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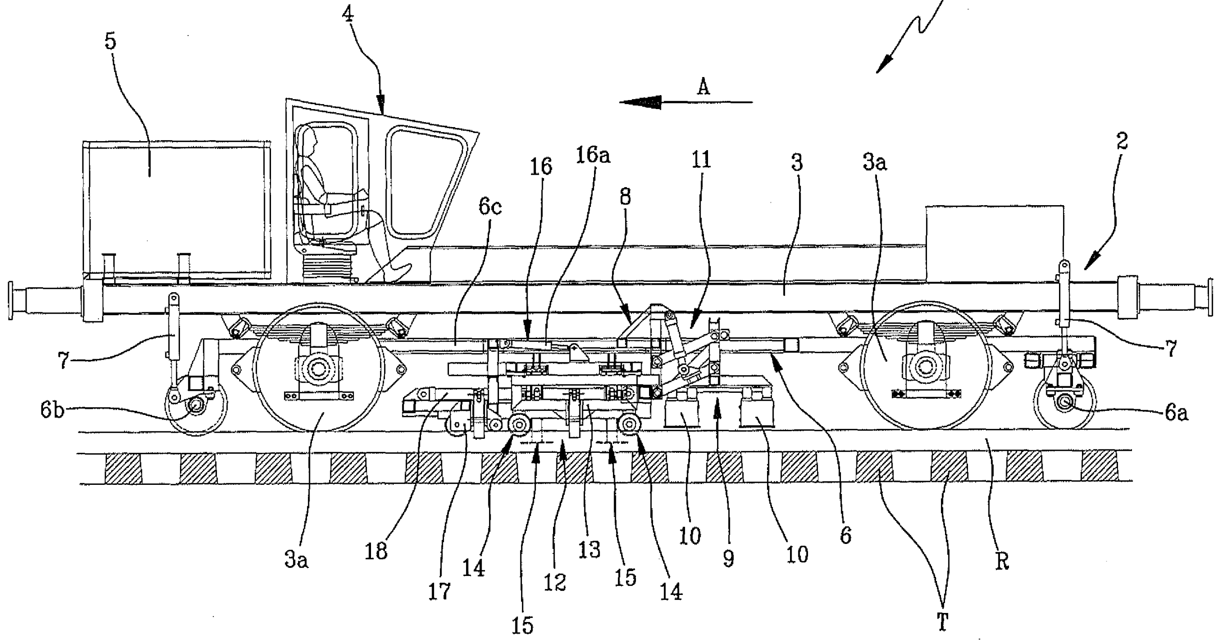
(54) **Working machine for railway tracks**

(57) A compaction and ballast removal machine for railway tracks comprises a railway car (2) movable along an advancing direction (A), a compaction unit (9) and a ballast removing unit (12) associated with the car (2) and slidably movable, both relative to each other and relative to the car (2), along the advancing direction (A). The machine (1) further comprises actuating means (16) operatively acting between the compaction unit (9) and the ballast removing unit (12) for determining a mutual positioning of the compaction (9) and ballast removing (12) units, and advancing means (18) acting at least on the compaction unit (9) for determining a positioning of the compaction unit (9) relative to the track.

FIG 1



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Description

[0001] The present invention relates to a working machine to be used for working operations on railway tracks and, more preferably, it pertains to a compaction and ballast removal machine for railway tracks.

[0002] The invention falls within the sector of working machines for building and maintenance of railway tracks, and in particular it is centred on compacting operations, i.e. operations concerning pressing of ballast portions included between two consecutive sleepers, and on ballast removal operations, i.e. removal of the crushed stones in contact with and under the flange of each rail at the empty-space regions between the sleepers.

[0003] Presently known are machines dedicated to either one of said two operations.

[0004] In particular, compaction machines are known which have a slidable truck resting on rails and two presser elements mounted on the truck and hydraulically operated by the power supplied from an endothermic engine. The truck is brought to position by a manual action of an operator who controls whether each of the two presser elements is positioned in a correct manner above the crushed stones included between two sleepers in succession and actuates the presser elements to carry out compaction of said crushed stones.

[0005] The ballast removal machines or ballast removers of known type comprise a slidable truck resting on rails and two elements oscillating around respective axes parallel to the rails and having curved lower ends adapted to be fitted between one of the rails and the underlying crushed stones to remove the crushed stones in excess and generate a gap of a 3 cm thickness or more. The oscillating elements are hydraulically driven by the power supplied from an endothermic engine mounted on the truck. In this case too, the truck is brought to position by a manual action by an operator who controls whether each of the two oscillating elements is positioned in a correct manner above the crushed stones included between two sleepers in succession and actuates the oscillating elements to carry out ballast removal of the crushed stones under each rail.

[0006] Said compaction and ballast removal machines have a drawback in that they require manual intervention by an operator which is necessary for correctly positioning the truck relative to the sleepers, so as to enable movement of the compacting elements and the oscillating elements respectively, without the same interfering with the sleepers.

[0007] Disadvantageously, a minimum time is required by the operator for manually positioning the trucks, as possible misalignments between the trucks and the sleepers are to be corrected and this adversely affects the productivity of the two above described machines. In particular, more time is required for the compacting operation than for the ballast removal operation and, taking into account the minimum time that is needed for correct positioning of the trucks, a productivity of about 800 meters of track for each working day is obtained.

[0008] Also known are automatic machines comprising a self-propelled railway vehicle equipped with a compacting device. In particular, the vehicle moves forward in a discontinuous manner and stops at each work cycle of the compacting device. An automatic mechanism may be also provided for detecting the correct positioning of the compacting device and adjusting the position of the compacting device which, for each operating cycle, corrects possible misalignments of the compacting elements relative to the track.

[0009] Disadvantageously, in this case too the sum of the time required for the compacting operation and the time required for adjusting the compacting device position impairs the productivity of these machines that is of about 400 meters of treated track for each working hour. This is incompatible with the narrow time bands that in the railway tables are left free for maintenance of the railway substructure and therefore also of the superstructure.

[0010] Moreover, due to the discontinuous advancing of the railway vehicle, there is a great energy waste, the traction members are submitted to great fatigue and, as a result, the time for carrying out the operations is prolonged, because it is necessary for the vehicle to execute continuous acceleration and braking cycles.

[0011] Also known are automatic machines of the above described type but equipped with a device for ballast removal, which however experience the same drawbacks as above.

[0012] Accordingly, it is a technical task of the present invention to make available a compaction and ballast removal machine for railway tracks that is devoid of the aforesaid drawbacks.

[0013] Within the scope of this technical task, the main aim of the invention is to make available a compaction and ballast removal machine for railway tracks that has a high productivity per hour.

[0014] In addition, it is an important aim of the invention to provide a compaction and ballast removal machine for railway tracks that has a very regular and uniform operation.

[0015] The foregoing and further aims that will become more apparent in the progress of the present description, are substantially achieved by a compaction and ballast removal machine for railway tracks having the features set out in claim 1 and/or in one or more of the claims depending thereon.

[0016] It is a further aim of the present invention to provide a method of carrying out working operations on railway tracks in accordance with claim 12 and/or one or more of the claims depending thereon.

[0017] A preferred but not exclusive embodiment of a compaction and ballast removal machine for railway tracks in accordance with the invention is now illustrated by way of non-limiting example and with reference to the accompanying drawings, in which:

- Fig. 1 is a side view of a working machine for railway tracks in accordance with the present invention;
- Fig. 2 is a side view of a first component of the machine in Fig. 1, with some parts removed for a better view of others;
- Fig. 3 is a side view of a second component of the machine in Fig. 1, with some parts removed for a better view of others;
- Fig. 4 is a side view of a third component of the machine in Fig. 1, with some parts removed for a better view of others;
- Fig. 5A is a side view of a portion of the machine seen in Fig. 1, with some parts removed for a better view of others and in a first operating configuration;
- Fig. 5B is a side view of the portion in Fig. 5A in a second operating configuration;
- Figs. 6a to 6d diagrammatically show four steps in succession concerning, movement of the compaction and ballast removal unit;
- Fig. 7 is a side view of the portion seen in Fig. 5A in a third operating configuration; and
- Fig. 8 is a side view of the portion in Fig. 5A in a fourth operating configuration.

[0018] In accordance with the drawings, a compaction and ballast removal machine for railway tracks in accordance with the present invention has been generally identified by reference numeral 1. In the side views in the accompanying drawings, the track is represented by a rail "R" and a succession of sleepers "T" spaced apart from each other by a distance "L" that is maintained as much as possible close to a predetermined value, but that inevitably suffers for a deviation from this value, due to positioning errors during the step of laying the track. Preferably, the machine according to the invention can be preferably used for tracks of high-speed railway lines, for which the distance "L" between sleepers must be of 60 cm.

[0019] The machine 1 comprises a car 2 having a frame 3 resting on wheels 3a, a driver's cab 4 mounted on frame 3 and a power unit 5 mounted on frame 3 as well. Car 2 can be of a substantially known type, and will not be herein described in detail. Preferably, car 2 is of the type with two axles as shown in the drawings and mainly aims at quickly bringing the work equipment (compaction and ballast removal equipment) to the intervention region, and also aims at accommodating a technician and possibly supplying a sufficient mass during the compacting step.

[0020] With reference to Fig. 1, car 2 is moved forward along the direction of arrow "A" during the working steps of the machine 1.

[0021] The machine 1 is provided, under frame 3, with a supporting truck 6 having a front axle 6a and a rear axle 6b provided with railway wheels for engagement with the track, in such a manner that the supporting truck 6 can be slidably carried by the track. Preferably, the supporting truck 6 is made of tubular metal elements, in particular a pair of longitudinal members 6c parallel to the rail "R" and two or more crosspieces not shown as they are perpendicular to the longitudinal members 6c and therefore cannot be seen. In addition, the wheels 6a, 6b are disposed at the front and rear ends of the supporting truck 6 relative to the advancing direction "A".

[0022] Provided between frame 3 and the supporting truck 6 is lifting means 7 acting on the supporting truck 6 to lift it up from the track when the machine 1 is being transferred or, more generally, when use of the machine 1 is not required for the compaction and ballast removal operations. In the embodiment herein illustrated, the lifting means comprises oil-pressure cylinders operated by the power unit 5 and acting at the front and rear ends of the supporting truck 6. Preferably, the oil-pressure cylinders are at least two in number for each end of the supporting truck 6.

[0023] Also provided is retaining means, not shown, acting between frame 3 and the supporting truck 6 to prevent sliding of the supporting truck 6 relative to frame 3 along a direction parallel to the track.

[0024] Slidably mounted on the supporting truck 6 is a slide 8, shown in detail in Fig. 2. Slide 8 can run relative to the supporting truck 6 along the aforesaid longitudinal members 6c and, therefore, in parallel to the advancing direction "A" of the machine 1. In more detail, each longitudinal member 6c has a C-shaped guide facing the opposite longitudinal member 6c and slideably mounted between the two C-shaped guides is a portion of said slide 8, preferably an upper portion 8c, in such a manner that slide 8 appears to be guided and at the same time supported by the longitudinal members 6c of the supporting truck 6.

[0025] Slide 8 too consists of a structure of the tubular metal type and is welded.

[0026] Also provided is second retaining means, preferably one or more oil-pressure pistons operated by the power unit 5 and acting on opposite sides between slide 8 and the supporting truck 6 in order to enable mutual (forward or backward) sliding of said slide and truck during operation of the machine 1 and to lock them in a mutual steady position, for the purpose of allowing safe transfer of the machine 1, for example.

[0027] A compaction unit 9 is installed on slide 8 and in particular on an end thereof opposite to the advancing direction "A" of the machine 1 (Fig. 1); said unit 9 has two compacting elements 10 steadily spaced apart from each other by a distance substantially equal to the predetermined distance "L" existing between two sleepers "T". The compaction unit 9 comprises an articulated kinematic mechanism 11, preferably an articulated quadrilateral, acting between slide 8 and the compacting elements 10 to keep the latter oriented in a constant horizontal direction. The compaction unit 9 is of a substantially known type and will not be further described.

[0028] The machine further comprises a ballast removing unit 12 operatively coupled to the compaction unit 9 to carry out ballast removal on a track portion that will be subsequently submitted to a compacting operation by means of said compaction unit 9.

[0029] In more detail, and as shown in Fig. 3, the ballast removing unit 12 comprises a ballast removing truck which is suitable to directly run on rails "R" by means of respective rolling members 14 which preferably comprise frusto-conical wheels of reduced sizes, as shown in the accompanying drawings. The ballast removing truck 13 is equipped with two pairs of ballast removing elements 15 arranged in such a manner that each pair is adapted to act on a respective rail "R". The ballast removing elements 15 can oscillate around respective oscillation axes "Y" parallel to each other and to the rails "R" for taking a work position at which they are inserted between the rail flange and the underlying crushed stones, and a rest position at which they move away from the rail and approach each other to enable transfer or advancing of the machine 1.

[0030] The ballast removing elements 15 are of a substantially known type and therefore description of same will not be further analysed in depth. The ballast removing truck 13 too consists of a tubular metal structure that is welded.

[0031] The ballast removing truck 13 comprises a respective pair of grasping jaws "P1" each of which is disposed at a position facing a rail "R" for reasons to be explained in the following.

[0032] By virtue of said rolling members 14, the ballast removing truck 13 can move on the track independently of slide 8 and of the supporting truck. Also provided are suitable engagement portions 13a (Fig. 2), both on the ballast removing truck 13 and on slide 8 so that raising of slide 8 (by the lifting means 7) causes simultaneous raising of the ballast removing truck 13 too. In Fig. 2, said engagement portions 13a comprise protrusions formed on slide 8 and adapted to be coupled to corresponding portions of the ballast removing truck 13 during raising of the supporting truck 6. In addition, since slide 8 and the ballast removing truck 13 are free to run relative to each other on the track, these engagement portions are freely movable relative to said corresponding portions of the ballast removing truck 13 along a direction parallel to the track and allow raising of the ballast removing truck 13, irrespective of the position taken by the latter relative to slide 8.

[0033] The supporting truck 6 and slide 8 therefore appear to be slidable independently of each other along the track. Preferably, as shown in Fig. 2, slide 8 has a portal-shaped upper conformation defining an underlying space in which the ballast removing truck 13 is slidably housed.

[0034] Advantageously, the machine 1 further comprises actuating means 16 acting between slide 8 and the ballast removing truck 13 for varying and/or steadily determining a mutual location of same along the direction denoted at A and parallel to the tracks during operation of the machine 1. The actuating means 16 comprises a oil-pressure operated adjustment piston 16a driven by the power unit 5 and having a first end rotatably fastened to slide 8 and a second end rotatably fastened to the ballast removing truck 13. Operation of said actuating means 16 carries out a mutual displacement between the ballast removing truck 13 and slide 8 while locking of the actuating means 16 gives rise to a (substantially stiff) steady coupling between the ballast removing truck 13 and slide 8 to a predetermined distance. In the last-mentioned case, the ballast removing truck 13 and slide 8 are integral with each other along a direction parallel to the track and therefore can only, translate by the same distance and jointly.

[0035] The machine 1 further comprises an auxiliary truck slidably movable on the track to run close to and away from the ballast removing truck 13 and slide 8. The auxiliary truck 17, as shown in detail in Fig. 4, comprises a pair of slidable supports 17a, each of which is movable on a respective rail "R" by means of wheels, only one of which is shown in Fig. 4, and a towing frame 17b connecting the slidable supports 17a and carried by said slidable supports 17a. Each of the slidable supports 17a is equipped with a respective pair of grasping jaws "P2" to be engaged with the corresponding underlying rail "R", for reasons to be explained in the following. The towing frame 17b is preferably rigidly connected to said slidable supports 17a. Both the grasping jaws "P1" of the ballast removing truck 13 and the grasping jaws "P2" of the slidable supports 17a are driven by oil-pressure actuators connected to and fluid-operated by the power unit 5.

[0036] The machine 1 comprises advancing means 18 acting between the towing frame 17b and slide 8 so that they move close to and/or away from each other, or also in order to steadily fix a mutual position of same. Alternatively, the advancing means 18 can act between the towing frame 17b and the ballast removing truck 13.

[0037] In more detail, the advancing means 18 comprises a main oil-pressure piston 18a operated by the power unit 5 and having a first end rotatably connected to a central portion of the towing frame 17b, i.e. a portion of the towing frame 17b disposed at the track centre line, and a second end rotatably connected to slide 8.

[0038] The operating modalities of the advancing means 18 will be described in detail when operation of the machine 1 is described.

[0039] In order to improve steadiness of the auxiliary truck 17, the towing frame 17b has a jutting out portion 19 slidably coupled, along a direction parallel to the track, to a guide portion 20 of slide 8 in such a manner that the jutting out portion 19 and guide portion 20 define a coupling of the sleeve type.

[0040] The machine 1 is designed to work in an automatic and co-ordinate manner, utilising movements defined by couplings and mechanical abutments of the different parts that are movable relative to each other (as clarified in the following and shown in Figs. 6a-6d); it should be noted, however, that in an alternative embodiment a system can be provided which comprises a processing unit the function of which is to control and govern operation of the compacting unit 9, the ballast removing unit 12, the actuators of the grasping jaws "P1" and "P2" and the actuating and advancing means, 16 and 18 respectively.

[0041] Moreover, the ballast removing unit 12 is equipped with sensor means (not shown) designed to detect a point indicating the centre line of a sleeper "T" during the advancing motion of the ballast removing unit 12 along the track. This enables the instant at which the ballast removing unit 12 exactly comes astride a sleeper "T" to be determined and, therefore, the instant at which the ballast removing elements 15 are disposed exactly astride the sleeper "T". Starting from that position, the ballast removing elements 15 can operate on the crushed stones surrounding the sleeper "T" without interfering with said sleeper.

[0042] Within the scope of the present description, by centre line of sleeper "T" it is intended the imaginary line dividing sleeper "T" into two symmetric parts perpendicularly to the major extension direction of the track.

[0043] Preferably, said sensor means is of the inductive type and detects metal elements being part of sleeper "T", such as bolts, track bolts, or portions of the attachment plate present on sleeper "T".

[0044] Advantageously and in the event of an electronic control of the movement, said sensor means will be connected to the processing unit that will be able to store data relating to the centred position of the ballast removing unit 12 detected by the sensor means, so as to use these data again when in the following step the compaction unit 9 in turn will be located astride the same sleeper "T". In this way, it will not be necessary to correct the position of the compaction unit 9 as the data previously detected by the ballast removing unit 12 can be utilised.

[0045] Operation of the machine 1 in accordance with the present invention will be now described.

[0046] The machine 1 is transferred onto the track portion for which the operations concerning compaction of the crushed stones and ballast removal are provided to be carried out.

[0047] Subsequently, the compaction unit 9 is operated in such a manner that the compacting elements 10 can work in a centred position relative to a sleeper "T". This manoeuvring that therefore adjusts positioning of slide 8 along the track in a precise manner, can be carried out manually, possibly with use, for co-operation, of said second retaining means (oil-pressure pistons acting from opposite positions) capable of driving a translation of the compaction unit 9 during the first centring.

[0048] Once said second retaining means has performed its task, said means is shut down so that it does not interfere any longer with the following automatic movement of the machine.

[0049] On the other hand, the described operation is not a problem because it is the only operation involving manual adjustment that is required and it exclusively takes place at the beginning of the machine setting up, while all the following operating steps carried out by the machine 1 are automatic.

[0050] During the manual-adjustment step of the compaction unit 9, or after the adjustment step, the adjustment piston 16a and main piston 18a are locked to a fixed position so as to make the slide 8, ballast removing truck 13 and auxiliary truck 17 integral with each other, while the grasping jaws "P2" of the slidable supports 17a are stably closed on the rail "R" so as to fasten both the slide 8 and the ballast removing truck 13 to a steady position. At this position, illustrated in Fig. 5A, the compacting elements 10 can be safely operated starting compaction of the crushed stones at the sides of sleeper "T".

[0051] Simultaneously with the compacting step, automatic adjustment of the ballast removing unit 12 takes place. In more detail, immediately after the beginning of the compacting step, the adjustment piston 16a is released and it moves the ballast removing truck 13 relative to slide 8 until bringing the ballast removing truck 13 close to a predetermined reference location (Fig. 6). This reference location is preferably defined by an abutment position of the ballast removing truck 13 relative to slide 8, and more preferably obtained by mutual contact between two locators 30a, 30b shown by way of example and only for explanatory purposes in Fig. 6a where one of them is fastened to slide 8 and the other to the ballast removing truck 13. Preferably, said abutment position is obtained by a maximum moving backward of the ballast removing truck 13 against the compaction unit relative to the advancing direction "A" of the machine 1.

[0052] Fig. 6a helps in understanding the above description and shows a sequence of three consecutive sleepers "Tl"-"T3". In this figure, distance "2L" represents the ideal distance (or project distance) between the centre line of sleeper T1 and the centre line of sleeper T’3 (ideally represented in chain line), should these sleepers be positioned on their path with no error.

[0053] If it were possible to position the sleepers with no error, i.e, all at the same distance L, no position adjustment of the compaction machine and the ballast removal machine would be necessary. Once the initial location reference is given, the two units would be to distance 2L from each other and could work astride the respective sleepers and at each cycle would advance by the distance 2L, so as to be positioned astride the following sleeper pair, respectively.

[0054] Actually, positioning of subsequent sleepers is only acceptable if it falls within a tolerance gap established by the regulations in force (L +/tolerance); due to the allowed tolerance, however, the sleepers are generally to a different distance from each other. Since compaction and ballast removal require a precise positioning of the equipment astride the sleeper, it is of fundamental importance that, before starting each working, the positioning error be determined (i.e. the exact position of the centre line of the sleeper astride which it is necessary to work is to be determined, for example).

[0055] The above applies both to the compaction unit 9 and to the ballast removing unit 12.

[0056] Finally, it should be noted that the positioning error x of the real sleeper relative to the ideal sleeper can be both a positive error (i.e. a more forward position relative to the advancing direction A, as shown in Figs. 6a-6d), and a negative error (i.e. the real sleeper is in a backward position relative to the ideal one along the advancing direction A).

[0057] In the absence of an error correction "x", i.e. if the ballast removing elements 15 were activated in the position shown in Fig. 6a, one of them would interfere with the underlying sleeper "T3" so that it would be damaged and would cause stopping of the machine 1.

[0058] Under this situation, according to the railway machine of the invention, the mid-line axis of the 15 and the mid-line axis of the compacting elements 10 in said reference location are provided to be to their relative minimum distance equal to the ideal or project distance of the sleepers (for instance, T'3-T1) minus the maximum admissible positioning error "X" between said sleepers (position shown in Fig. 6a). Actually, for establishing the reference location, a slightly greater error than the maximum admissible error can be considered so as to be sure that the desired sleeper centre can always be found.

[0059] From this position of relative minimum distance between the mid-line axes, the ballast removing truck 13 will be able to move relative to the compaction unit 9 along the advancing way and direction A by a distance equal to at least (and generally slightly higher than) 2X, i.e. from the position of maximum error to the right of the project position to the position of maximum error to the left of the project position.

[0060] Therefore, preferably, the maximum stroke of the ballast removing truck 13 carried out by the adjustment piston 16a is equal to at least twice the maximum admissible error relating to distance "L" between the sleepers. By way of example, considering a project distance "L" between the centre lines of sleepers "T" equal to 60 cm and assuming a maximum admissible error of 5 centimetres in the distance between said sleepers "T" (T1 and T3), the reference or abutment location defines a distance "D=2L-X", measured between the centre line 3 of the compacting elements 10 and the centre line of the ballast removing elements 15, equal to twice said distance "L" minus the error, i.e. 117.5 centimetres. The base hypothesis of the above is that the error is statistically distributed in a centred position relative to the value of the project distance "L", which means that real distances between sleepers "T" of 117.5 and 122.5 centimetres are likely to occur to an equal extent. In this context, the reference location defines a statistically extreme position, i.e. it represents a condition of maximum error by defect (2L-X).

[0061] Alternatively, it would be possible to obtain adjustment of the positioning of the ballast removing truck 13 by a backward movement of the latter starting from the reference location that in this case would determine a maximum distance between the ballast removing truck 13 and slide 8. Under this circumstance, distance "D" would be equal to twice distance "L" between sleepers "T" plus half the maximum error "X", i.e. 122,5 centimetres (2L+X).

[0062] Going back to the first possibility and starting from the reference location, the ballast removing truck 13 is moved forward by the adjustment piston 16a along the track and in particular in the same way as the advancing direction "A" of the machine, until the sensor means detects that the ballast removing truck 13 is in a centred position relative to the second sleeper "T3" following sleeper "T1" on which the compaction unit 9 is operating. Corresponding to this position is an error value "x" (see Fig. 6b); in case of use of a railway machine provided with an electronic control, the error "x" is sent to the processing unit and stored therein to be subsequently used. Shifting of the ballast removing truck 13 is allowed because the main piston 18a, that is presently locked, is connected to slide 8, while the ballast removing truck 13 can move being only governed by the adjustment piston 16a.

[0063] When this position is reached, jaws "P1" of the ballast removing truck 13 are closed on rail "R" and grasp it, and the ballast removing operation can start while the previously started compacting operation is going on. The position reached is also shown in Fig. 5B.

[0064] At the same time, the adjustment piston 16a is locked while jaws "P2" of the slidable supports 17a are released. In this position the ballast removing truck 13 is fastened to rail "R" and slide 8 is locked to the ballast removing truck 13 since the adjustment piston 16a is locked. Thus the main piston 18a is activated and it extends causing the auxiliary truck 17 to move forward in the advancing direction "A" of the machine, i.e. causing the auxiliary truck 17 to move away from slide 8 (i.e. from the compaction unit 9) and from the ballast removing truck 13 (Fig. 6c).

[0065] This moving apart of the auxiliary truck 17 takes place as long as an abutment surface 31a of said auxiliary truck abuts against a corresponding surface 31c of the ballast removing truck 13.

[0066] When elongation is over, the main piston 18a is locked again and jaws "P2" of the slidable supports 17a are closed again on rail "R" so as to steadily grasp it. The reached position is shown in Fig. 6c and also in Fig. 7.

[0067] By operating in this manner the auxiliary truck 17 will move forward by the distance 2L between two ideal sleepers, +/- the positioning error "x" of sleeper T3 already detected by the ballast removing unit 13.

[0068] It should be noted that by operating in this manner no electronic control is required to be used, but the location references are identified by mechanical abutments 31a, 31b, 31c.

[0069] When the ballast removing and compacting operations have been completed, jaws "P1" of the ballast removing truck 13 are released and, while maintaining the adjustment piston 16a to a locked condition, the main piston 18a is operated again and, by its retraction, causes the ballast removing truck 13 and slide 8 to move forward along the track in the advancing direction "A" of the machine.

[0070] Said moving forward stops as soon as slide 8 (i.e. the compaction unit 9) abuts by its surface 31b against the reference surface 31a of the auxiliary truck 17 (Fig. 6d). By operating in this way, the stroke of the main piston 18a, or stroke of the compaction unit 9, is equal to the amount "2L+/-x", i.e. it is equal to the distance between the centre line of sleepers ideally laid, increased by the previously determined error "x" (or reduced by error "x", because error "x" can be by excess or by defect). Advantageously, in this way the centre line of the compacting elements 10 is automatically in alignment with the centre line of sleeper "T3" relative to which the ballast removing elements 15 had been centred in the previous step, and consequently a further step for adjustment of the position of the compaction unit 9 is not necessary.

[0071] The compacting elements 15 can therefore start a new step of compacting the crushed stones surrounding sleeper "T3" while the adjustment piston 16a is activated again (said piston being first brought to the end-of-stroke position to the right, i.e. to the distance "2L-X" from the mid-line axis of the compactor, and then the ballast removing truck 13 being driven in translation until the sensors detect the centre line of the following sleeper of interest) so as to align the ballast removing elements 15 relative to the underlying sleeper "T5", reaching a configuration of the type shown in Fig. 8. As a matter of fact, the step sequence 6a-6d is repeated.

[0072] From this instant on, the steps already seen above are repeated, and in particular it is obtained that the machine 1 is able to determine error "x" in an independent manner for each ballast removing cycle while the compacting working can advantageously use the value of error "x" measured in the preceding step and transferred to the compaction unit 9 itself, thanks to the appropriate abutment surfaces.

[0073] Obviously, as an alternative, it will be possible to use an electronic control circuitry and store in the processing unit the subsequent positioning errors measured by the sensor means of the ballast removing unit 12 for positioning of the compaction unit 9 in the following cycle.

[0074] During all steps of compaction, ballast removal, detection of error "x", and adjustment of the ballast removing truck 13 which involve an intermittent advancing of slide 8 and of the ballast removing truck 13, the car 2 of the machine 1 moves forward at a constant speed along said advancing direction "A" and this is allowed due to the fact that a possibility of relative sliding exists between slide 8 and the supporting truck 6.

[0075] In addition, the present invention can be advantageously used not only on compaction-ballast removal machines but also on machines designed to carry out other types of simultaneous working operations, more specifically machines having a first unit adapted to perform a first working and a second unit adapted to perform a second working and where one of the two operations calls for a longer intervention time than the other.

[0076] The present invention achieves the intended purposes and overcomes the drawbacks encountered in the known art. In particular, determining the positioning error by means of the ballast removing unit and using said error value for the subsequent compacting operation, this greatly reduces the required time for carrying out a compacting- ballast removing cycle. In fact, in this sector it has been experienced that the ballast removing operation calls for a lower time than the compacting operation and in this context the invention aims at utilising the interval between completion of the ballast removing operation and completion of the compacting operation for performing the necessary surveys in order to determine said error value. In particular, it has been estimated that the productivity of the machine according to the invention is substantially doubled as compared with that of the traditional machines, reaching a productivity of about 1 km of treated track for each working hour.

[0077] In addition, the slidable mounting of the compacting and ballast removing units on the car allows said car to move at a constant speed without impairing the ballast removing and compacting operations, so that advancing of the machine is made more smooth and fluent, the intermittent advancing of the whole machine provided in the known art being eliminated.

Claims

1. A working machine for railway tracks, **characterised in that** it comprises:

   - a first unit adapted to carry out a first working operation on the track, a compaction unit (9), for example;
   - a second unit adapted to carry out a further working operation on the track, a ballast removing unit (12), for example; said units (9, 12) being slidably movable relative to each other at least along an advancing direction (A);
   - actuating means (16) operatively acting between the first and second units (9, 12) to determine movement and/or mutual positioning of said units (9, 12) along the advancing direction (A);
   - sensor means co-operating with the second unit (12) for determining the correct positioning of same relative to the track before carrying out working;
   - the actuating means (16) shifting the second unit (12) relative to the first unit (9) during an operating step of the first unit (9) in which the same is rigidly linked to the track (R); during this mutual shifting the sensor means determining a reference location for the correct positioning of the second unit (12);
   - advancing means (18) acting at least on said

first unit (9) for determining a correct positioning of said unit (9) relative to the track using the preceding reference location of the correct positioning of the second unit (12) determined by the sensor means.

2. A machine as claimed in claim 1, **characterised in that** it further comprises a railway car (2) movable along an advancing direction (A), the first unit (9) and second unit (12) being associated with said car (2) and being further movable relative to said car (2) along said advancing direction (A).

3. A machine as claimed in claim 1, **characterised in that** it comprises a towing frame (17b) slidably connected to said units (9, 12) and suitable to be steadily connected to the track in a removable manner for defining a steady anchoring position, preferably said advancing means (18) comprising a main piston (18a), an oil-pressure piston for example, having one end connected to the towing frame (17b) and the opposite end connected to the compaction unit (9), said towing frame (17b) being stably connected to a pair of slidable supports (17a) for example, for being slidably carried relative to the track, each of said slidable supports (17a) being for example suitable for coupling to a respective rail (R) and equipped with a respective pair of grasping jaws (P2) for defining said steady anchoring relative to the track.

4. A machine as claimed in one or more of the preceding claims, **characterised in that** said actuating means (16) comprises an adjustment piston (16a), preferably an oil-pressure operated piston, having one end connected to the ballast removing unit (12) and the opposite end connected to the compaction unit (9).

5. A machine as claimed in one or more of the preceding claims, **characterised in that** said ballast removing unit (12) comprises a ballast removing truck (13) slidably supported by the track by means of its rolling members (14) and a plurality of ballast removing elements (15) movable between an operating position and an inactive position at which they are disposed to a raised location relative to the track, preferably said ballast removing truck (13) having one or more pairs of jaws (P1) for carrying out a steady anchoring of the ballast removing truck (13) to the track.

6. A machine as claimed in one or more of the preceding claims, **characterised in that** it comprises a slide (8) slidably supported relative to the track and connected to said compaction unit (9) to move said compaction unit (9) along the track, the machine preferably further comprising a supporting truck (6) equipped with railway wheels to be engaged with the track and slidably supporting said slide (8) by means of linear guides.

7. A machine as claimed in claim 6, **characterised in that** it comprises lifting means (7) operatively acting between the car (2) and the supporting truck (6) to lift the supporting truck (6) relative to the track; said compaction unit (9) and ballast removing unit (12) having respective engagement portions (13a) adapted to determine lifting of the ballast removing unit (12) relative to the track during lifting of the supporting truck (6).

8. A machine as claimed in one or more of the preceding claims, **characterised in that** the second unit (12) comprises a locator (30a) adapted to abut against a corresponding locator (30b) of the first unit (9) for establishing a predetermined reference location between said units, the actuating means (16) moving the second unit (12) relative to the first unit (9) starting from said predetermined reference location for determining the correct-positioning reference location of the second unit.

9. A machine as claimed in claim 3, **characterised in that** the towing frame (17b) comprises an abutment surface (31a) adapted to abut against a corresponding surface (31b) of the first unit (9) at a first operating position of maximum retraction, the abutment surface (31a) being adapted to abut against a corresponding surface (31c) of the second unit (12) at a second operating position of maximum elongation, preferably passage from the second operating position of maximum elongation to the first operating position by movement of the abutment surface (31a) of the towing frame (17b) involving automatic centring of the first unit on the correct-positioning reference location determined by the sensor means of the second unit.

10. A machine as claimed in one or more of the preceding claims, **characterised in that** said ballast removing unit (12) comprises said sensor means designed to detect positioning of the ballast removing unit (12) relative to the track and, more preferably, relative to a centre line of a sleeper (T).

11. A method of carrying out working operations on railway tracks, **characterised in that** it comprises the steps of;

- setting a first working unit (9) at a correct work position of thereof;
- setting a second working unit (12) at a predetermined reference location relative to the first working unit (9);
- preferably activating said first working unit (9) for carrying out the first working operation;

- moving the second working unit (12) at least along an advancing direction (A) relative to the first working unit (9) until bringing said second working unit (12) to its correct work position;
- activating said second working unit (12) for carrying out the respective working operation;
- shifting said first working unit (9) to the following correct work position coincident with said correct work position of the previously defined second working unit (12), said step of shifting the second working unit (12) being preferably obtained by moving forward the second working unit (12) in the same way as said advancing direction (A).

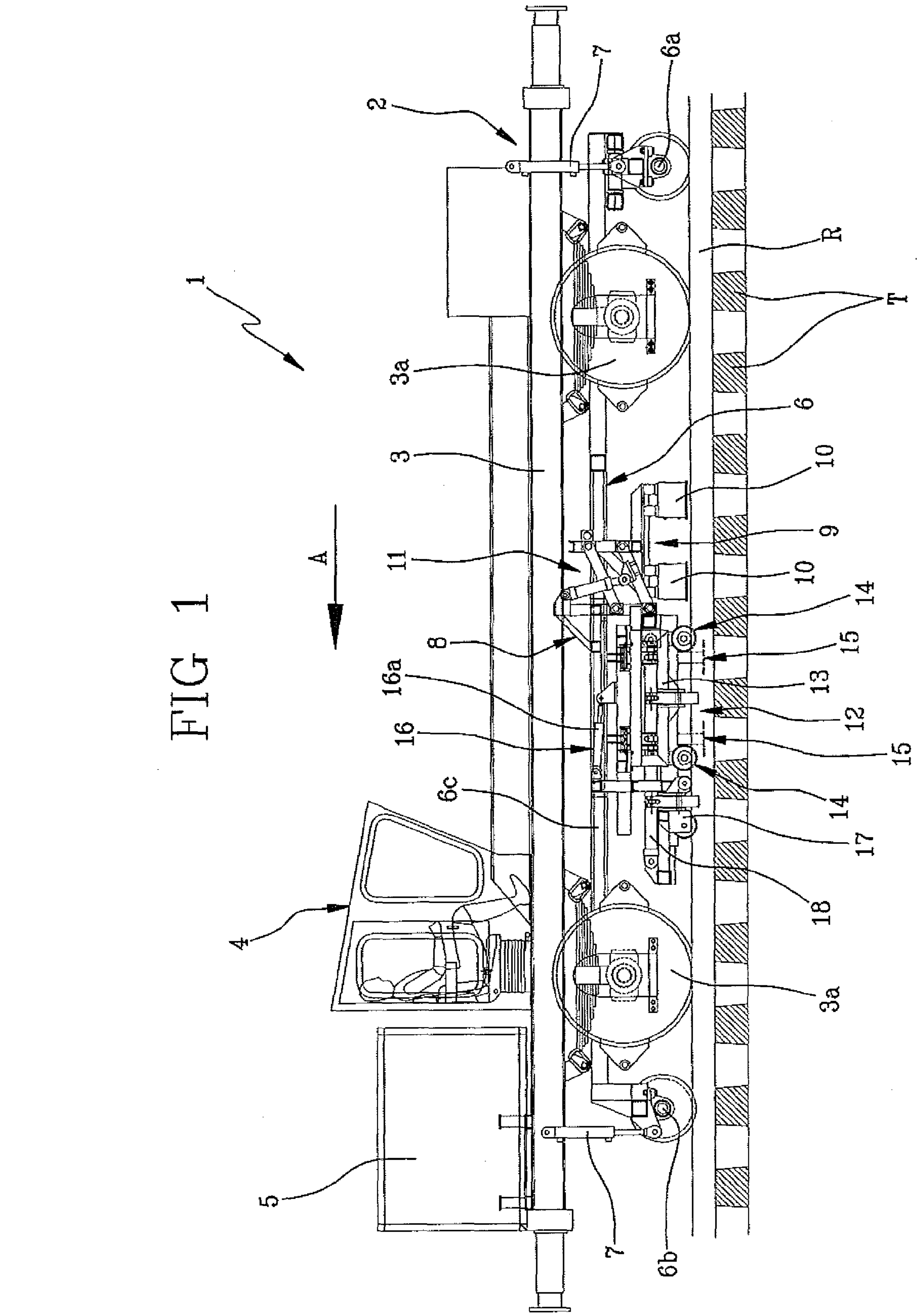
12. A method as claimed in claim 11, **characterised in that** the first and second working units (9, 12) are moved to the subsequent work position, steadily connected to each other for example, by shifting said first working unit (9) by a distance equal to a predetermined value (2L) to which a positive or negative amount (x) is added, for instance said predetermined value (2L) being coincident with a fixed distance for each subsequent working step of the first working unit (9), said amount (x) being coincident with a positive or negative positioning error along the advancing direction (A) varying for each subsequent working step of the first working unit (9).

13. A method as claimed in the preceding claim, **characterised in that** said predetermined value (2L) is coincident with twice the constant distance, fixed in accordance with the rules in force, between centres of two sleepers (T) in succession, the amount (x) being coincident with the real, positive or negative, distance deviation relative to the advancing direction (A), measured with respect to the predetermined value.

14. A method as claimed in one or more of claims 11 to 13, **characterised in that** it comprises the steps of:

- detecting said amount (x) through sensor means adapted to determine reaching of said correct work position by the second working unit (12), said detecting step being carried out during the step of shifting said second working unit (12) while the first working unit (9) is fixed relative to the track, preferably said detecting step comprising the step of:
- detecting, through sensor means, the position of a centre line of a railway sleeper (T) preferably astride which working is to be primarily carried out by said second unit (12) and subsequently working is to be carried out by the first unit (9), and **characterised in that** preferably said predetermined value corresponds to a distance existing between a portion of the first working unit (9) designed to be operatively positioned at a centre line of a railway sleeper (T), and a portion of the second working unit (12) designed to be operatively positioned at a centre line of a railway sleeper (T), said distance being measured at said reference location.

15. A method as claimed in one or more of claims 11 to 14, **characterised in that** said step of shifting said first and second working units (9, 12) comprises a step of steadily connecting said first and second working units (9, 12) with each other and a step of shifting said first and second working units (9, 12) steadily connected to each other, by a predetermined value (2L) plus said amount (x).


1
2
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3a
3a
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6a
6b
6c
7
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14
15
15
16
16a
17
18
A
R
T

FIG 1

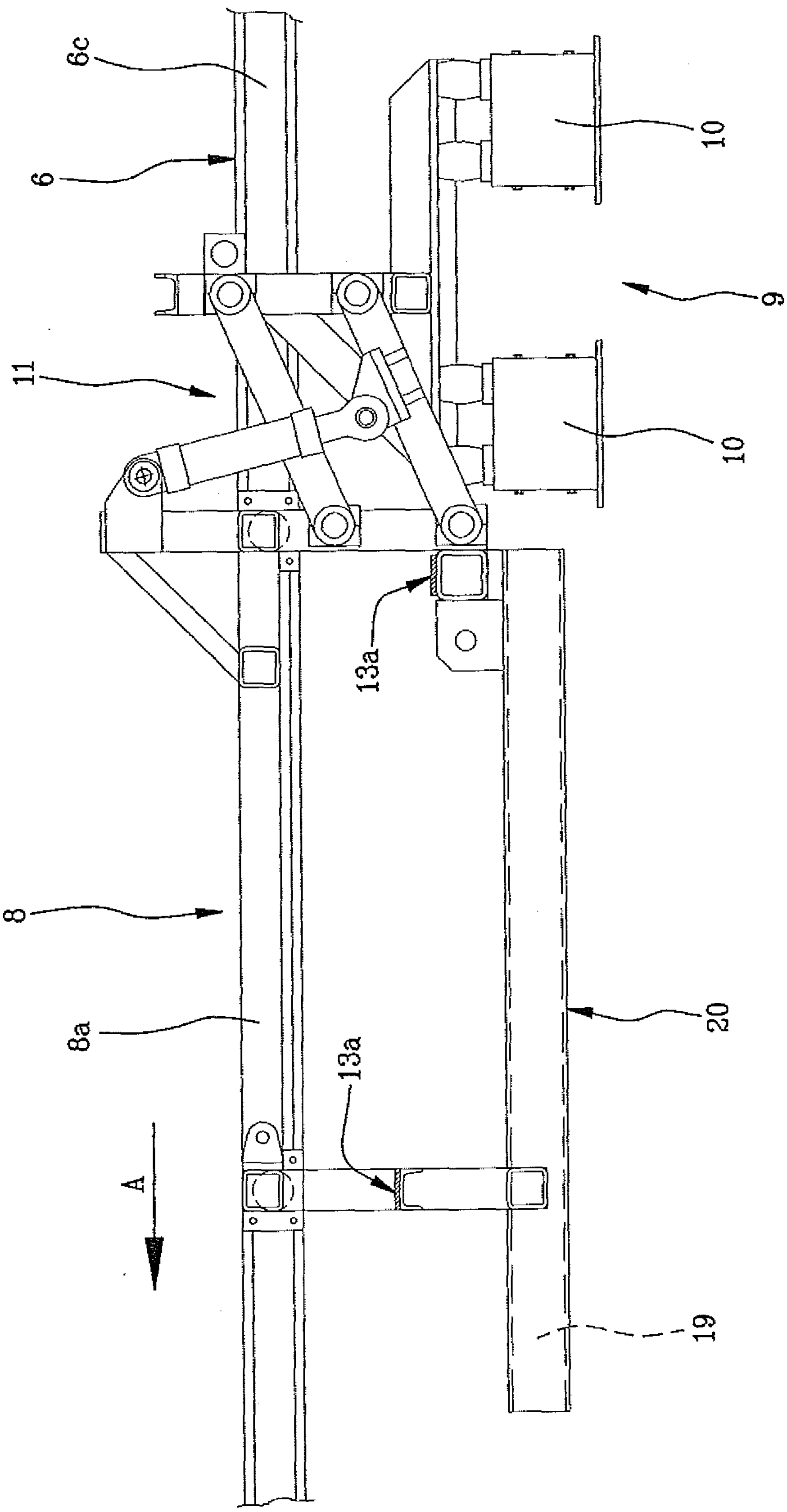


FIG 2

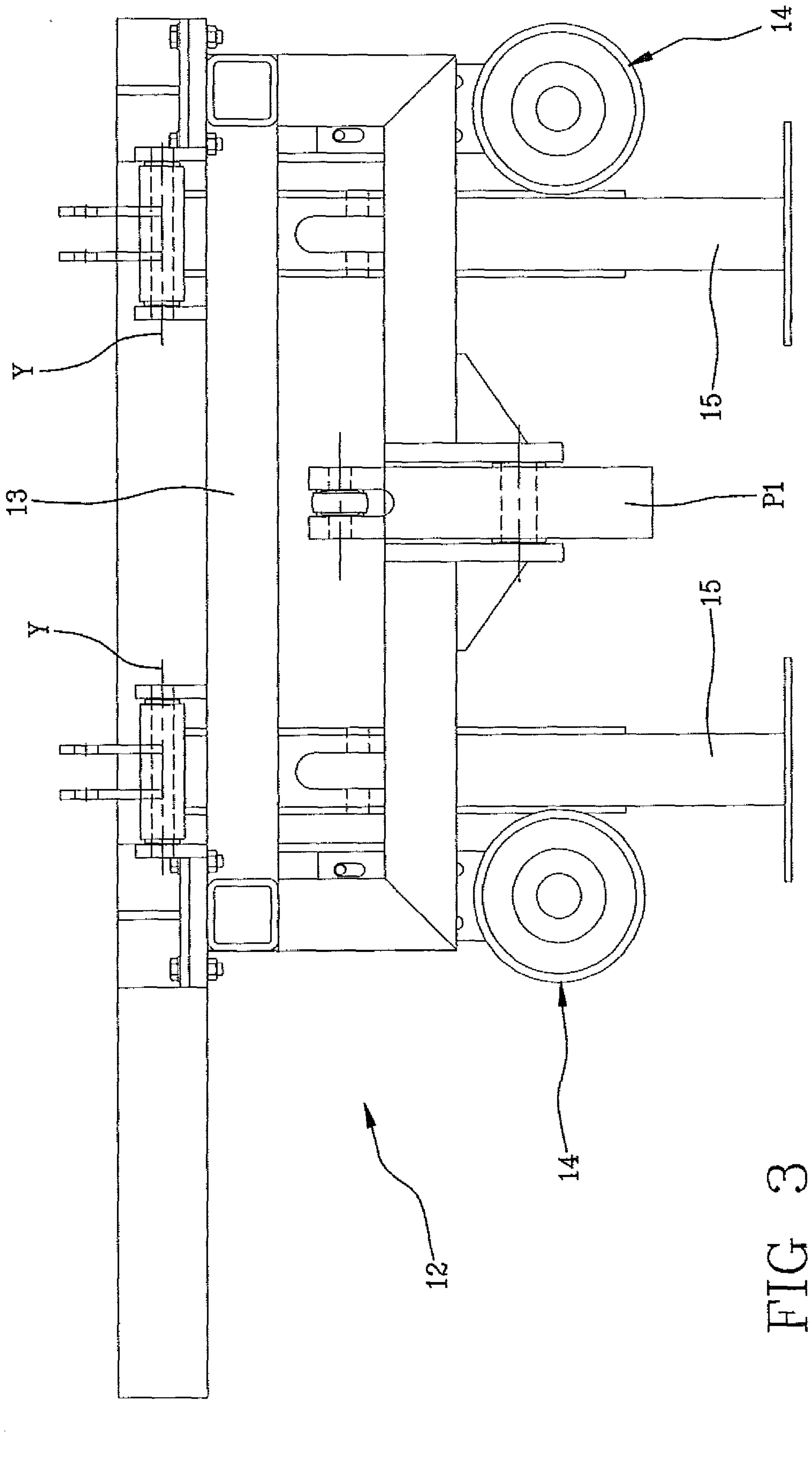


FIG 3

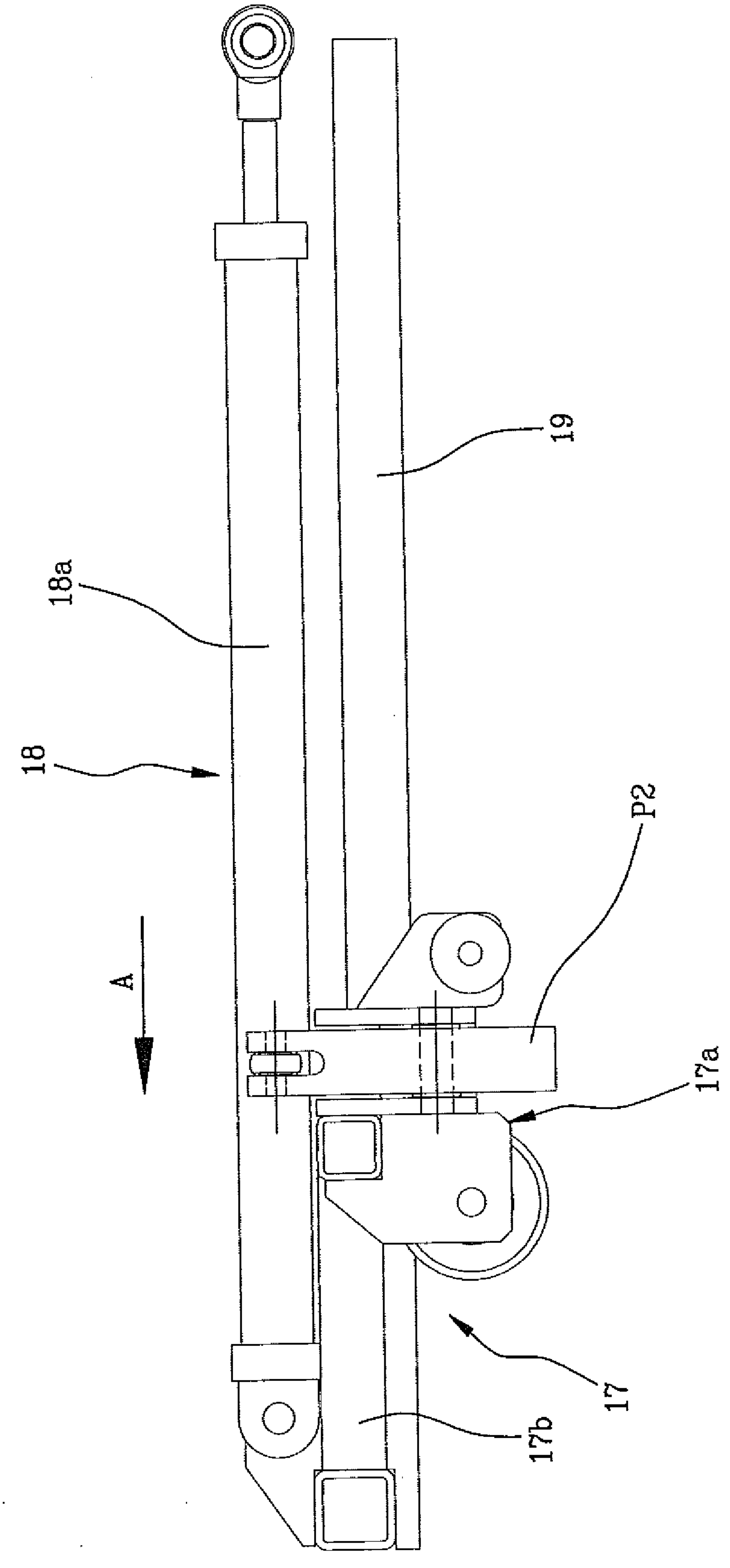


FIG 4

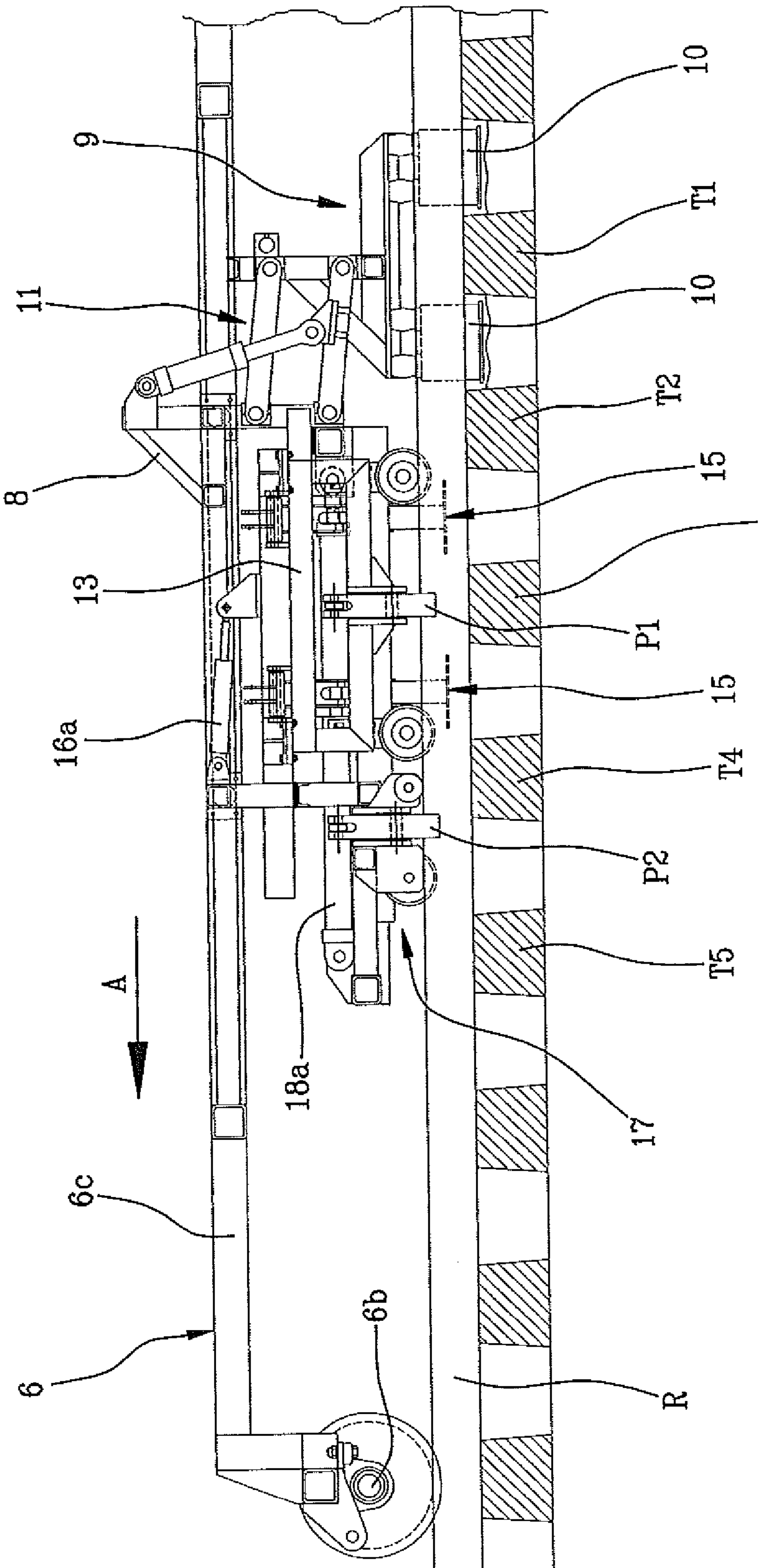


FIG 5a

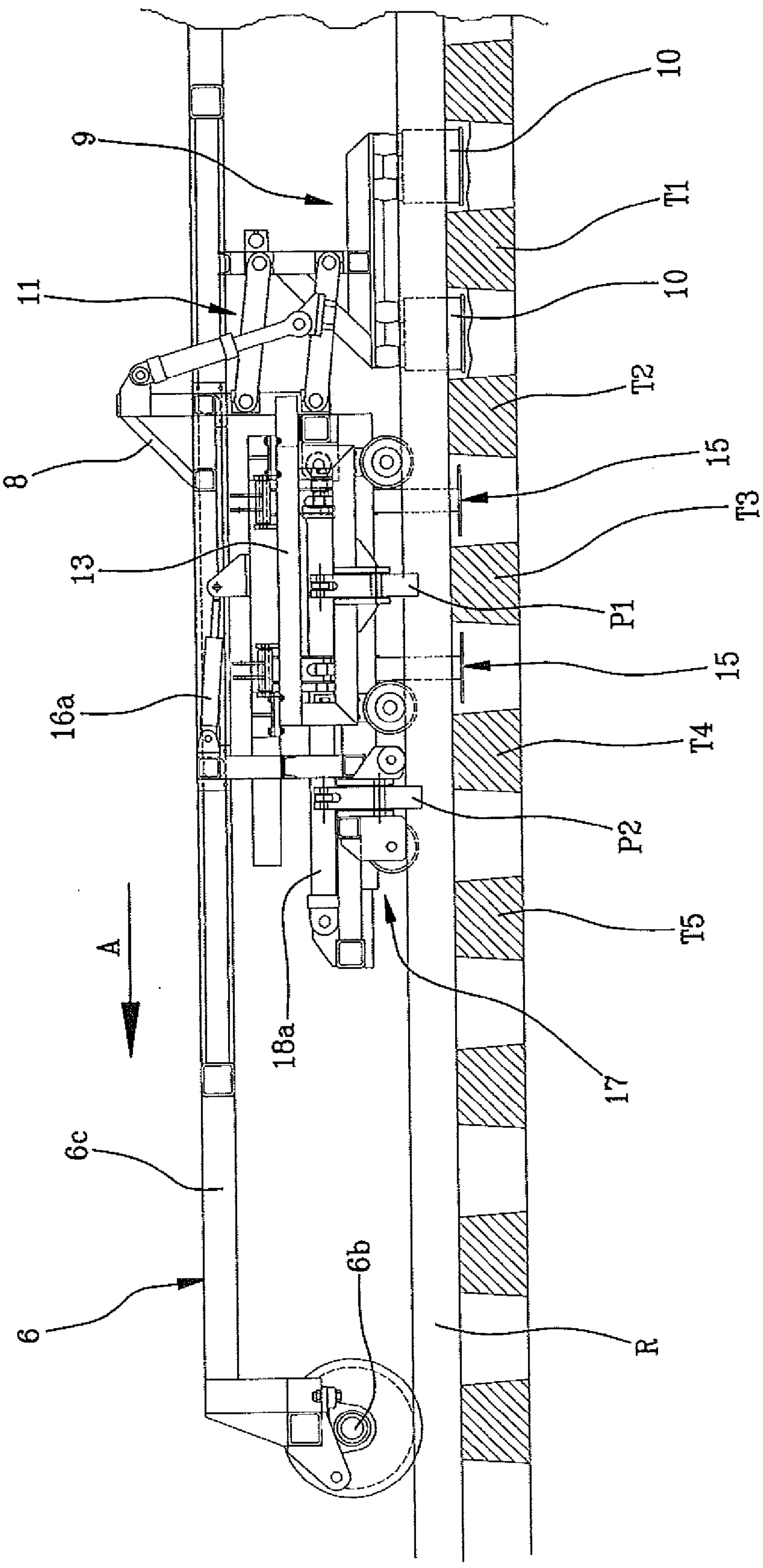
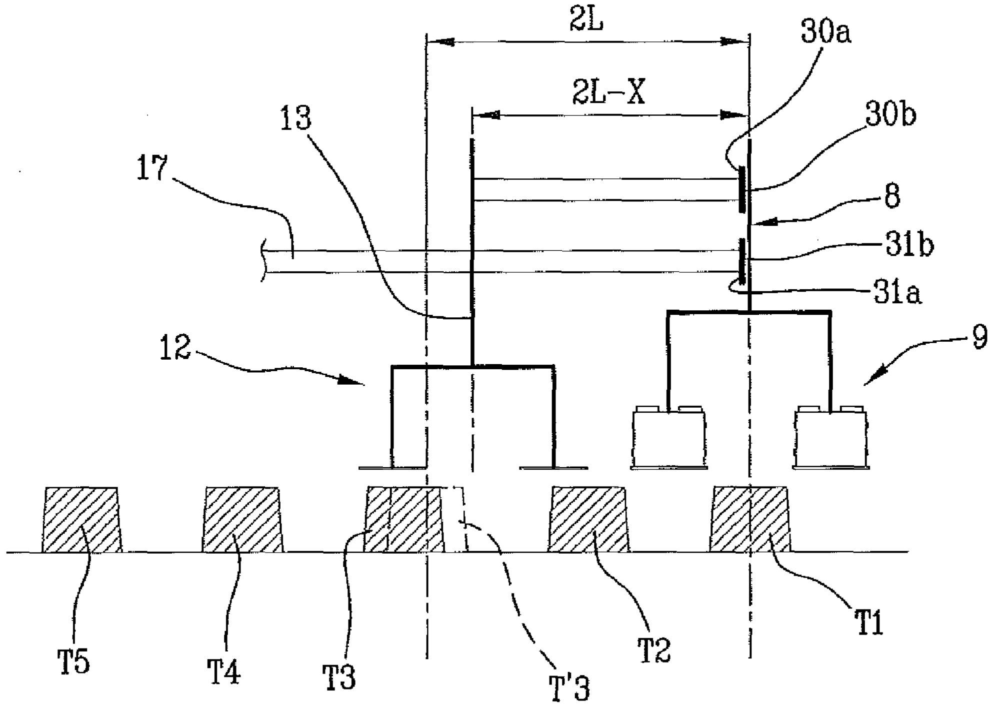


FIG 5b

FIG 6a


2L
30a
2L-X
13
30b
17
8
31b
31a
12
9
T5
T4
T3
T'3
T2
T1

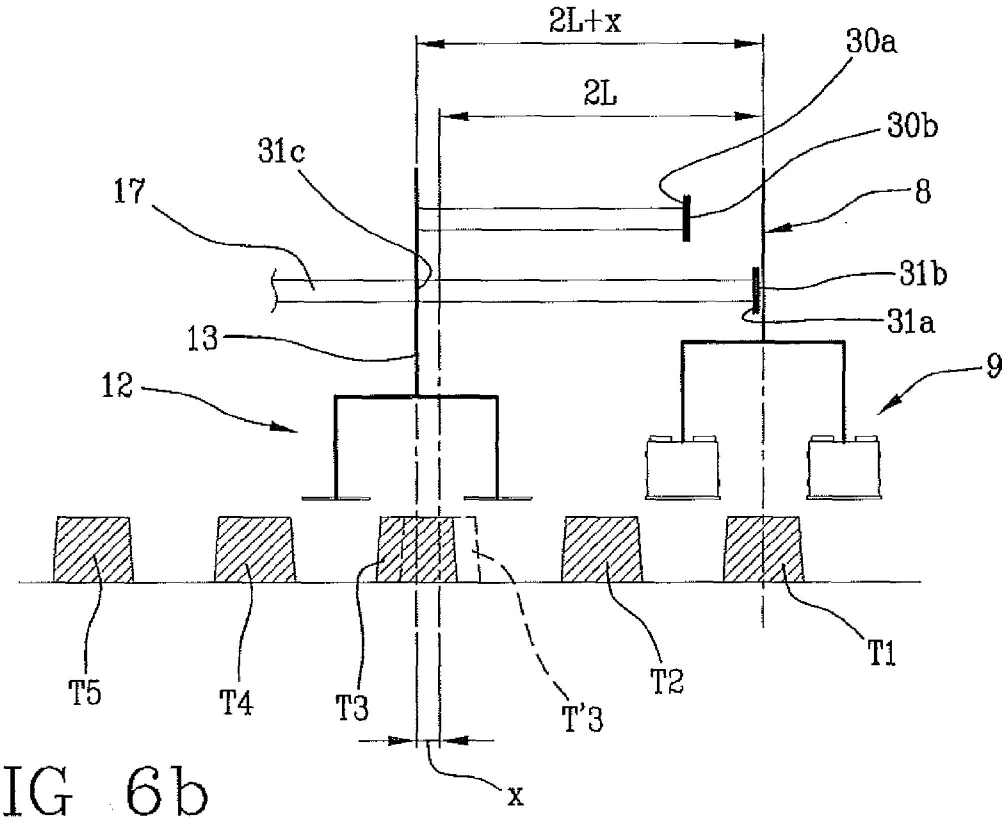
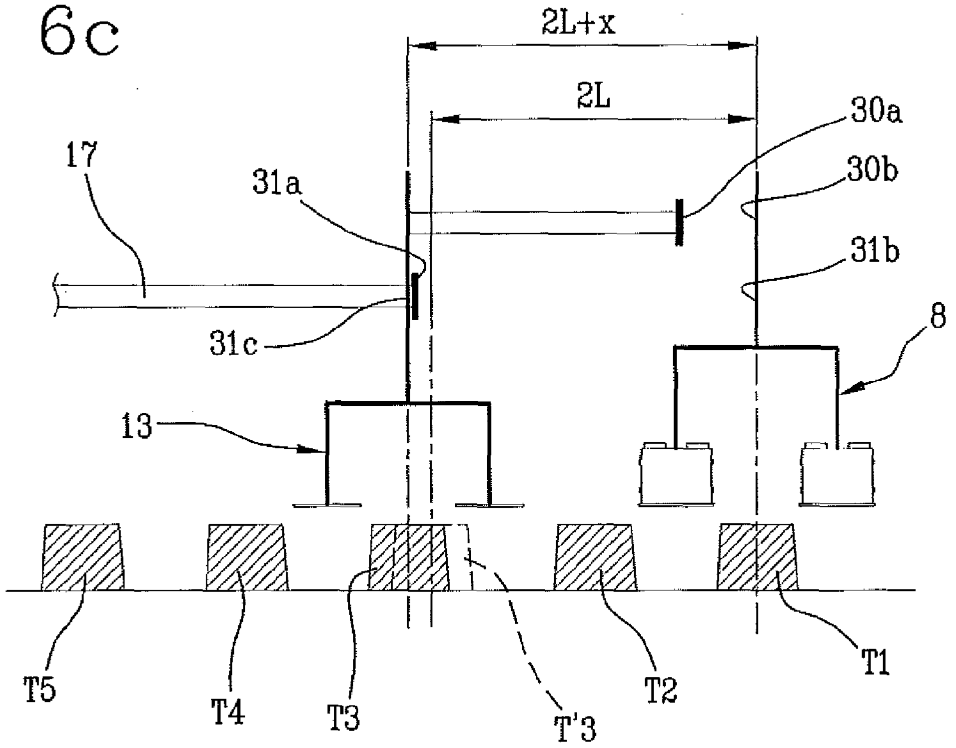

2L+x
30a
2L
30b
31c
17
8
31b
31a
13
12
9
T5
T4
T3
T'3
T2
T1
x

FIG 6b

FIG 6c


2L+x
2L
30a
30b
31b
17
31a
31c
8
13
T5
T4
T3
T'3
T2
T1

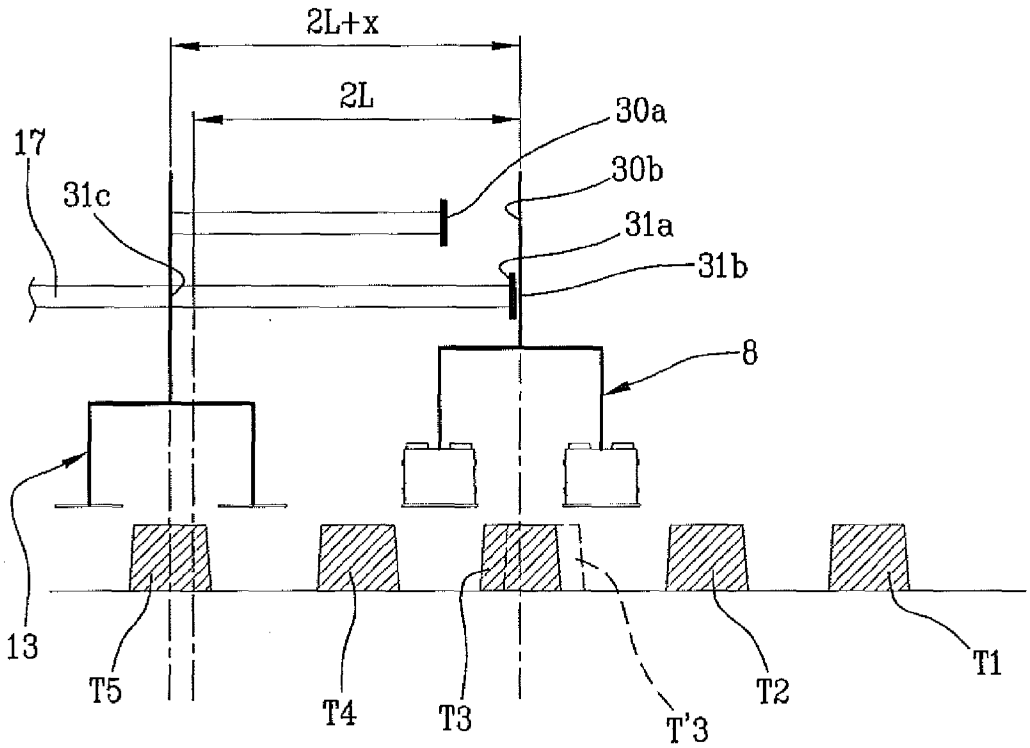

2L+x
2L
30a
30b
17
31c
31a
31b
8
13
T5
T4
T3
T'3
T2
T1

FIG 6d

FIG 7

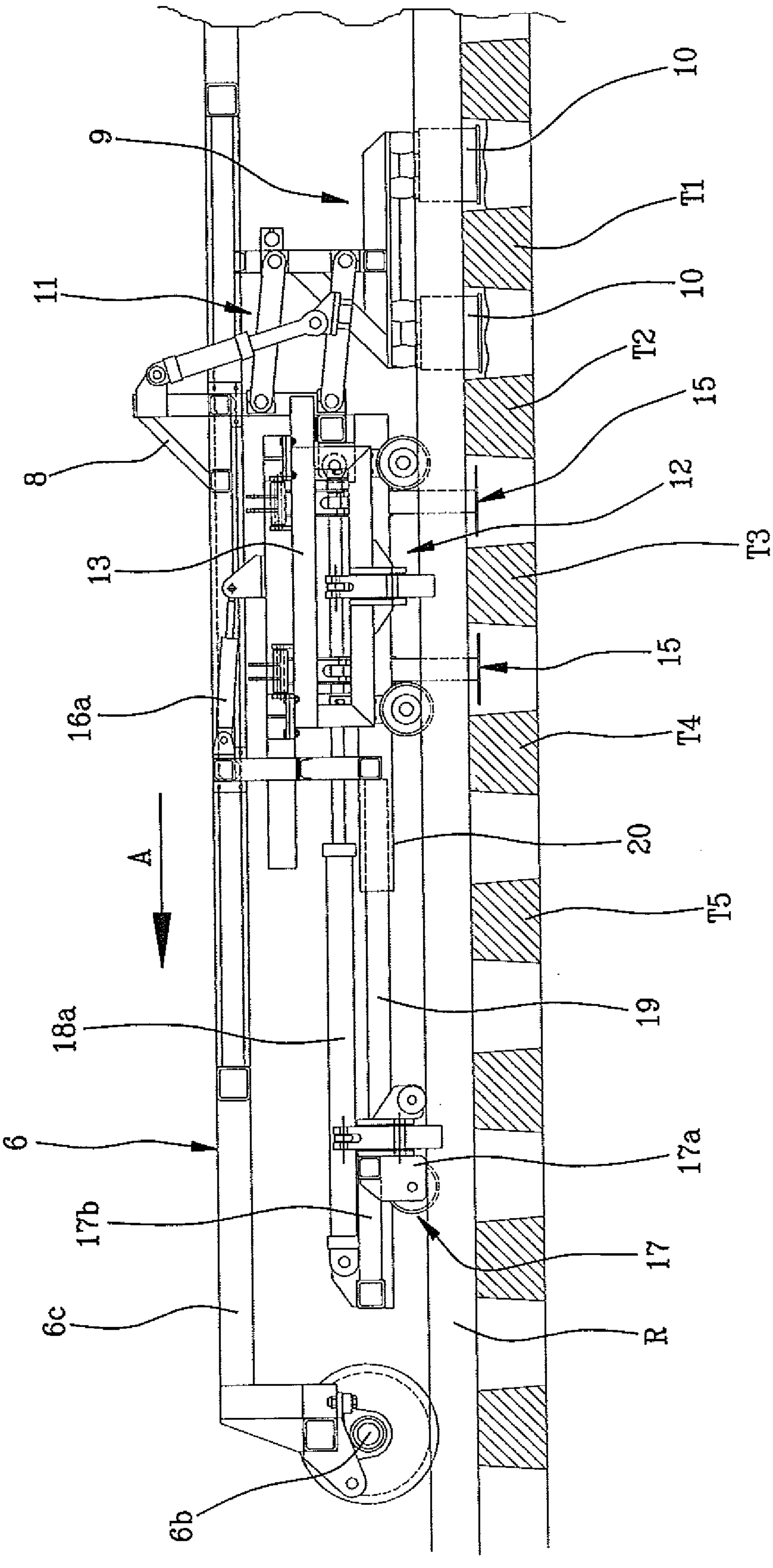

10
9
T1
10
11
T2
15
8
12
13
T3
15
16a
T4
20
A
T5
19
18a
17a
6
17b
17
6c
R
6b

FIG 8