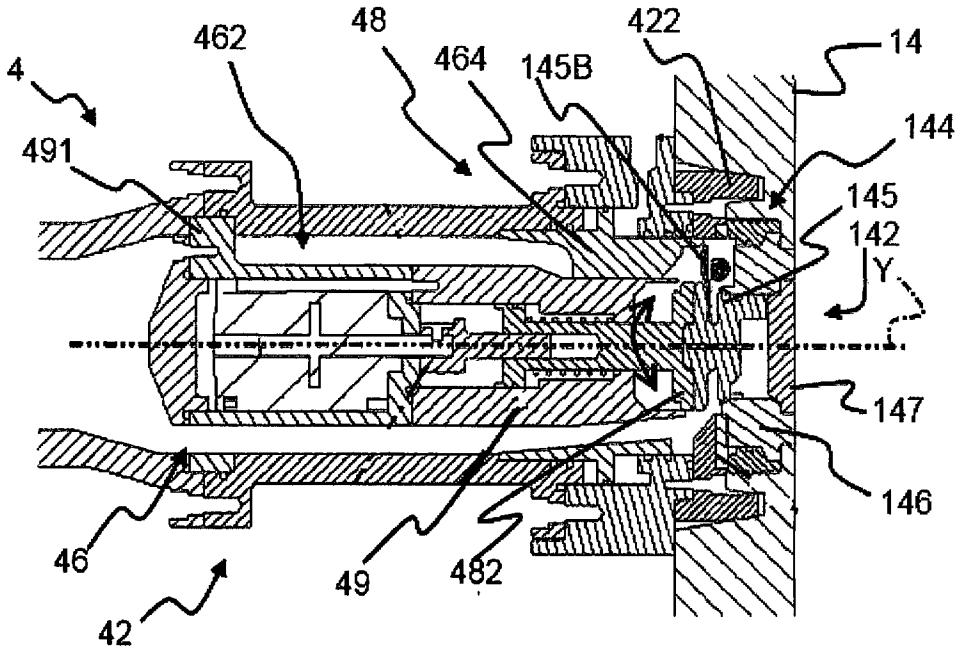
462
145B
422
464
484
144
14
491
142
147
Y
145
146
46
42
49
48
482

Fig.4B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4
145B
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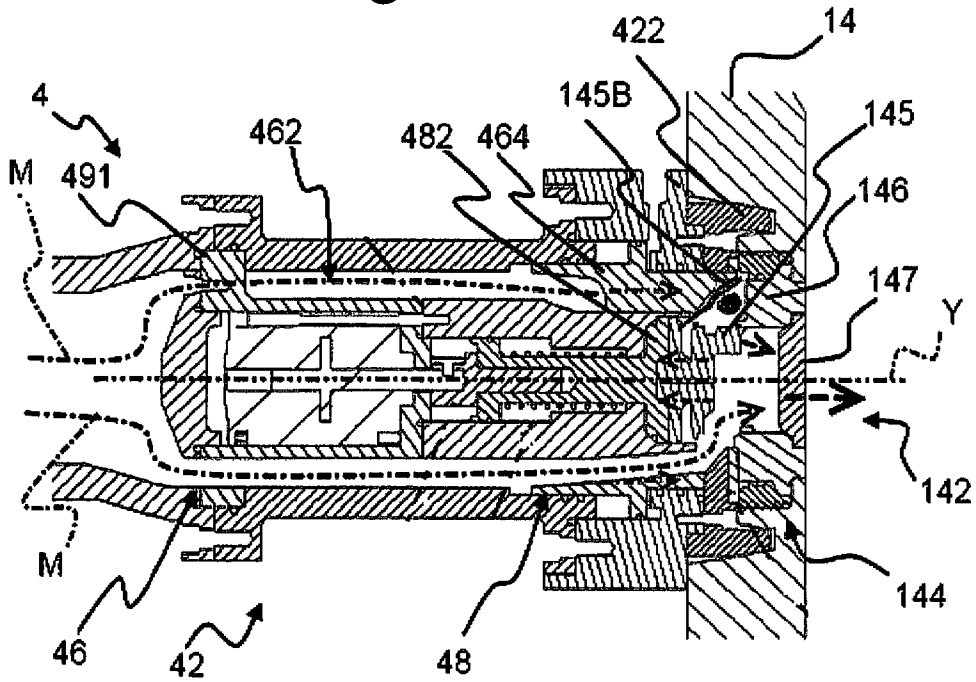
144
145
142
Y
147
146
46
49
482
42

Fig.4C


422
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482
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M
491
146
147
Y
142
M
144
46
42
48

Fig.4D

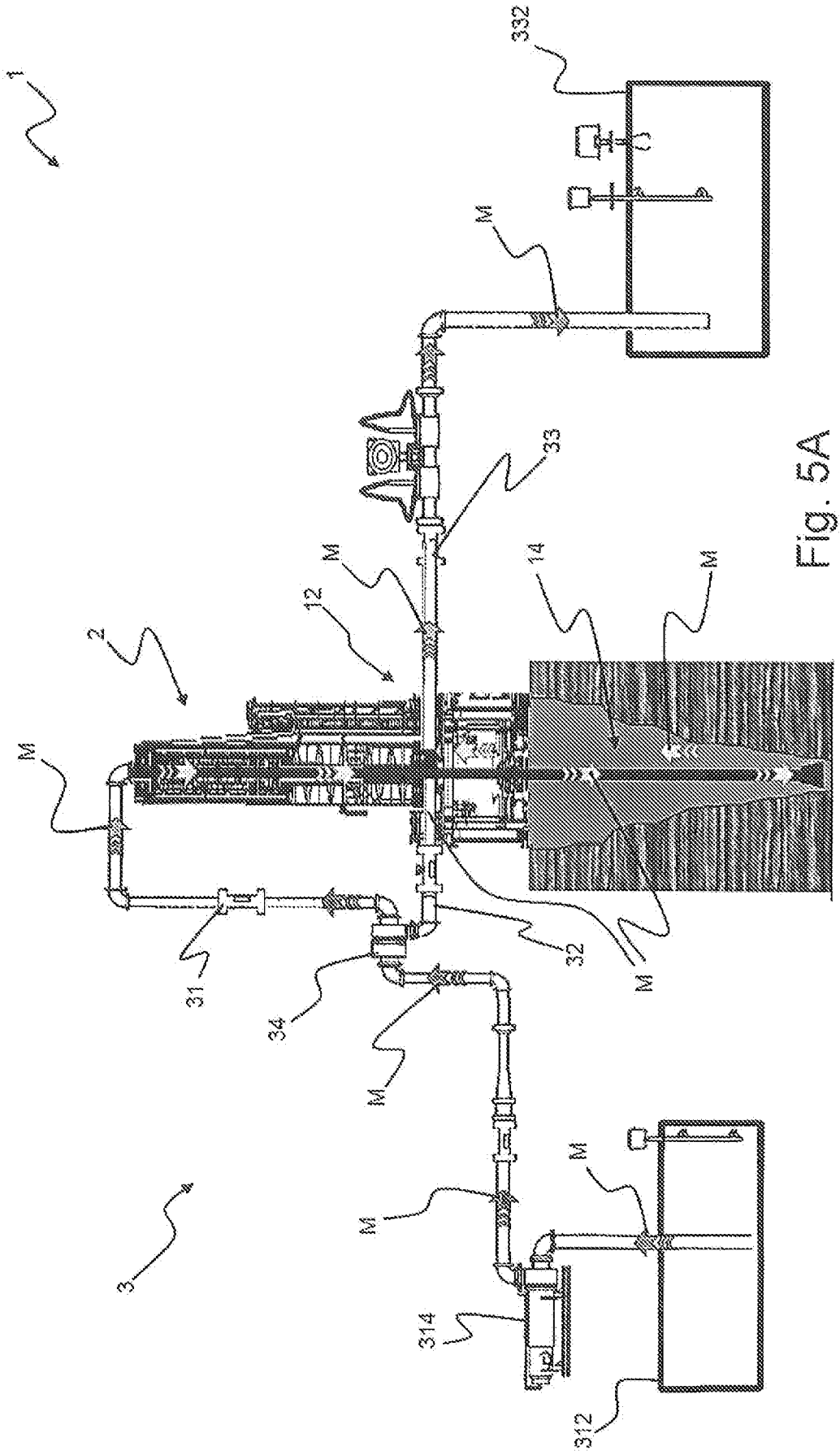
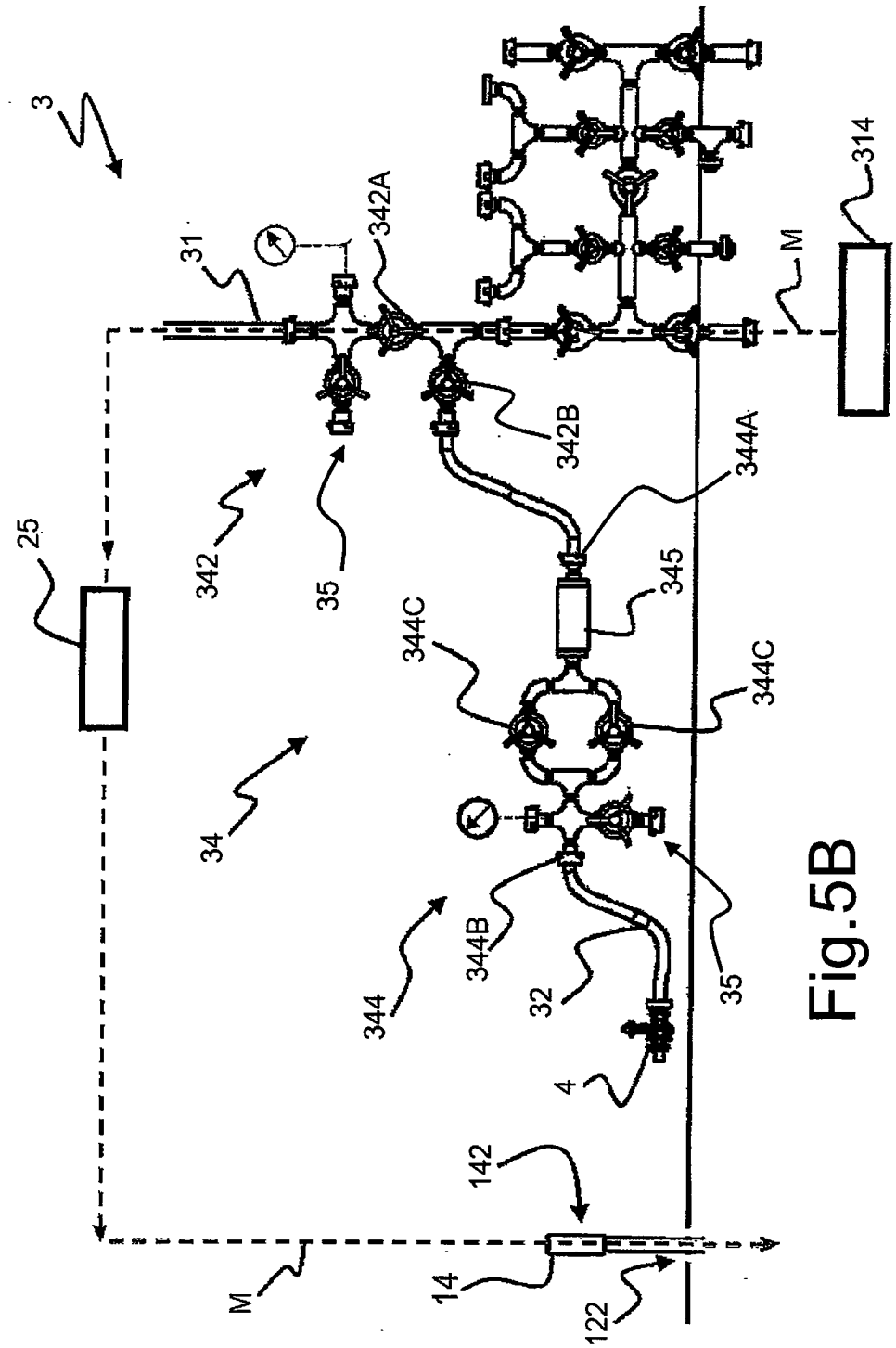


Fig. 5A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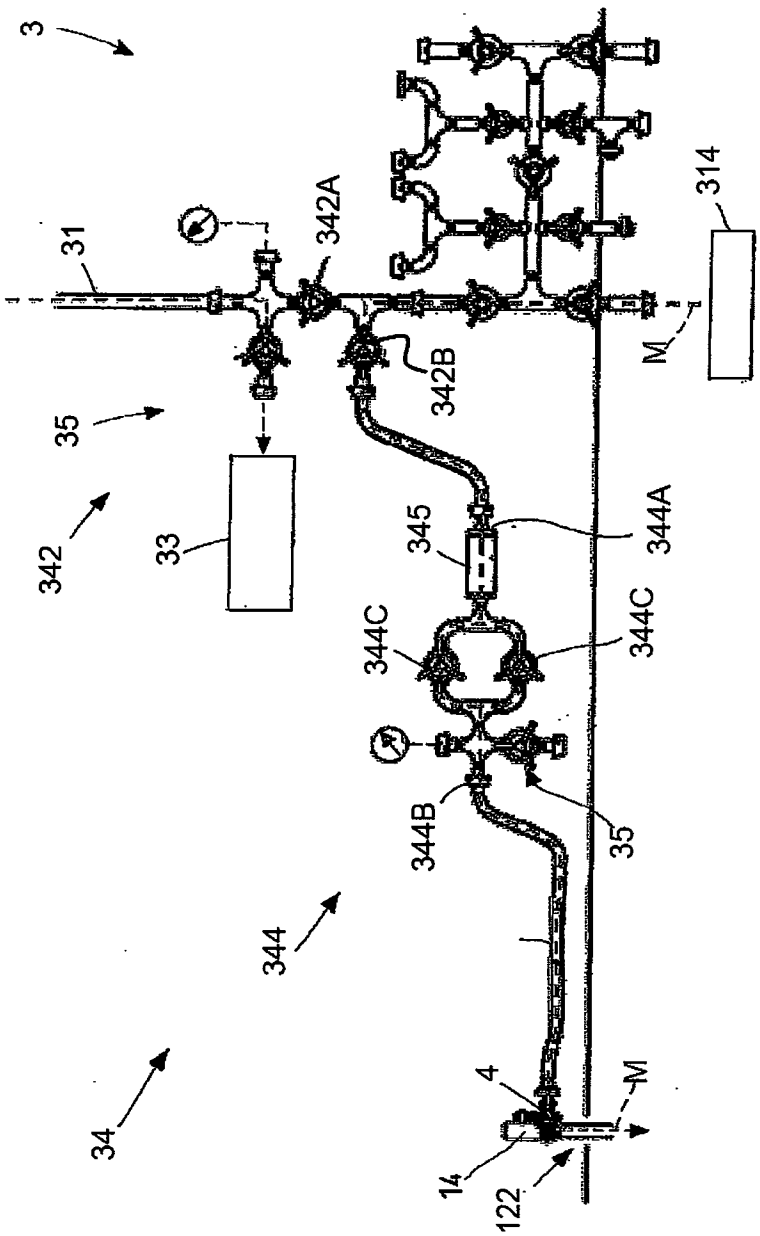
31
342A
342B
344A
342
35
25
345
344C
344C
34
344
344B
32
35
4
142
14
122
M
M
314

Fig.5B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344C
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344B
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34
4
M
14
122

Fig.5C

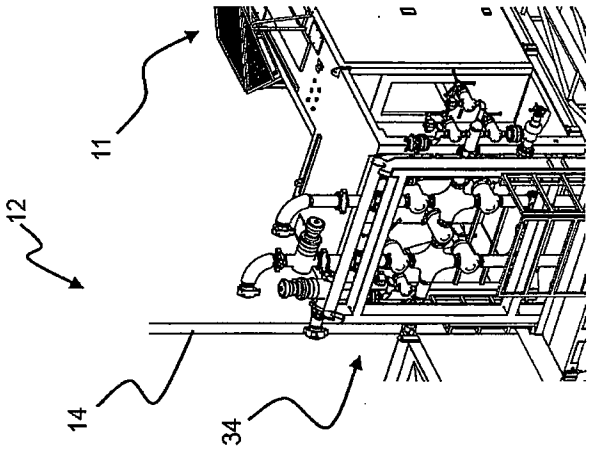


Fig.5D

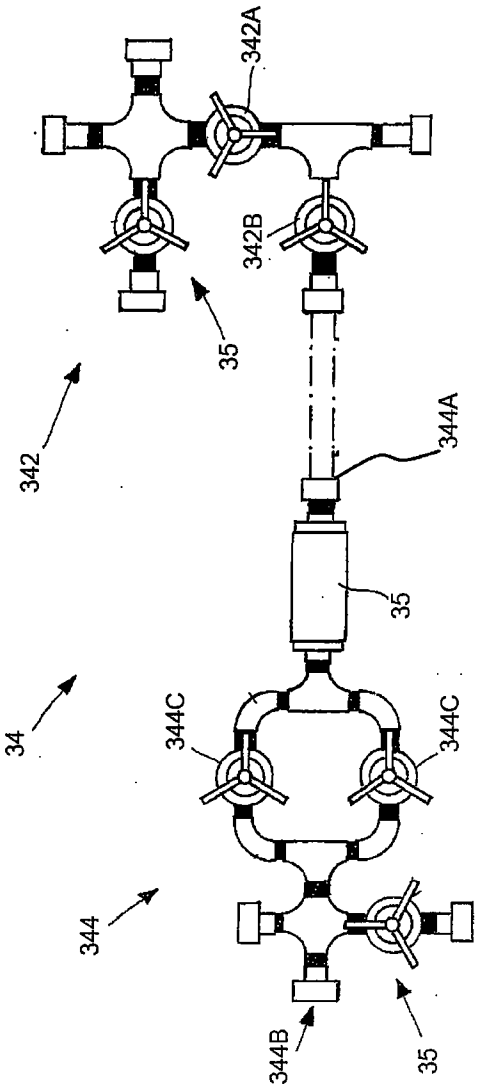


Fig.5E

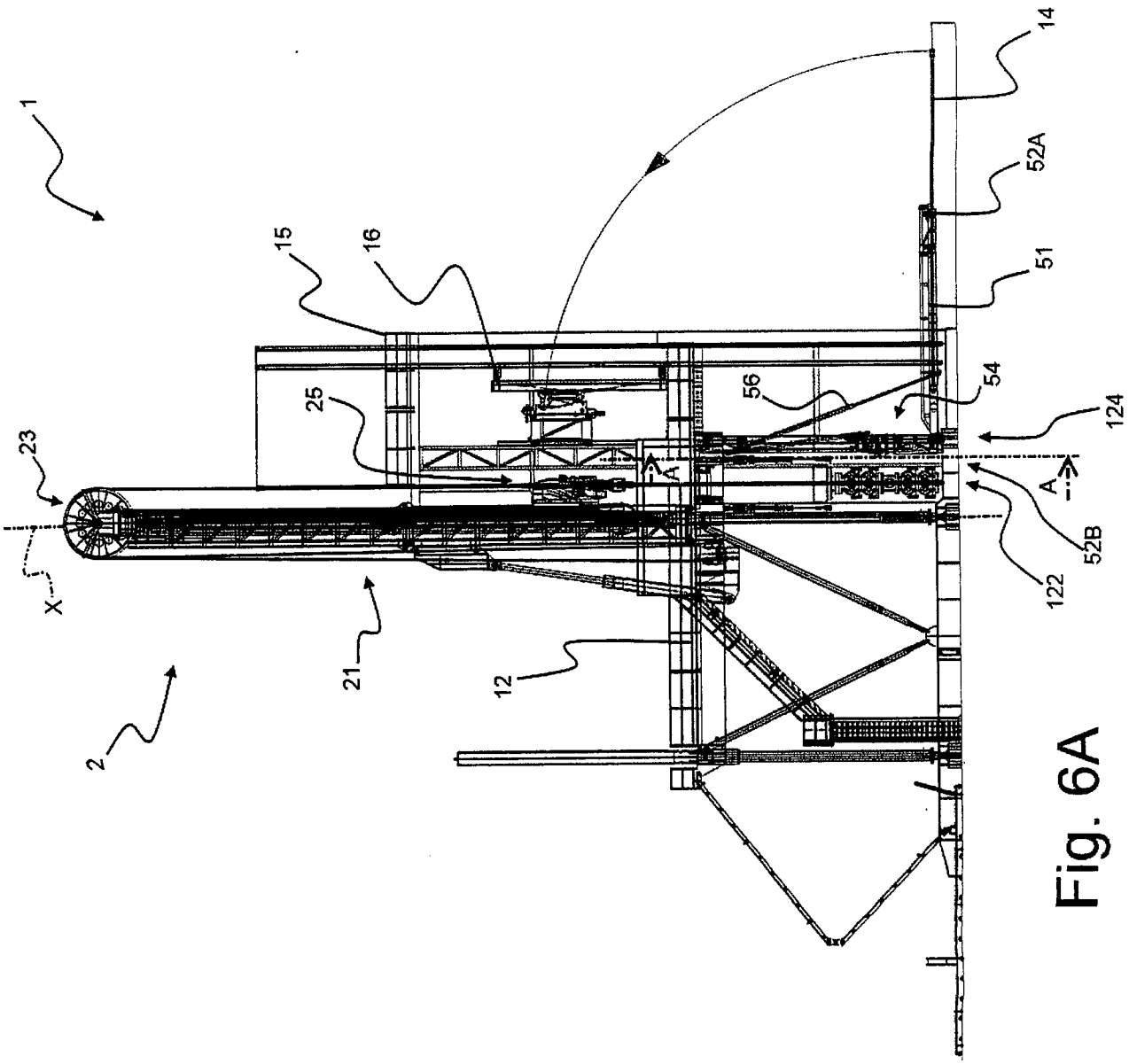


Fig. 6A

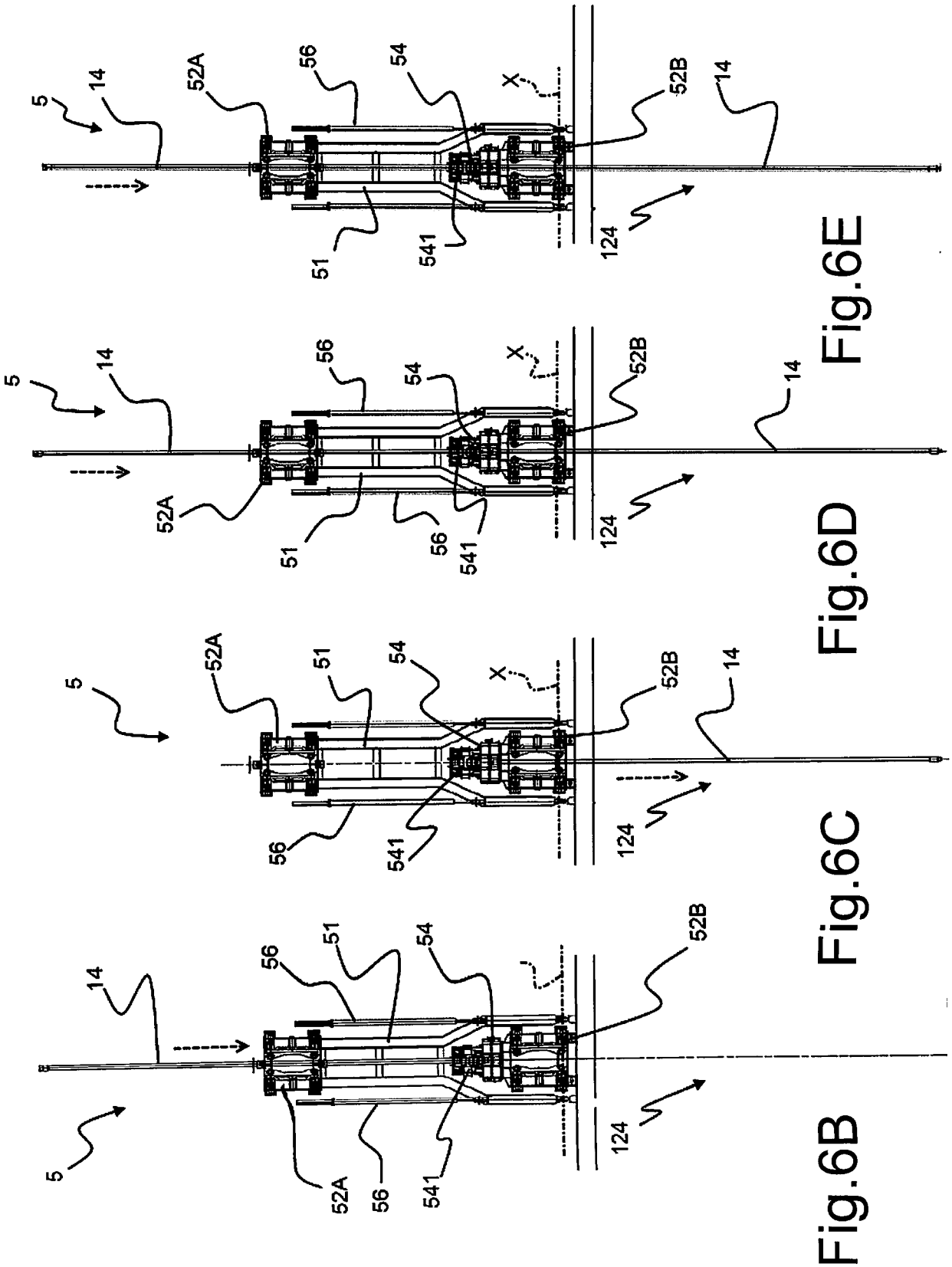


Fig.6B

Fig.6C

Fig.6D

Fig.6E

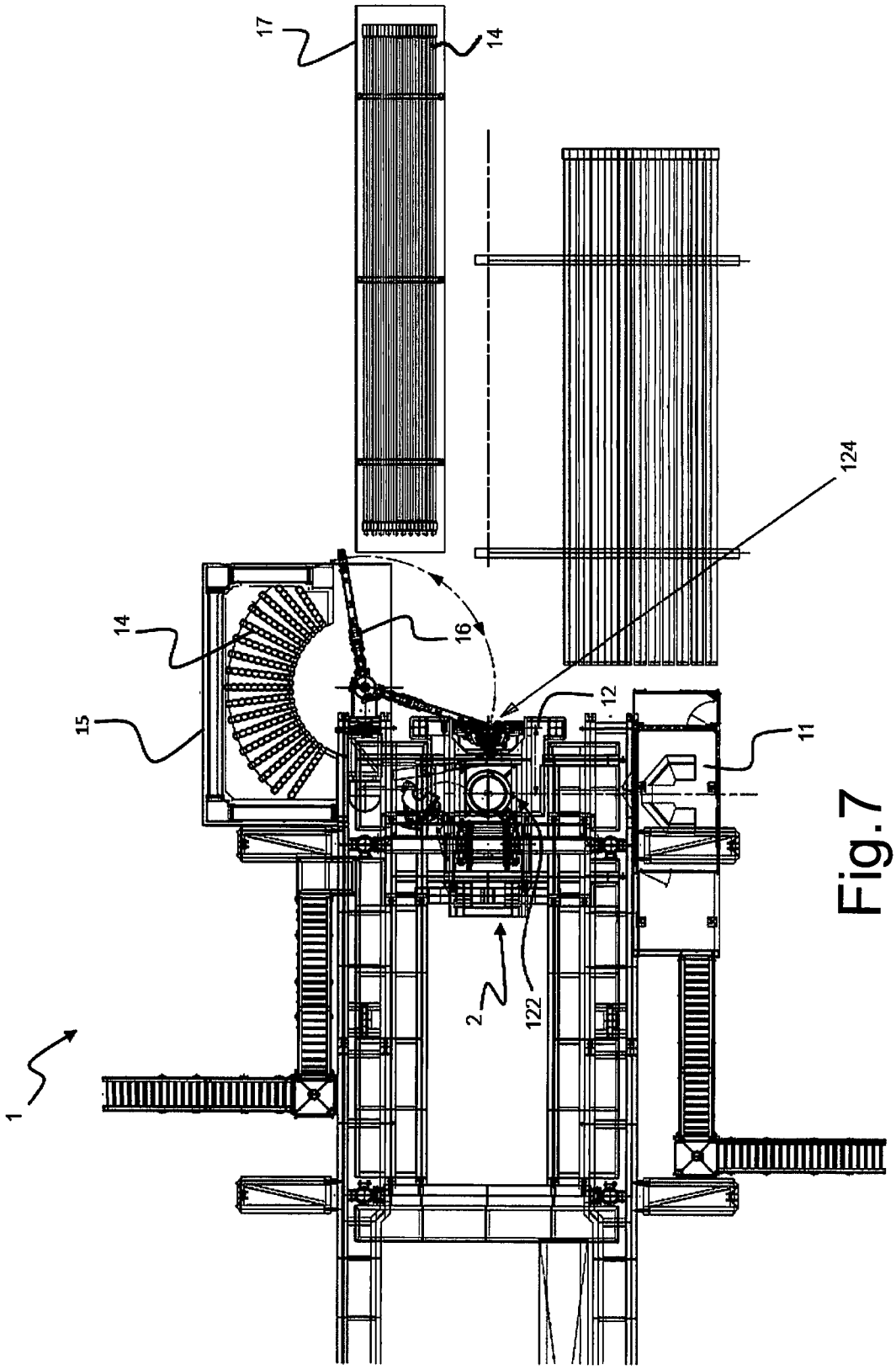


Fig.7

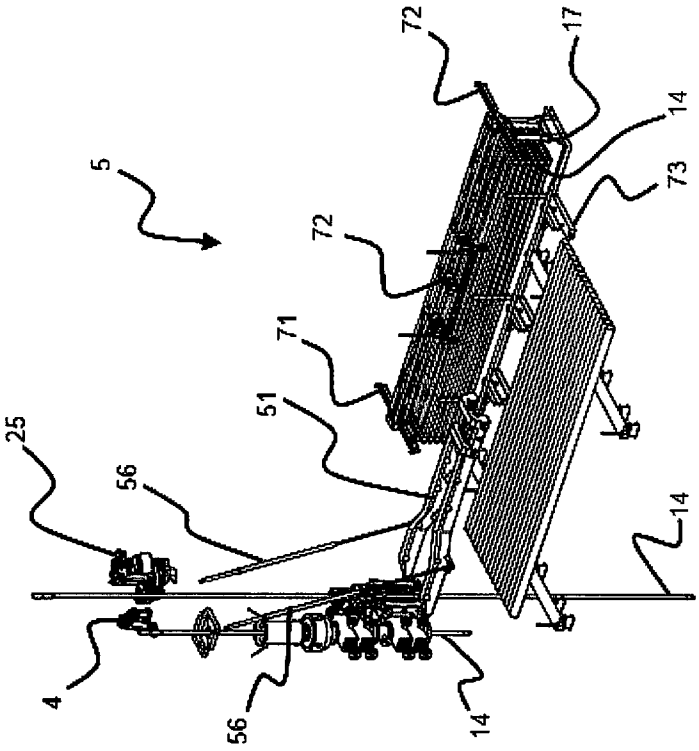
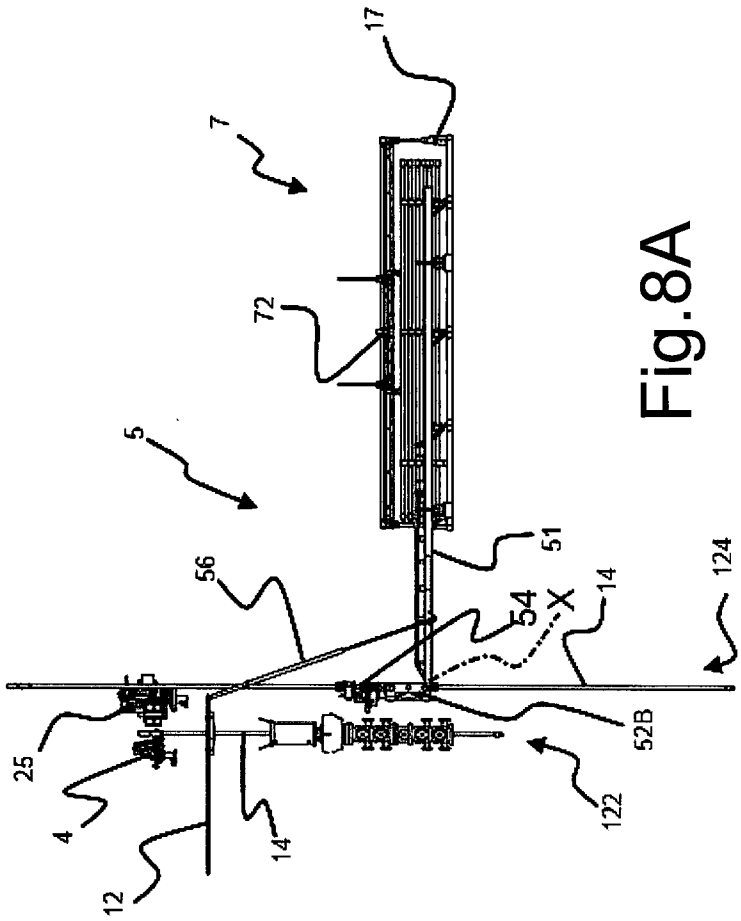

72
17
14
73
5
72
71
51
25
56
14
4
56
14

Fig.8B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7
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5
51
56
54
X
14
124
52B
25
4
122
14
12

Fig.8A