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(54) Automatic silo for automobiles.

(57) The invention relates to a silo for automobiles, made of steel or reinforced concrete, provided with superposed, side-by-side, mutually opposite and facing compartments (14) into which the automobiles are ensiled by means of a robot carriage (5) comprising telescopic, bilateral combs (22) adapted to penetrate both the combs (15) arranged at the bottom of each compartment (14) and constituting the supporting base for the ensiled automobiles, and the combs (48-49-60) of the loading and unloading platforms (42) existing in the silo.

The motion of the robot carriage is effected by a transelevator (44) running on rails (20-77), which has no capstans or counterweights on board and, therefore, is light, particularly rapid and reliable, and which effects all the horizontal, vertical or coordinate displacements required for a rapid and reliable parking of automobiles.

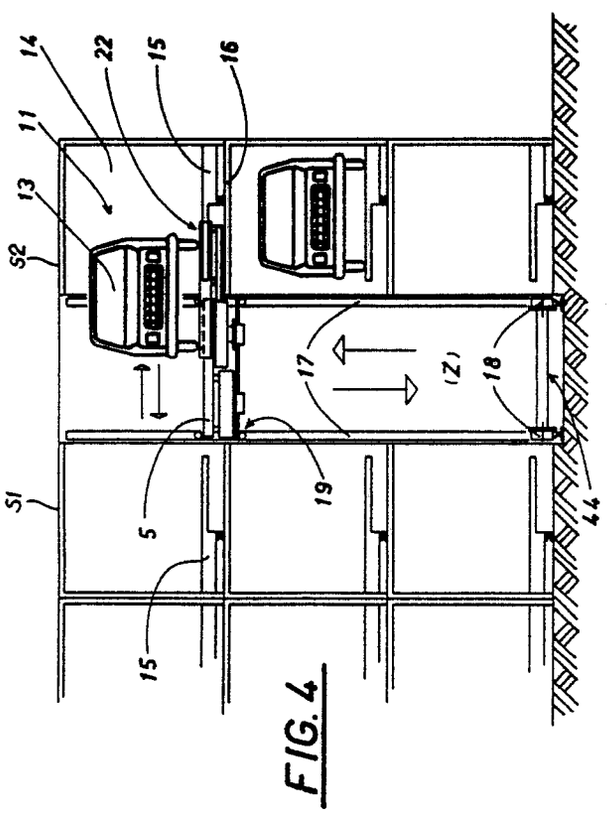

FIG. 4

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"Automatic silo for automobiles"

The invention relates to a silo for automobiles, made either of steel or reinforced concrete, laid underground, partially underground, completely exposed, or arranged within a floating shell, the characteristics of which will becomes apparent from the following description of a preferred embodiment thereof, shown merely as a non-limiting example in the Figures of the accompanying sheets of drawings, in which:

Figure 1 is a side elevational and partly sectional view of the silo for automobiles;

Figure 2 is a cross sectional view of the silo;

Figure 3 is a plan view of the silo;

Figure 4 is an enlarged detail of the cross sectional view;

Figure 5 is a side view of the robot carriage during the de-ensilage or the ensilage of an automobile;

Figure 6 shows a detail of the combs in the step of transfer/loading of automobiles onto the stationary combs of a garage compartment;

Figure 7 is a detail view of an automobile wheel resting on a stationary comb of a garage compartment;

Figure 8 is a general plan view of the robot carriage while loading or unloading an automobile into or from a garage compartment;

Figure 9 shows further details as seen on the line IX-IX of Figure 8;

Figure 10 shows the robot carriage in the retracted position or the transfer step;

Figure 11 is a plan view showing the arrangement of the platform provided with loading and/or unloading combs within the silo;

Figure 12 is a side view emphasizing the approach ramp to and from the loading and/or unloading platform;

Figure 13 is a front view of the platform with the loading and/or unloading combs;

Figure 14 is a side view showing an automobile positioned centrally on the pick-up platform, with its front wheels sunk in the ditch;

Figure 15 is a side view showing an automobile while being picked up from the combs of the loading platform by the action of the combs of the robot carriage shown in the engagement position;

Figure 16 is a side view showing the automobile already raised an spaced from the loading platform during their ensilage step;

Figure 17 is a side view showing the auxiliary front combs of the loading and/or unloading platforms in their active position to permit a de-ensiled automobile to be driven out;

Figure 18 is a plan view of the platform with its combs;

Figure 19 is a front view of the control for the ditch comb for sinking the front wheels onto the loading platform;

Figure 20 shows the comb of Figure 19 in the step of inter-penetration with the combs of the robot carriage;

Figure 21 is a side elevational view of the transelevator which operates in the silo;

Figure 22 is a cross sectional view of the silo presenting opposite compartments, wherein the transelevator is emphasized;

Figure 23 is a detail plan view of one of the two upper carriages of the transelevator;

Figure 24 is a front elevational view of one of the geared motor units for the horizontal motion of the transelevator;

Figure 25 is a plan view of the silo, emphasizing the transelevator and the two systems for picking up and returning the automobiles;

Figure 26 is a plan view of the capstan/geared-motor unit for the vertical motion of the robot carriage arranged on the up-and-down moving elevator car or cabin of the transelevator;

Figure 27 is a detail plan and sectional view of one of the vertical guides for the car or cabin which carries the robot carriage.

From Figures 1 and 2, it will be realized that the silo of the invention is of the type comprising a modular and sectional building S made of steel or reinforced concrete, formed with parallelepipedal garage compartments 14 arranged after each other and onto each other so as to form opposite multi-story parallelepipedal constructions S1-S2 arranged parallel to each other and spaced apart by a service corridor Z.

According to a first characteristic of the invention, said compartments 14 are disposed with their longer dimension in the direction of the length of the constructions S1-S2, and said compartments are open towards said corridor Z.

The bottom of each compartment, intended to support an automobile, consists of horizontal combs 15 whose teeth are perpendicular to the open side of the compartments and are secured to supporting members so that the complementary teeth of the composite combs 22 can penetrate between them so as to be movable vertically therein along a certain length, said combs 22 being associated with a robot carriage 5 (see below) which, in turn, is mounted in an elevator car or cabin arranged on a transelevator device constituted by a powered carriage tower 44 (see below) travelling on guide means 20 and others, all ar-

ranged along the corridor Z. The transelevator 44 is operatively connected to automatic motion means which permit to transfer the robot carriage 5 into alignment with the selected compartment 14 in order to either ensile or de-ensile an automobile.

The comb-like structure 22 of the robot carriage may be translated towards either the right-hand or the left-hand side of the transelevator 44, so as to operate in the compartments of both the construction S1 and the construction S2.

The constructional details of the robot carriage and the transelevator will be described hereinafter.

Each compartment is provided with a double-plate bottom 16 with a drip-drain, so as to protect the automobiles therebelow from any liquid dripping from the automobiles arranged above. In Figure 4, the numeral 17 indicates the vertical guides for the transelevator 44, the numeral 18 indicates the wheels of the transelevator carriage, which roll on the guides 20, and the numeral 19 indicates the sliding blocks for the vertical displacements of the robot carriage 5.

The silo as described above operates as follows.

An automobile comes on to the positions 1 or 2 of Figures 1 and 3, waits for the "go ahead" of the traffic lights 3, 4 and then proceeds onto the comb-like structure 22 of the robot carriage 5 which has been suitably positioned for this purpose.

The driver drives the front wheels of the automobile to sink into a ditch C suitably formed in the structure 22 (see below), for the purpose of constituting a reliable reference for the automobile on the handling means 22, whereafter said driver blocks and vehicle, engages the gearbox, activates the hand brake, gets out and, if desired, he locks the door of his vehicle and, finally, in a safety area, he gives the consent signal by inserting a card into a terminal.

We omit the description of all the known operations, such as: ascertainment of the vehicle's weight, check of the outline, detection of the presence of persons, issue of the coded card for vehicle withdrawal, mode of payment and every other auxiliary operation as conventional in automatic silos.

Thereafter, the automobile which has been placed on the robot carriage 5 is transferred by the transelevator 44 directly to an available compartment allotted by the electronic terminal. The coordinate movement of the transelevator in the horizontal and vertical directions, will minimize the positioning and centering time of said robot carriage in the approach to the selected compartment. When the transelevator has completed the positioning and centering movements pertaining to it, the robot carriage 5, by means of an independent motion of the comb structure 22, will carry the automobile through a small distance upwards and will translate it parallelly to its axles, to transfer it over the combs 15 constituting the bottom of the selected compartment. During this operation, the teeth of the structure 22 penetrate between the teeth of the combs 15 which are at a suitably lower level with respect to the wheels of the automobile. Thereafter, when the structure 22 has completed its translational stroke, said structure is lowered again to softly deposit the automobile onto the comb 15 and to disengage from the wheels of said automobile, so that it may be retracted within the outline of the transelevator which automatically will move back to a stand-by position for repeating a new ensilage or de-ensilate cycle.

As illustrated hereinafter, the robot carriage 5, by virtue of the particular double and telescopic formation of the comb-like structure 22, can ensile automobiles indifferently into the compartments of the construction S1 or the construction S2.

The de-ensilage operation occurs exactly in the contrary manner. The transelevator 44 with the robot carriage moves towards the exits 7 or 8 of the silo (Figures 1-3). By inserting the card into the suitable terminal, the driver will enable the withdrawal of his vehicle. When the structure 22 will have reached the exits 7-8 and the safety devices will have been opened, the driver may withdraw his vehicle and may drive to the cash counter to pay the toll.

In Figures 3 and 4, the numeral 11 indicates a robot carriage 5 while ensiling an automobile 13 into a compartment 14, whilst in Figures 1, 2 and 3, the numeral 12 indicates an automobile 13 already ensiled.

It is now apparent that the silo according to the invention has the following advantages over the known solutions:

- the automobile is handled gently, as if it were a package. In fact, during the ensilage and de-ensilage movements, the automobile is completely motionless and can be safely handled, even if with flat tires;
- the handling of the automobiles is carried out with no intermediate structures, such as carriages, pallets, platforms, or the like, the management of which creates a number of problems;
the ensilage and de-ensilage operations involve the displacement of the automobiles normally to their longitudinal axis, i.e. transversely; therefore, they are effected in shorter time because the width of an automobile is much smaller than its length.

Merely as a non-limiting examples, a possible embodiment of the robot carriage 5 will be now described. Figure 6 shows that the combs 22 of the robot carriage 5 are higher than the combs 15 of a garage compartment during the step of deposition of an automobile onto said combs 15, while Figure

7 shows that said combs, 22, once the automobile has been laid down onto the stationary combs 15, are retracted to the centre of the robot carriage due to the telescopic action of the frame 23 which is movable with respect to the frame 24 which, in turn, is movable with respect to the base of the car or cabin 65. The car 65 constitutes the support and the connection for the robot carriage, it is slidable on the skids 19 within the guides 17 in the uprights M, and permits all the horizontal and vertical displacements of the robot carriage. The entire structure of the transelevator 44 is fixed to the uprights M and is movable horizontally by means of the carriages 66, on the rail 20 (see below).

The telescopic action of the comb-carrying frame 23 and frame 24 in the opposite directions is made possible by a set of V-shaped guides 31 jointly slidable between a double row of V-shaped wheels 32 (Figures 5 and 8). The displacement of the frames 23 and 24 is effected by means of ball-recirculation screw-members and nut-members.

Figure 8 shows the robot carriage while loading an automobile 13 onto the stationary combs 15 of the compartment 14. The combs 22 of the robot carriage are shown in their transversely fully extended position to suitably position the automobile 13 within the compartment.

The screw members 33 are coupled two by two and stationarily fixed to the respective frames, while the nut members 34 mounted on each screw member are rotated by a pair of toothed wheels 35 (Figure 5) meshing with the gearwheels 36 actuated by the motors 37 through respective clutches (Figure 8). Both the upper motor and lower motor 37 are secured together with the supports 38 (Figures 9-10), to V-shaped guides 39 also slidable between a double row of V-shaped wheels 40 (Figures 5-8). Therefore, the two groups formed by the guides 39, motors 37, toothed wheels 35-36, supports 38, nut members 34 engaging simultaneously the pairs of right-hand or left-hand screw members 33, constitute two differential units that make the bi-directional displacement of the frames 23-24 gradual, progressive and, at the same time, speedy. Figure 10 shows the robot carriage 5 in its retracted position with the driving units in a symmetrical central position capable of ensuring the telescopic displacement of the frames 23-24, either rightwards and leftwards.

According to a preferred embodiment of the invention, as an alternative to the solution shown in the Figures 1, 2 and 3 wherein the vehicles to be parked are placed directly onto the robot carriage 5, the vehicles are previously deposited in an independent manner onto a loading platform. A similar platform is provided for returning the vehicles. If necessary, the two platforms may be also be adapted to effect both the loading and unloading operations. The presence of these platforms gives additional operative flexibility to the silo because, while the robot carriage/transelevator unit is effecting either an ensilage or de-ensilage operation, a successive vehicle may be deposited onto the loading platform preparatory to the parking. This modification may permit some constructional simplificiations of the robot carriage, as explained below with more detail. This modification will be now described further with reference to Figures 11 to 20.

It will be noted in Figures 11 and 12 that the automobile is driven by its driver up a slightly inclined ramp 41 to reach a comb-equipped platform 42 so arranged beside the corridor Z as to substantially simulate an ensilage compartment. As shown in Figure 11, the platform 42 may be formed with a through exit 45 so as to be usable both as a loading and an unloading platform.

With reference to Figures 14 and 18, it will be noted that each platform 42 comprises two groups of co-planar, stationary combs 60 and 48 which are designed to support the front and rear wheels of a vehicle, respectively. Said combs are supported overhangingly by a supporting structure, similarly to the bottom combs 15 of the garage compartments. Arranged between said two groups of combs there is provided a horizontal board 52 controlled by a hydraulic pantograph system 53, constituting a bridge between said combs so as to permit the longitudinal movement of the vehicle. The board 52 is usually in its upper position as in Figure 14 and is provided with its own teeth 54 which are disposed parallelly to and co-planar with the teeth 50 so as to grant the vehicle a smooth path of travel.

Longitudinal guides 55 are arranged on the entrance and the exit ramps as well as on the board 52 to ensure the required transverse centering of the vehicle with respect to said platform. In combination with this means, a light beam of conventional nature may be projected onto the hood of the vehicle to be positioned on said platform, which visually helps the driver to effect a correct transverse centering of his vehicle.

The longitudinal centering is ensured by a ditch existing between the comb 48 and a stationary shoulder 47, into which the front wheels are driven to sink slightly when the vehicle is suitably positioned on the platform.

The ditch is defined at its bottom by one of the teeth of the comb 48 which, unlike the other one, is movable vertically, is indicated at 49, and is connected to the guiding and hydraulic driving system 50-51.

Once the vehicle has been centered and sunk in the ditch as described above, the driver switches off the engine, leaves the gearbox engaged, ac-

tivates the handbrake, gets out and, if desired, locks the door, exits through a small safety gate, inserts a previously-withdrawn card into a terminal which stores the required data and starts automatically the following operative cycle:

- the board 52 is lowered as in Figure 15, and the tooth 49 of the comb 48 is lifted to annul the effect of the ditch C1. In this manner under the combs 48 and 60 there is created the space which is necessary for accommodating the comb-like structure of the robot carriage 5 therebetween;
- the transelevator 44 and robot carriage 5 are moved into register with the platform 42 whereon the automobile to be ensiled has been parked, and said robot carriage is suitably centered with respect to said platform;
- the telescopic comb-like structure of the robot carriage 5 is extended and is inserted at a suitably lower level between the combs of the platform 42, as in Figure 15;
- the structure carrying the robot carriage 5 is suitably lifted as shown in Figure 16, so as to lift the vehicle 13 off the combs of the loading platform;
- the robot carriage 5 is moved into the transelevator 44 which, at due time, is activated to transfer the vehicle to the selected compartment, according to the sequence of operational steps described previously.

The vehicle de-ensilage and withdrawal cycle occurs with a procedure contrary to that described above and the vehicle concerned is brough back to the platform 42 or any other equivalent platform (Figures 11 and 12). This cycle is also controlled by the driver after he has introduced into the terminal that card which has been memorized upon the ensilage step. During this step, the platform is assumed to be in the condition of Figure 14, with the front portion thereof in the condition as shown in Figure 17, with an auxiliary comb-like structure 56 inserted co-planarly between the comb-like structure 48-49, following the activation of the respective jack 58. This condition ensures a complete restoration of the planar path of travel for the vehicle, which may be then unloaded smoothly from the platform. The driver will then drive his vehicle to the cash counter to pay the toll for parking his vehicle.

As stated above, there may be any number of platforms 42, depending upon the size of the silo.

All the hydraulic jacks of the board 52, comb 49 and auxiliary combs 56, are controlled by a remote-control unit 58 (Figures 17 to 20). Figure 18 shows with more detail the comb-like structure discussed above. The numeral 55 indicates the longitudinal guide ridges, 52 indicates the board and the respective control jack 59, the numerals 48 and 60 indicate the stationary combs, and 49 the movable comb with the respective plate 50 provided with gibs 61 for clearance adjustment. The numeral 56 indicates the auxiliary combs (Figure 17) with the respective tightening guides 62. The assembly of the guides is supported at both ends by means of supports 63 also provided with gibs 64 for clearance adjustment.

The numeral 54 indicates a comb which is solidary with the board 52.

Figure 19 is a front view of the condition of Figure 14. The front wheels of the vehicle have been sunk into the ditch, while the movable comb 49 and auxiliary comb 56 is lowered. This Figure also shows the side guide ridges 55. The hydraulic jacks 51-57 and hydraulic control unit 58 are shown at the bottom. Figure 20, finally, shows the same components as Figure 19 in the condition of Figure 15, during the introduction step of the comb-like structure 22 of the robot carriage 5, while the comb 49 is in a raised position and the auxiliary comb 56 is in a lowered position.

With reference to Figures 21 to 27, there is shown a preferred embodiment of the transelevator 44. Figure 21 shows a vehicle 13 arranged on the robot carriage 5 that has taken it, for example, from one of the loading and unloading platforms 42. The robot carriage 5, in turn, is connected rigidly to a car or cabin 65 which is adapted to penetrate the base of the structure of the transelevator concerned (see Figures 21-24-27). This condition is made possible because the base of the transelevator has the shape of a rectangular ring of such dimensions as to be penetrated by the base of said car or cabin 65. This solution permits a maximum lowering stroke of the car 65, the respective robot carriage and the automobile arranged thereon, to skim the rail 20. This condition permits, inter alia, to arrange the loading and unloading platform 42 at a low level.

It will be noted in Figure 21 that the vertical structure of the transelevator 44 is provided at the bottom, at both ends thereof, with pivotable carriages 66 having on board the geared motors 67 each of which rotates, through integral gear drives 68 (Figures 21, 22, 24, 25), the respective wheels 18 running on the base rail 20.

Fixed parallelly along the entire length of the rail 20 is a rack 69 (Figure 24) in mesh with a toothed wheel 70 which is co-axial with the wheels 18 and has a pitch diameter equal to the outer diameter of said wheels. This solution permits, in addition to a strong adhesion of the four driving wheels to the rail 20, to obtain through an encoder the exact number of revolutions of the wheels 18 and to transmit this function to an electronic processor controlling the automatic operation of the silo of the invention.

Two pairs of uprights M stem from the base of

the transelevator 44 and are connected to each other at the upper end thereof. Secured to the inner sides of the uprights M, in a protected position and parallelly thereto, are corresponding guides 17 wherealong the car or cabin 65 can run through rollers 19 (Figures 25-27).

The frame connecting the upper ends of the uprights M to each other is provided, at each end thereof, with a double pair of vertical-axis idle wheels 73 for lateral stabilization (Figures 21-23). Mounted on said frame are also the pivots 75 swingably supporting the frames 71 which mount the idle wheels 74 and sheaves 76.

The wheels 74 run on the rails 77 which are secured to the ceiling of the corridor Z, while the stabilization wheels 73 run along the inner sides of said rails.

Secured to the top of each end of the structure of the silo S, at the level of the rails 77, are pairs of idle sheaves 80 vertically aligned with threaded drums 86 (Figures 21-26) keyed on electrical capstans 78 which are mounted on the base of the silo. Keyed on the through-shafts of the capstans 78 (Figure 26) are also a pair of threaded drums 82, and a pair of ropes 179 stem therefrom and are passed around idle pulleys 84, which are parallel and close to said sheaves 80, the other ends of said ropes being connected to counter-weights 83 which are slidable in the vertical stationary guides 85.

Connected to the electrical capstans 78 are the opposite ends of ropes 79 which are passed around the idle sheaves 80, then around the pulleys 76 arranged at the top of the transelevator and, finally, are passed in tackle fashion around idle pulleys 72 arranged on the top of the car or cabin 65.

If the transelevator is moved horizontally by means of the base geared motors 67 and if the capstans 78 are at a standstill, the car or cabin 65 and robot carriage associated therewith keep still at the level where they are, because the ropes 79 are freely running on the idle pulleys 80-76-72.

If, however, in conjunction with the horizontal displacement of the transelevator 44, the capstans 78 or at least one of them are actuated, a vertical and in coordinate displacement of the car or cabin 65 will be effected.

The presence of a double driving system for horizontal displacement and of two lifting capstans grants the following advantages. The double driving system for the horizontal displacement ensures, due to the four driving wheels, a strong towing drive and maximum reliability because the double driving system enables the transelevator to work even if one of the motors should fail. The presence of the double capstan, in addition to the reliability of said double driving system, causes the vertical speed of travel of the car or cabin 65 to be the double of the linear speed of travel of the ropes 79 wound on both threaded drums 86. This condition permits to obtain very high up-and-down speeds and permits to reduce the stress on the electrical capstans which, with the aid of the counterweights 83, may safely be operated continuously. As stated above in connection with the horizontal displacement, if one of the capstans 78 should fail, the functioning of the silo is ensured by the other capstan, though at reduced speed.

The movable electrical motors for the transelevator 44 and robot carriage 5 are fed through the suitably arranged rail-shaped conductors 87-88 (Figures 21-22).

It is apparent that, due to the floor-supported arrangement of the capstans 78, ropes 79 and counter-weights 83, and due to the construction of the transelevator assembly with an extremely lightweight material, the transelevator 44 may be operated rapidly also during the horizontal displacements.

The centering or registering of the robot carriage 5 and respective comb-like structure with respect to the comb-like structure of the compartments 14 or the loading and unloading platforms 42, during all the ensilage and de-ensilage operations, is always controlled by an electronic computer capable of ensuring the utmost precision and reliability and provided with an apparatus for self-diagnosis and detection of prospective faults.

The various safety and control devices which are known and easily conceivable by those skilled in the art have been omitted from the description.

Finally, it is to be understood that the description is referred to a preferred embodiment of the invention and that many changes and modifications, especially of constructional nature, may be made thereto without departing from the principle of the invention, as disclosed above, as shown in the accompanying sheets or drawings and as claimed hereinafter.

Claims

1. A computerized automatic silo for automobiles, of the type comprising a parallelepipedal ensilage structure (S) made of steel framework and/or reinforced concrete, covered and protected on each side against weather, adapted to contain garage compartments arranged side by side, superposed onto each other in a multi-story arrangement, preferably opposite to each other and open towards a service corridor (Z) which is provided with longitudinal rails (20-77) whereon a powered tower structure (44) may run, said structure being as high as the ensilage structure and

being provided with an elevator unit (5) designed to pick up the vehicle to be parked and to automatically ensile it into one selected compartment, and adapted to effect as well the contrary operation of withdrawing the vehicle from the selected compartment and returning it to the exit station, characterized in that the longer dimension of said compartments (14) is parallel to the longitudinal direction of said service corridor (Z) and the elevator unit mounted on the transelevator tower (44) is provided with telescopic structures which may be extended in cantilever fashion from either side of the transelevator to introduce the vehicles into and withdraw them from any one of the selected compartments, by translating said vehicles normally to their longitudinal axis and by supporting said vehicles by their wheels, the arrangement being such as to achieve the following advantages over the known techniques wherein the vehicles are displaced longitudinally during the ensilage and de-ensilage steps:

- the handling of the vehicles is effected with no interposed structure such as pallets, platforms, carriages or the like;
- the vehicles are handled as packages, because they are completely inert during the entire ensilage and de-ensilage cycles, which may be safely carried out even if one or more tires are flat;
- the handling of the vehicles being ensiled or de-ensiled requires a displacement of said vehicles which is proportional to their width and which requires, therefore, a shorter time than the conventional longitudinal displacement and which permits a reduced overhanding extension of the supporting and translating means (5) associated with the elevator unit of said transelevator.

2. A silo according to claim 1, characterized in that said compartments (14) for ensiling the vehicles are provided at the bottom thereof with combs (15) the teeth of which are oriented normally to the service corridor (Z) and therefore parallelly to the axes of the wheels of the vehicles which are disposed onto said combs and which are thereafter picked up therefrom by a complementary comb-like structure (22) which is associated with the robot carriage (5) arranged on the transelevator (44) and which is activated according to the following logic: during the ensilage step, the combs of the robot carriage are at a suitably higher level than the combs of the selected compartment and while in this condition they penetrate into the latter combs so that the wheels of the vehicle will not interfere with the stationary combs, and on completion of the translation stroke the movable combs will be lowered to lay down the vehicle onto the stationary combs and move away from the wheels to be retracted to their rest position, while during the de-ensilage step the movable comb of the robot carriage (5) is moved in the contrary manner.

3. A silo according to the preceding claims, characterized in that each compartment is provided with a double bottom (16) below said comb-like structure (15) supporting the ensiled vehicle, for the purpose of protecting the vehicles arranged below from any liquid dripping from the vehicles ensiled at the upper stories.

4. A silo according to the preceding claims, characterized in that the vehicle to be parked is driven by its own means onto the comb-like structure of the robot carriage (5), which is suitably positioned for this purpose at the entrance station of the silo, said comb-like structure being preferably provided with a ditch (C) or a projection for the abutting positioning of the vehicle's front wheels, whereby the vehicle will be properly centered with respect to said comb-like structure and, thereafter, with respect to the stationary comb-like structure constituting the bottom of the selected compartment.

5. A silo according to the claims 1 to 3, characterized in that the vehicles to be ensiled or de-ensiled are positioned onto a loading platform (42) arranged beside the service corridor (Z) and provided with:

- an entrance ramp (41) and an exit ramp (45) at the opposite sides thereof and preferably provided with longitudinal ridges (55) for centering the vehicle transversely;

a set of stationary co-planar combs (48-60) having the same orientation as the bottom combs of the comparments and designed to support the front and rear wheels of the vehicles;

- at least one movable comb (49) controlled hydraulically to be either lowered and raised, and used for sinking the vehicle's front wheels into the ditch and, therefore, for achieving the correct longitudinal centering of said vehicle;
- a board (52) bridging said stationary combs and vertically movable by means of a hydraulically-controlled pantograph system (53) so that when a vehicle has been positioned on the platform said board may be lowered to clear a space required for the insertion and engagement movement of the comb-like structure of the robot carriage (5), said board (55) being povided with longitudinal guide ridges (55) and with auxiliary combs (54) that, when said board is in the upper position, penetrate co-planarly with the stationary comb (60) supporting the rear wheels of the vehicle, for constituting therewith an even running plane for the vehicle;
- a pair of auxiliary combs (54) hydraulically controlled to be raised and lowered, and designed to

penetrate into the stationary comb which supports the front wheels, to constitute therewith an even running plane for the outgoing vehicles.

6. A silo according to the preceding claims, characterized in that the small vertical displacements of the robot carriage with the comb-like telescopic structure designed for the introduction and withdrawal of the vehicles onto and from the comb-like supporting base of the ensilage compartment or the loading and unloading platform, are effected by suitable means mounted in said robot carriage.

7. A silo according to claims 1 to 5, characterized in that the small vertical displacements of the robot carriage (5) with the comb-like structure designed for the introduction and withdrawal of the vehicles onto and from the comb-like supporting base of the ensilage compartment or the loading and unloading platform, are effected by the same means used for moving vertically the elevator structure (65) carrying said robot carriage.

8. A silo according to the preceding claims, characterized in that the robot carriage (5) mounted on the transelevator structure (44) comprises telescopic carriages (23-24) capable of bilateral-symmetrical strokes, which are moved in a mutually-guided manner by sheaves (32) and by a double pair of endless screw-members (33) and ball-recirculation nut-members (34) actuated by clutched drives and respective variable-speed reversible motors (37), said carriages supporting two sets of combs (22) parallel to the direction of movement of said carriages and intended to operate, respectively, one on the front wheels in a fixed position and the other on the rear wheels of vehicles having any wheels base.

9. A silo according to the preceding claims, characterized in that the transelevator tower comprises:

- a pair of uprights (M) connected to each other at the bottom portion thereof by a ring-like structure which can accommodate the movable cabin (65) mounting the robot carriage (5) therein and provided at the ends thereof with pivotable carriages (66) slidable on one or more lower rails (20) and driven by respective geared motors (67);
- said uprights (M) being connected to each other at the top thereof by a frame onto which there are mounted idle vertical-axis wheels (73) and idle horizontal-axis wheels engaging the inner sides and the top side, respectively, of the upper guide rails (77);
- said uprights (M) supporting, protected on their inner sides, vertical guides (17) onto which the cabin (65) carrying the robot carriage (5) is caused to run;
- the top portion of said up-and-down movable cabin (65) being provided with horizontal-axis idle pulleys (72) around which are passed, in tackle fashion, ropes (79)which are passed around idle pulleys (76) mounted on the top portion of the transelevator (44), and also passed around idle pulleys (80) arranged at the ends of the top portion of the silo, said ropes being directed from said pulleys downwards and connected to a pair of electrical capstans (78) arranged on the floor of the silo and, in turn, balanced by a system of ropes (179) and counterweights (83), all being arranged to achieve the following advantages:
- the horizontal motion of the transelevator and the vertical motion of the up-and-down movable cabin are effected by a double driving system which makes the general operation of the apparatus of the invention safer and more reliable and which is helpful in the acceleration/deceleration steps and registering/centering steps;
- the driving units for the up-and-down movable cabin are arranged on the floor. The transelevator (44), therefore, is of reduced weight and can travel faster;
- when the ropes (79) supporting the up-and-down movable cabin are activated simultaneously by both capstans (86), the speed of the vertical displacements of said cabin is the double of that which is ensured by only one capstan.

10. A silo according to the preceding claims, characterized in that parallelly to at least one of the rails for the horizontal displacement of the transelevator and at least one of the vertical guides for the vertical displacement of the up-and-down movable cabin, there are fixed racks co-operating with toothed wheels which through an encoder enable the detection of the exact position and speed of the composite structure of the invention, so that the latter can be reliably managed by the electronic computer which provides for the complete automation and the operation of the silo.

11. An automatic silo for motor-vehicles, characterized in that it comprises:

a) at least a pair of ensilage strucures (S1, S2), each structure being formed by a plurality of compartments each having the shape of a right angle parallelepiped with a rectangular base (14) and each designed to receive a motor-vehicle (13), the compartments of each structure being equal to each other, superposed in a plurality of stories and arranged side by side, each structure being spaced from the other so as to define a service corridor (Z) between the two structures, the longitudinal axes of said compartments being disposed parallelly to the longitudinal axis of the service corridor (Z), and said compartments (14) being open towards said service corridor (Z);

b) a transelevator device (44) capable of displacing, within said service corridor (Z), in the directions of its length and of its height, a robot carriage (5)

adapted to receive a motor-vehicle (13), so as to carry said robot carriage (5) to the level of and in registration with any desired compartment (14), suitable translating devices being provided on said robot carriage (5) to translate the motor-vehicle (13) laterally and in both directions with respect to the movement of the transelevator device (44) into and from each compartment (14), so that a motor-vehicle (13) may be either deposited into or withdrawn from each compartment.

12. An automatic silo for motor-vehicles, completely or partly as described, as shown and for the purposes disclosed above.

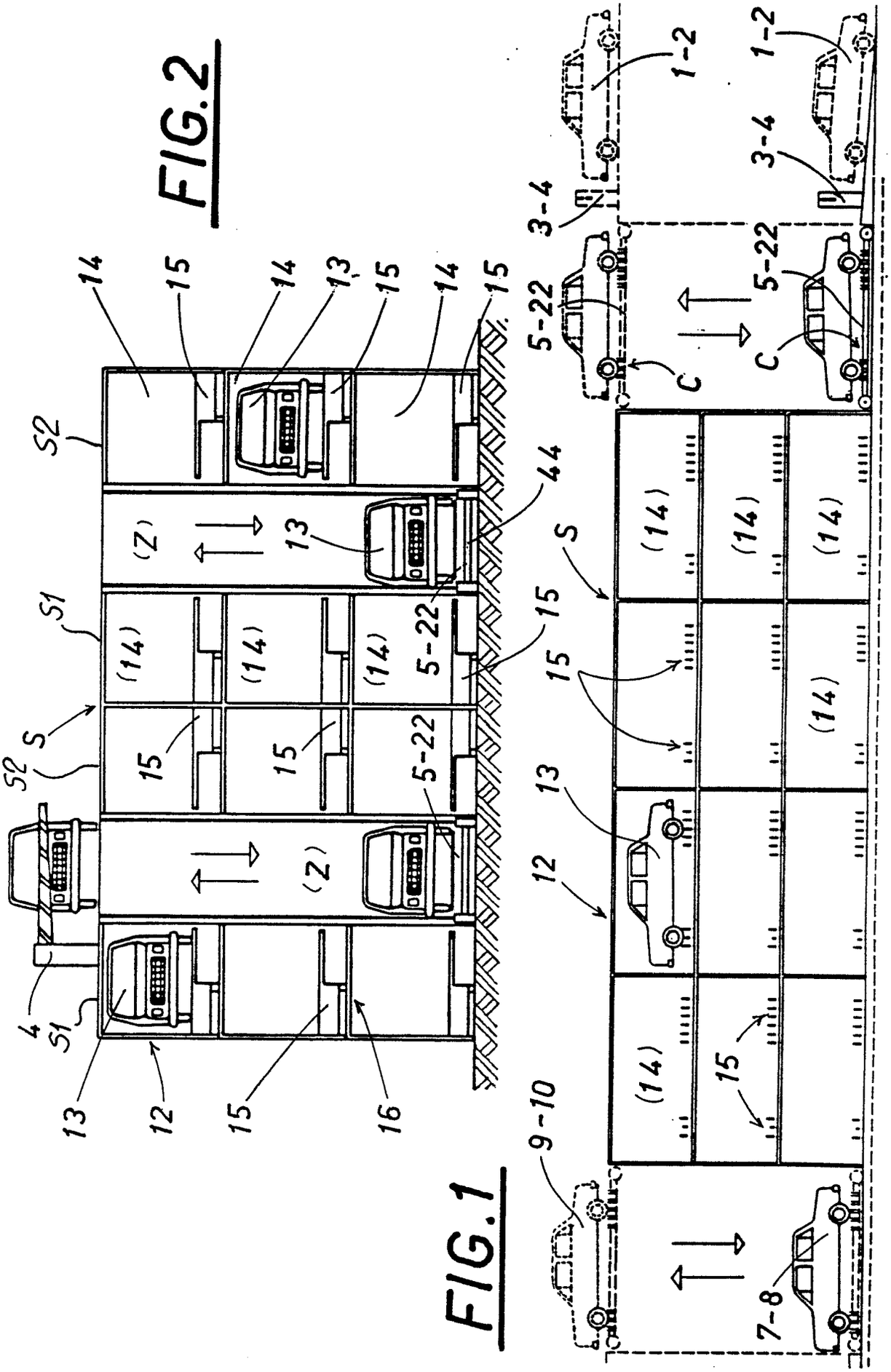
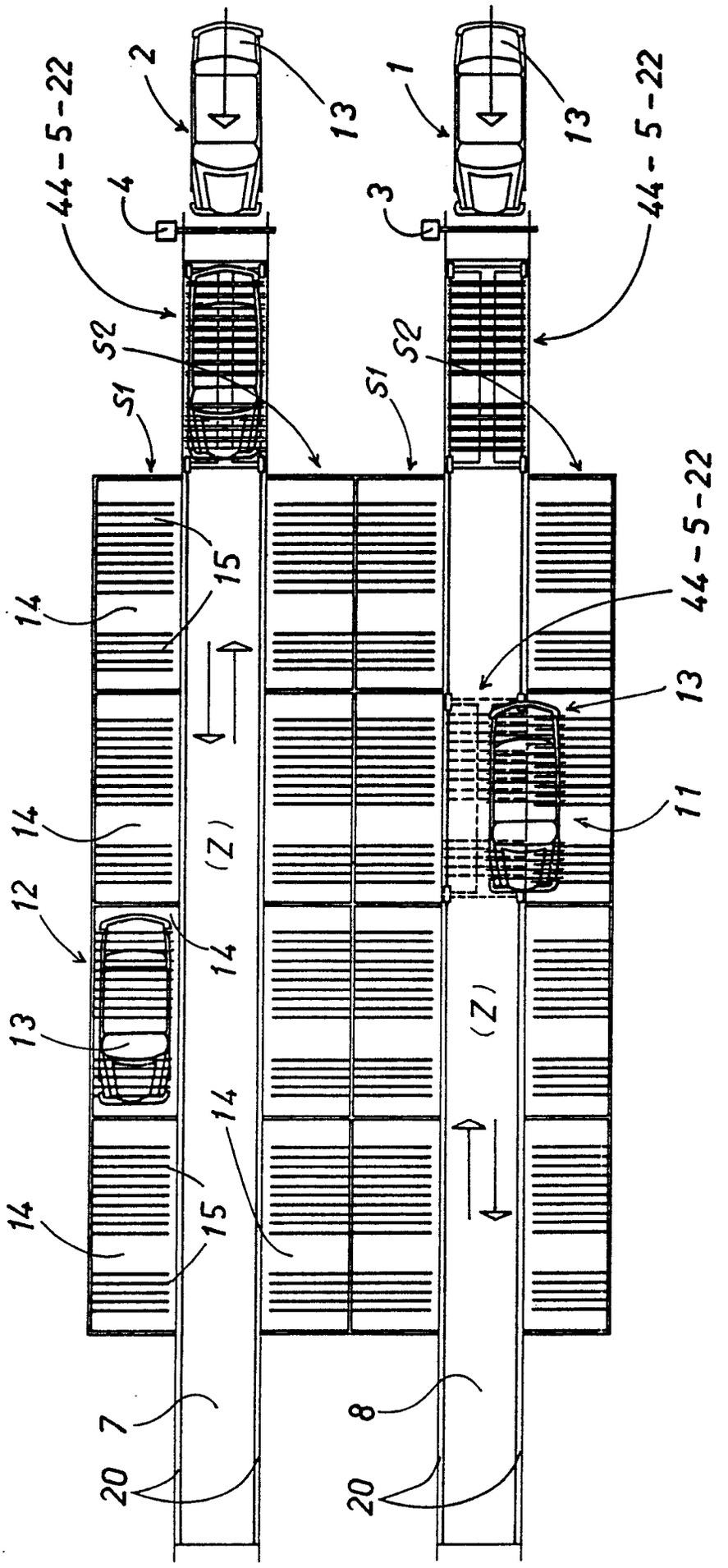


FIG.2
FIG.1
14
15
13
S2
S1
S
(2)
(14)
5-22
44
4
12
16
1-2
3-4
C
9-10
7-8


44-5-22
2
13
1
13
44-5-22
4
3
44-5-22
S2
S1
S1
S2
15
14
44-5-22
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14
(Z)
11
12
14
13
14
15
14
(Z)
7
8
20
20

FIG. 3

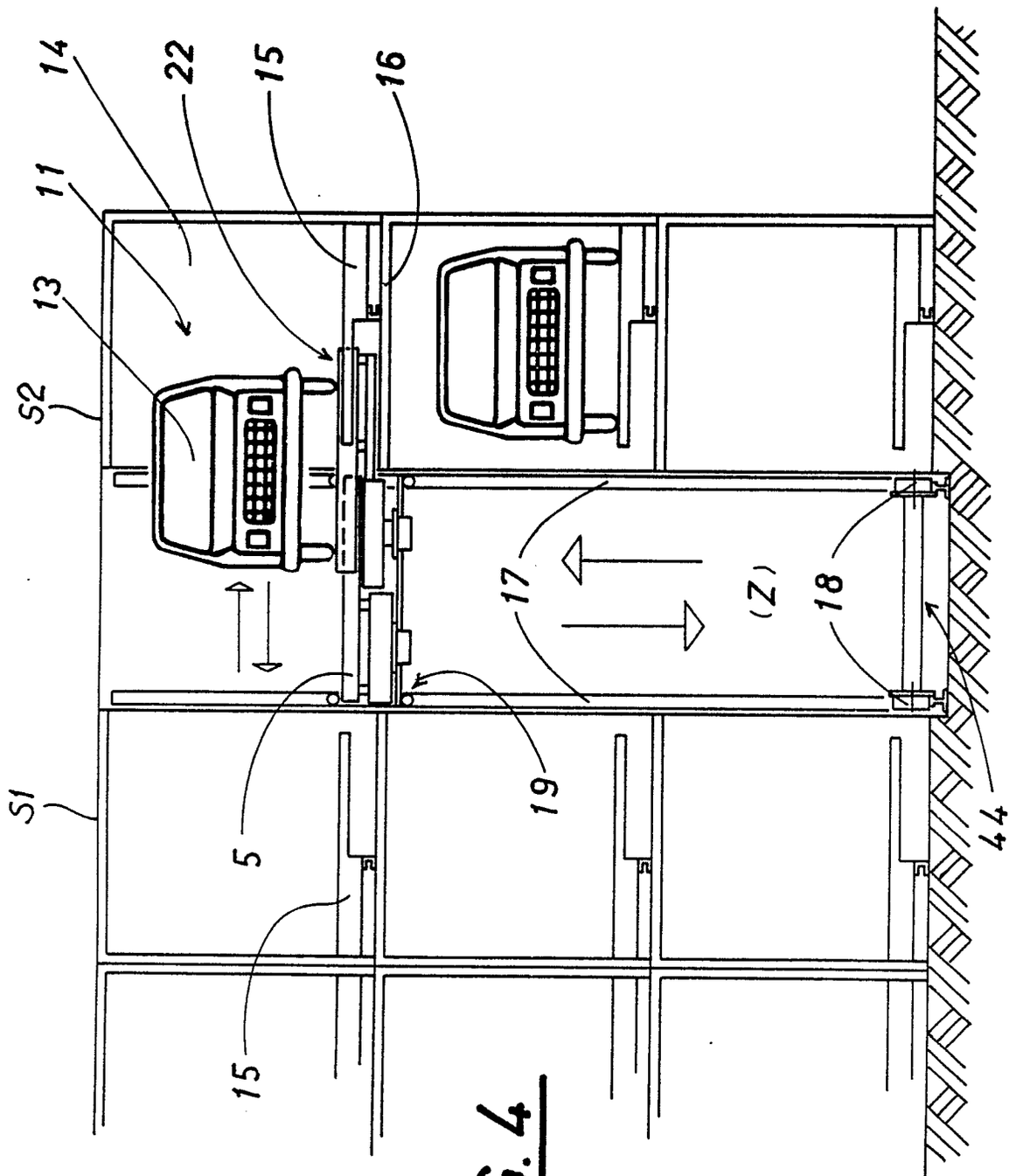


FIG. 4

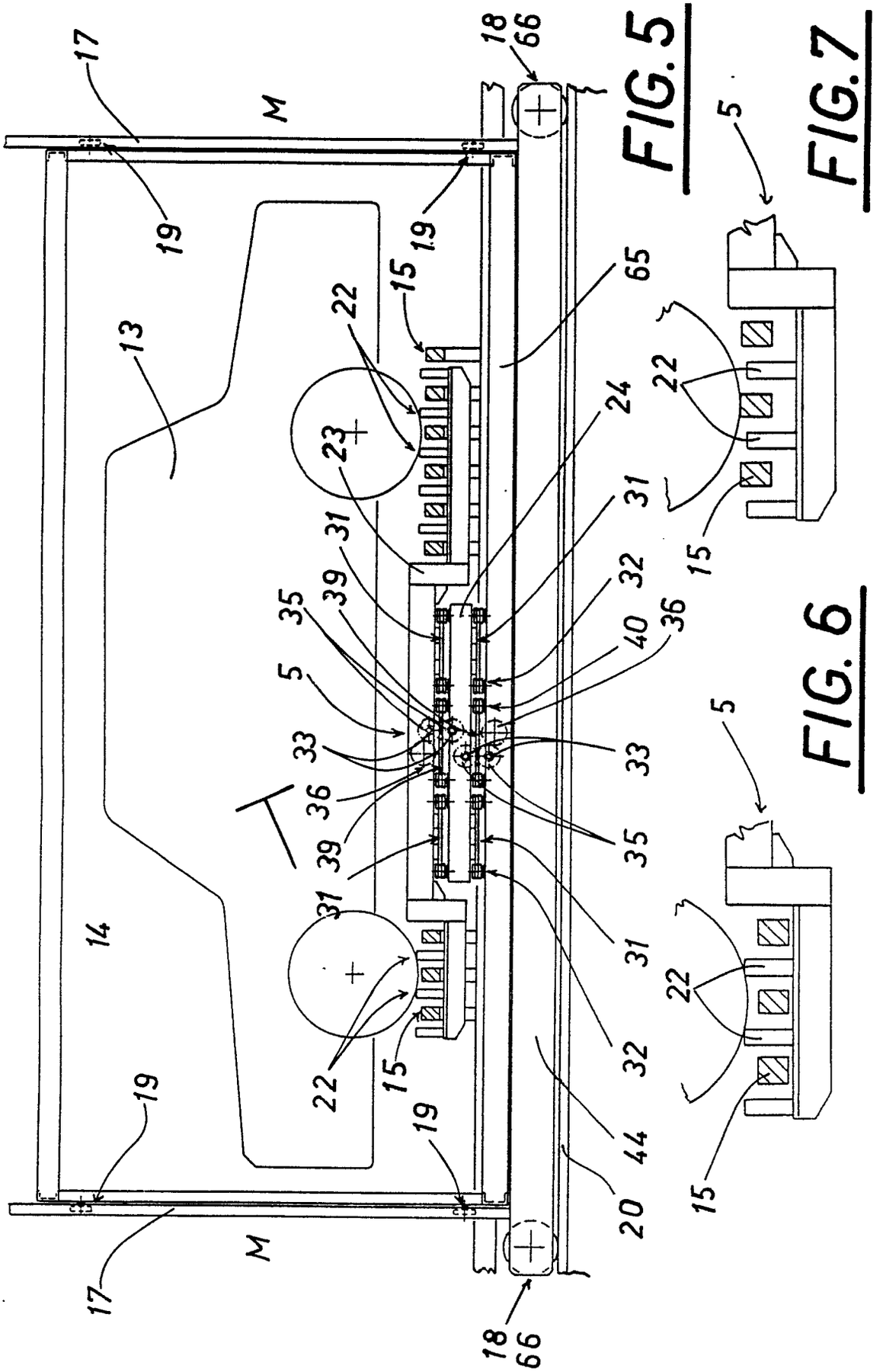


FIG. 5

FIG. 7

FIG. 6

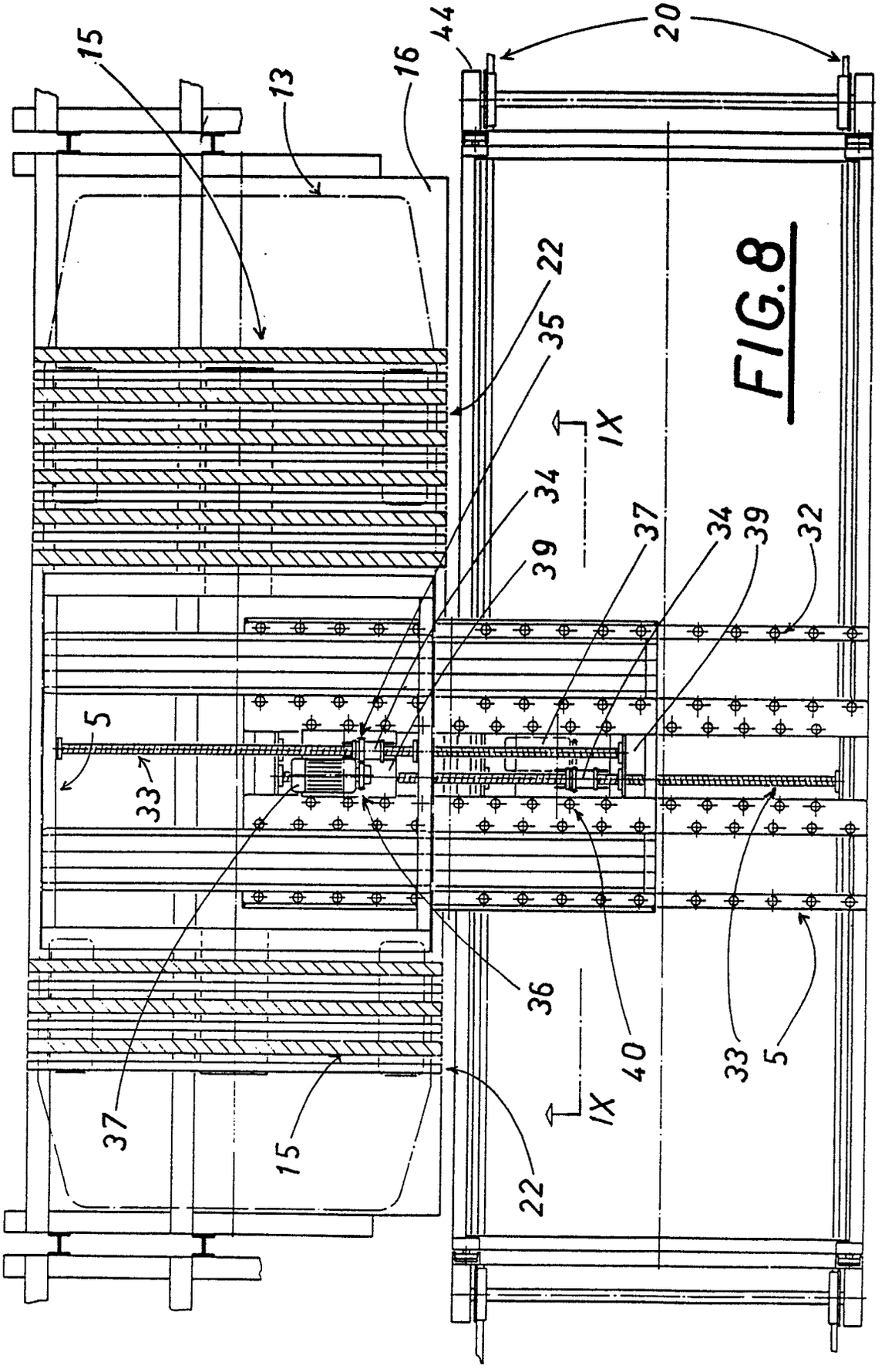


FIG.8

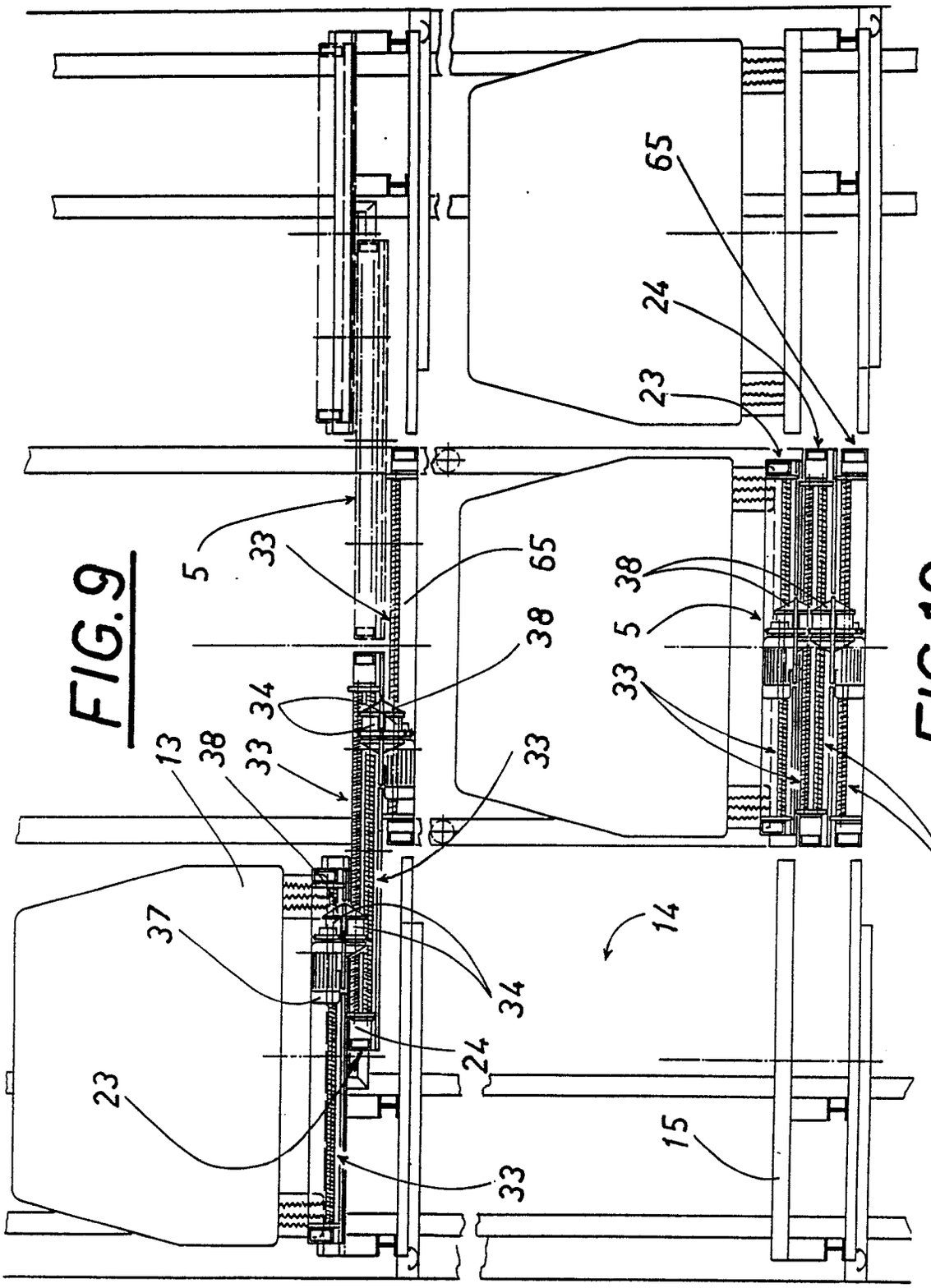


FIG.9

FIG.10

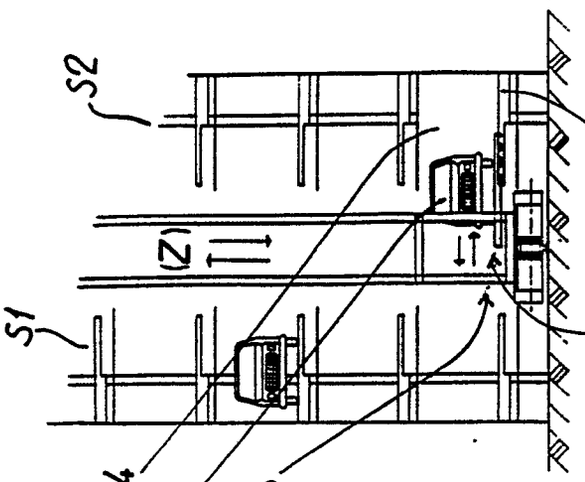


FIG.13

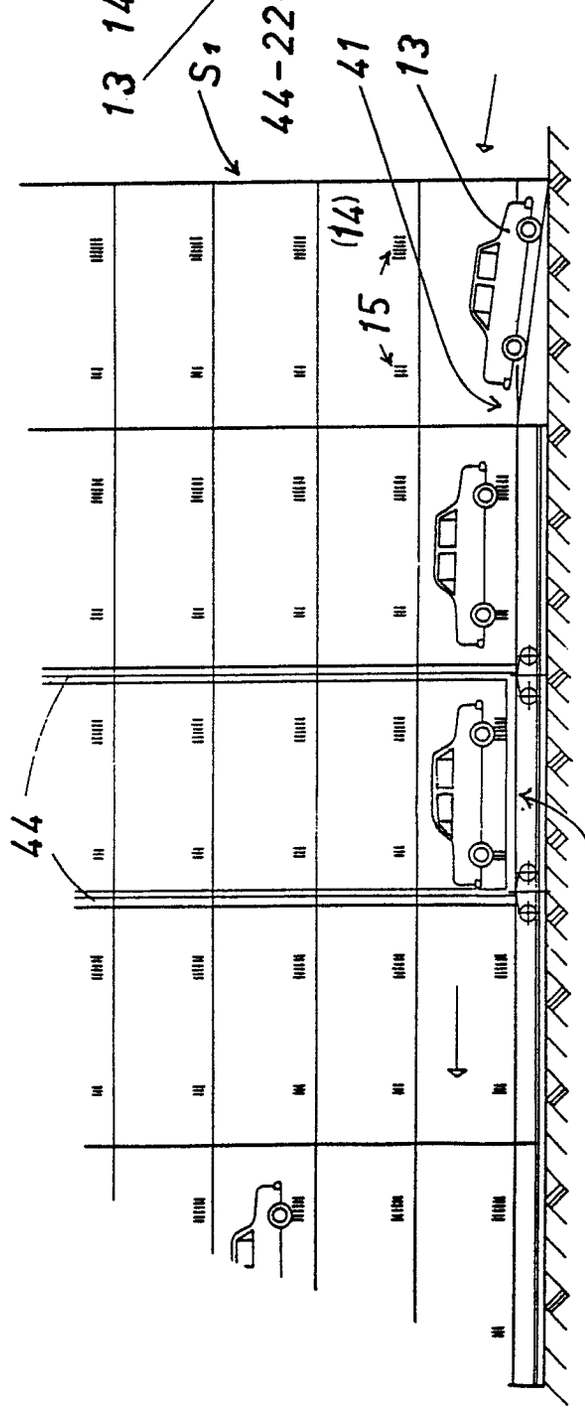


FIG.12

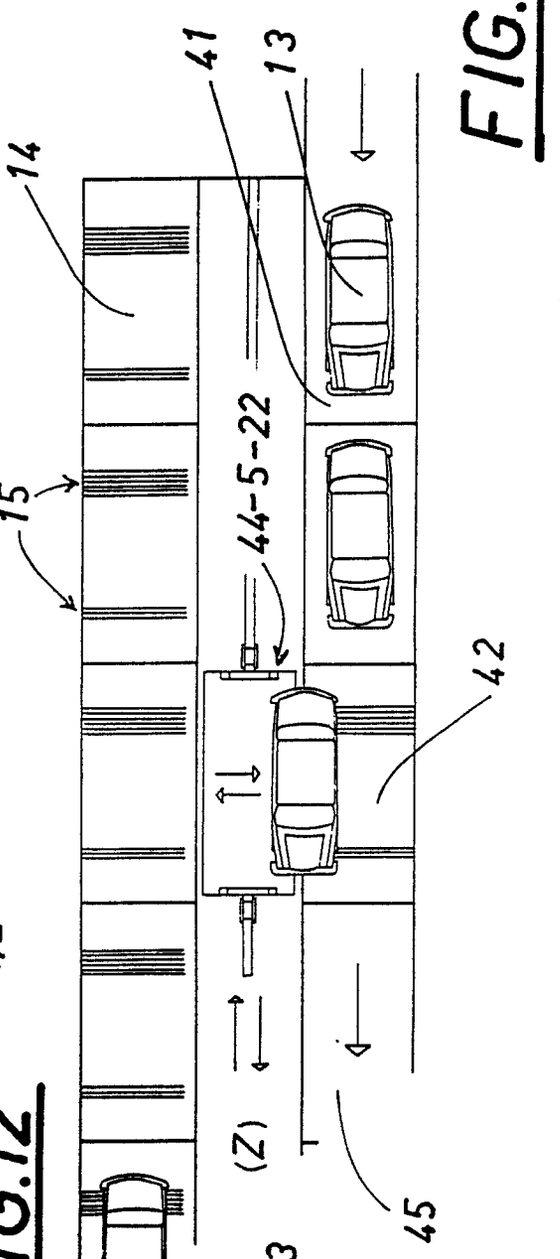


FIG.11

FIG.14

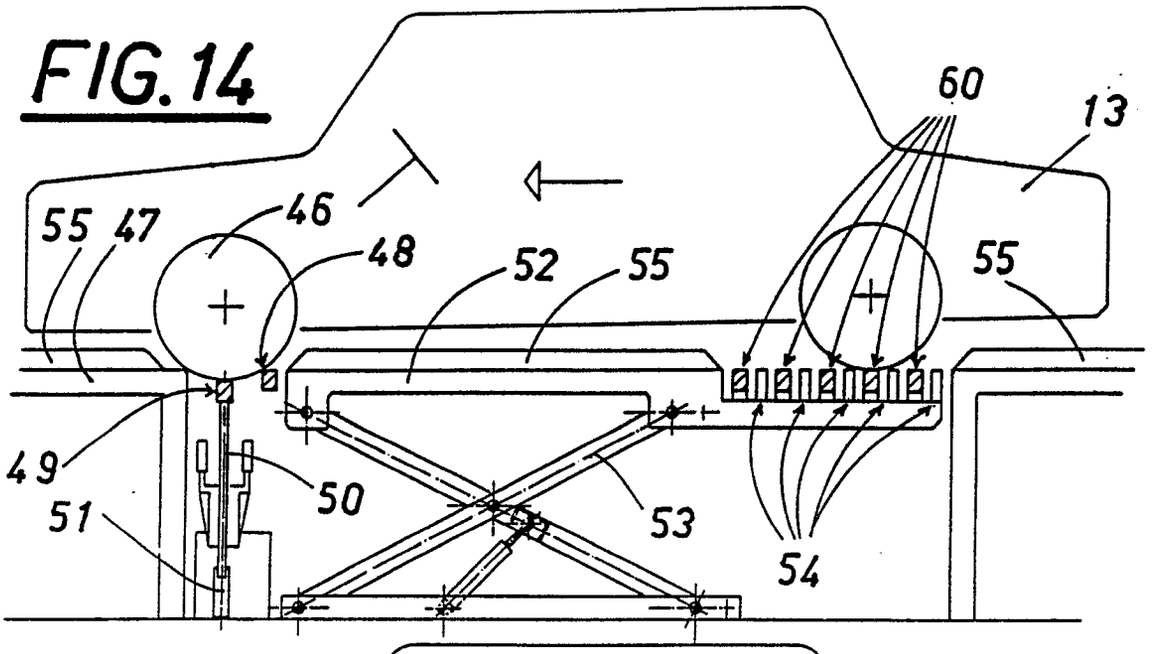


FIG.15

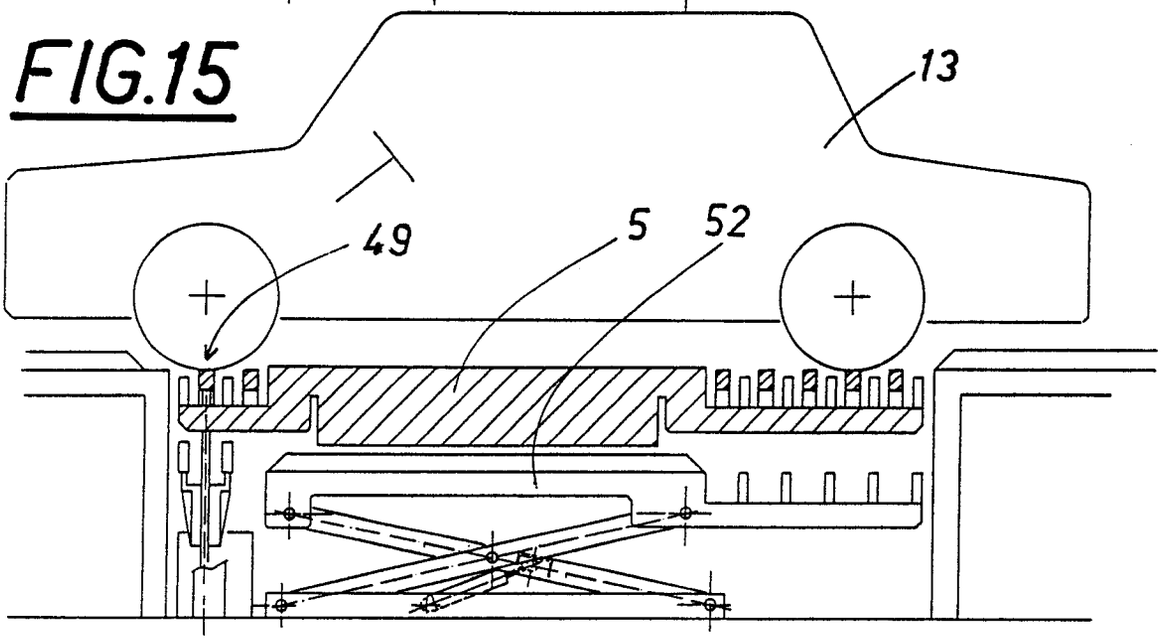
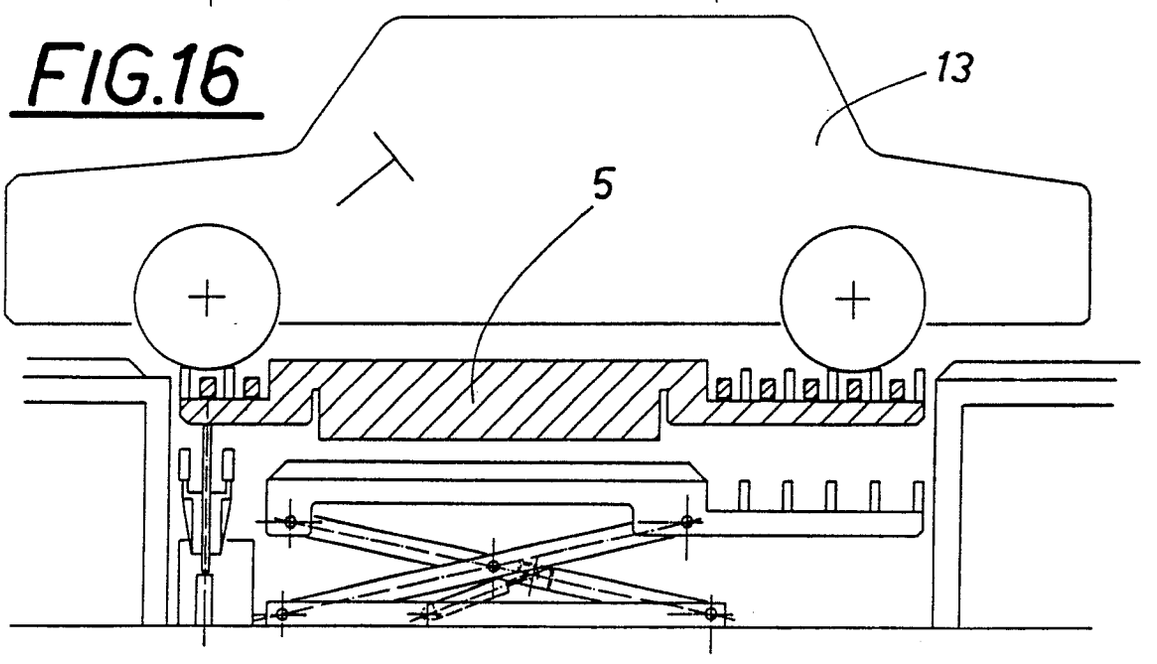


FIG.16



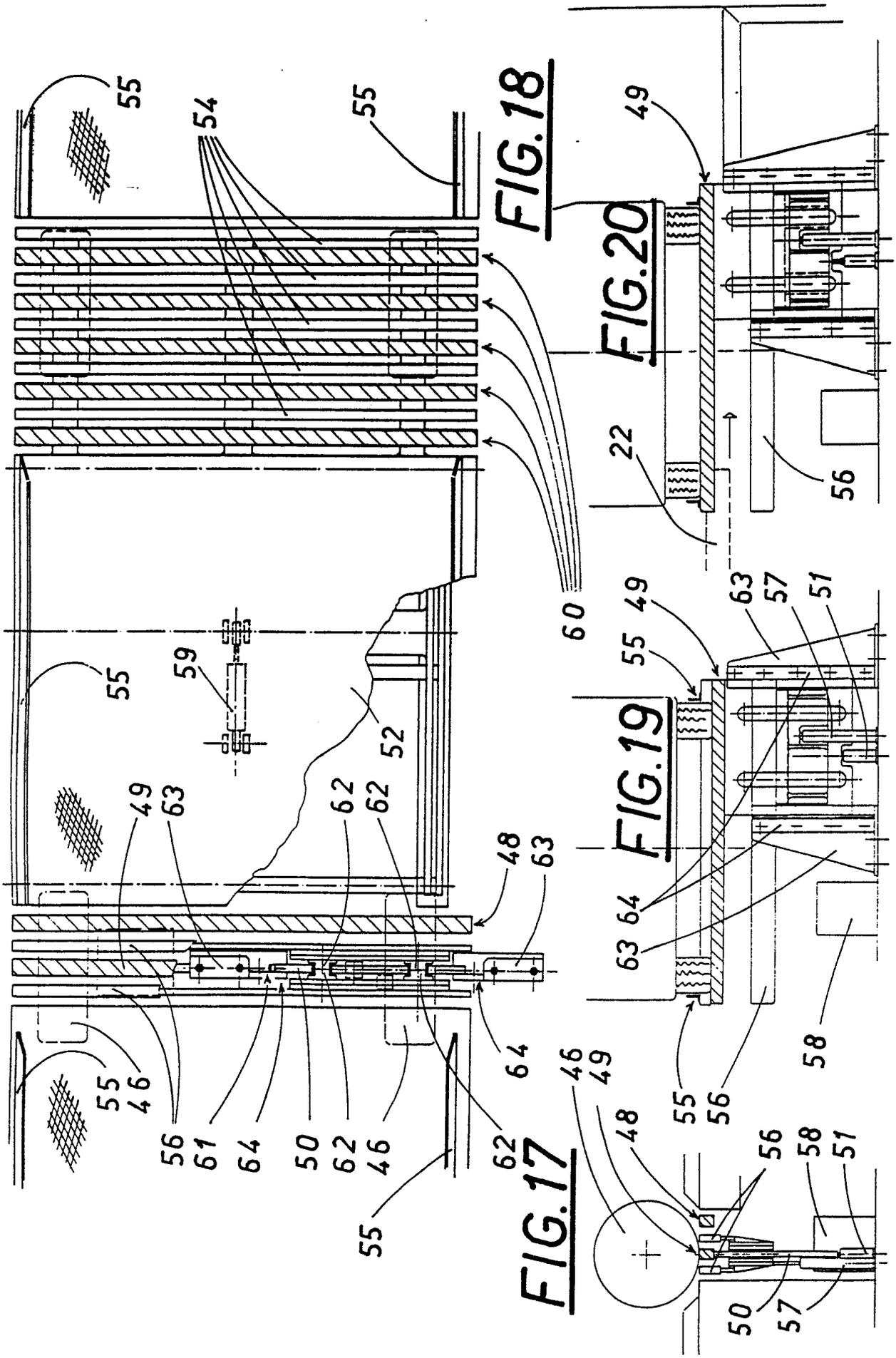

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FIG.17
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FIG.18
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FIG.20
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FIG.19
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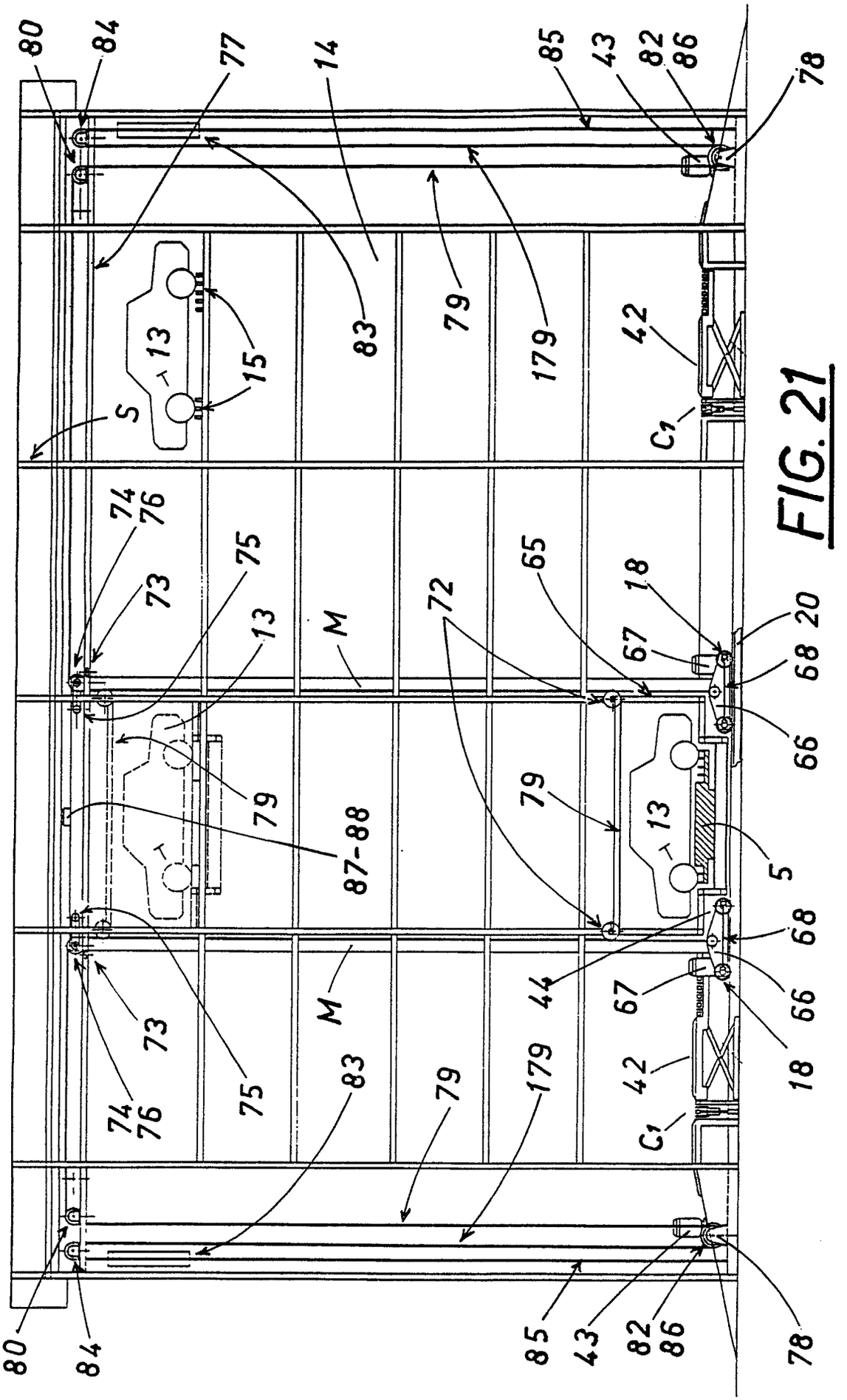
80
84
77
14
85
43
82
86
78
13
15
83
79
179
42
S
C1
74
76
73
75
13
M
72
65
18
20
67
68
66
79
87-88
5
44
73
74
76
75
83
79
179
42
C1
18
66
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82
86
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80
84

FIG. 21

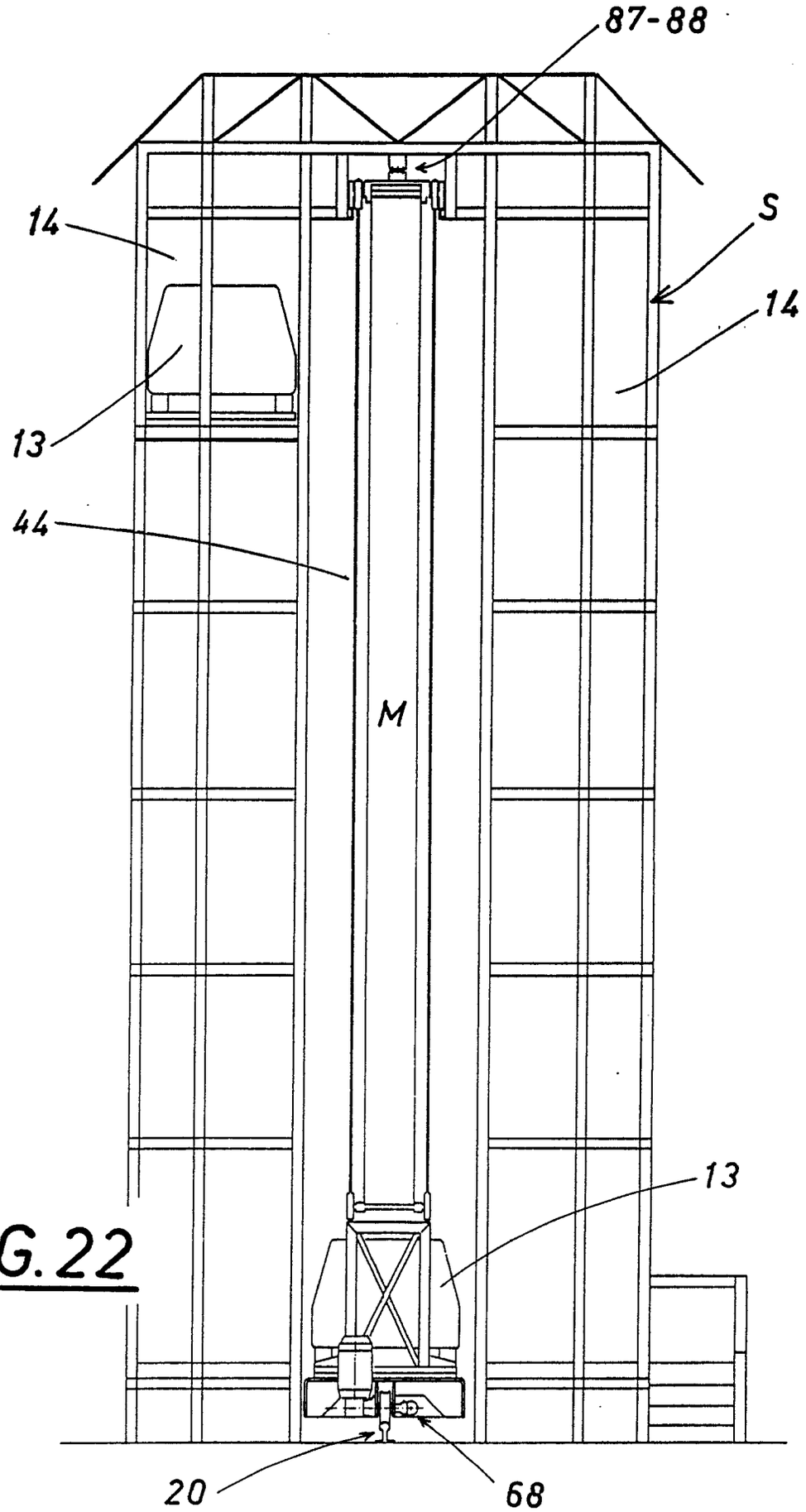

FIG. 22

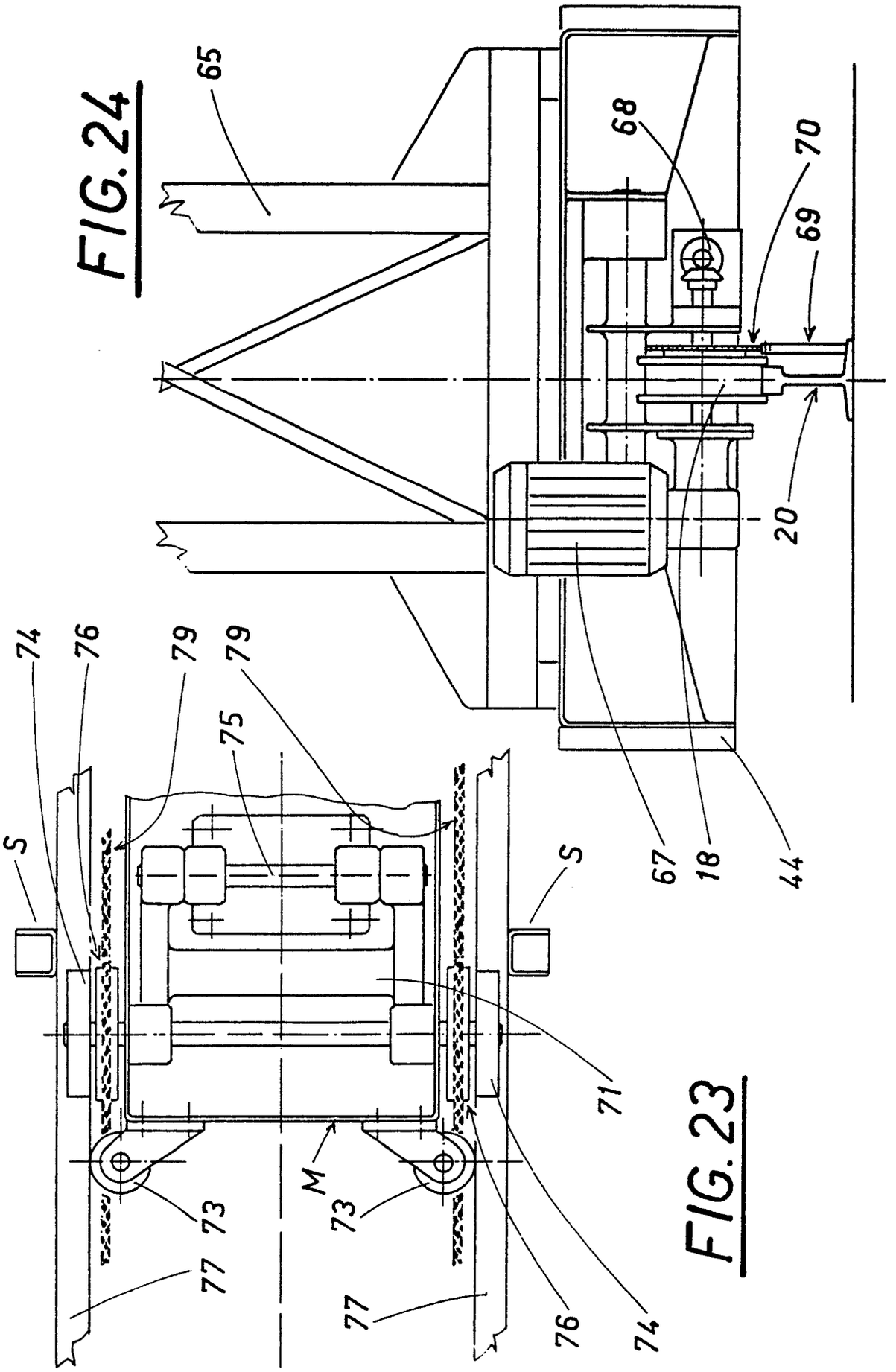

FIG.24

FIG.23

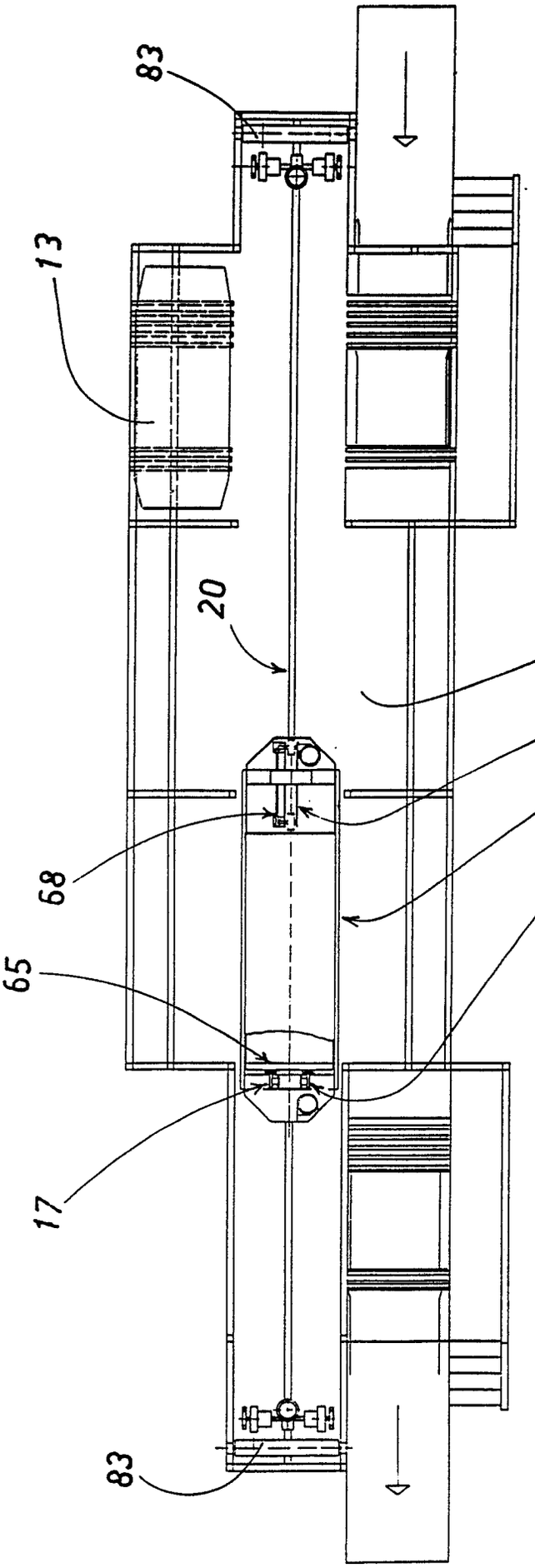

FIG. 25

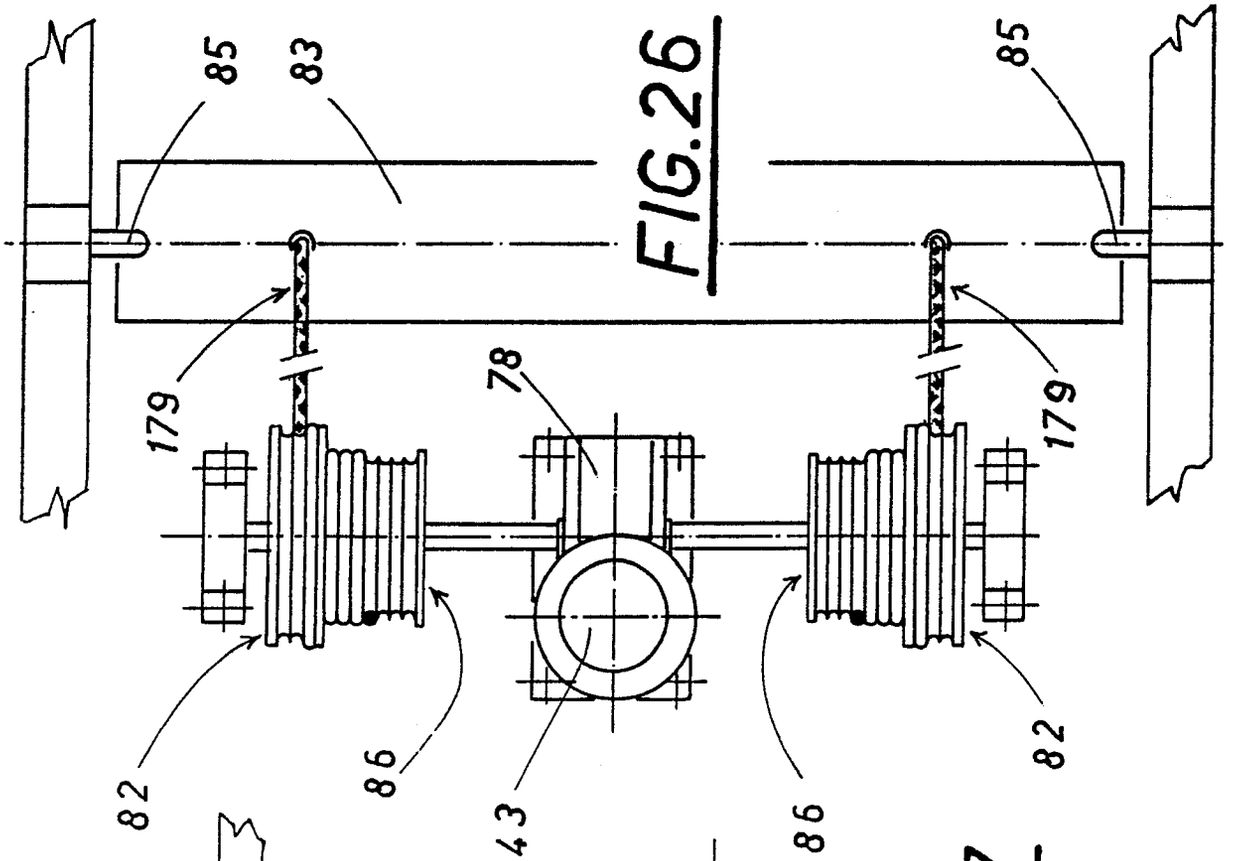

FIG.26

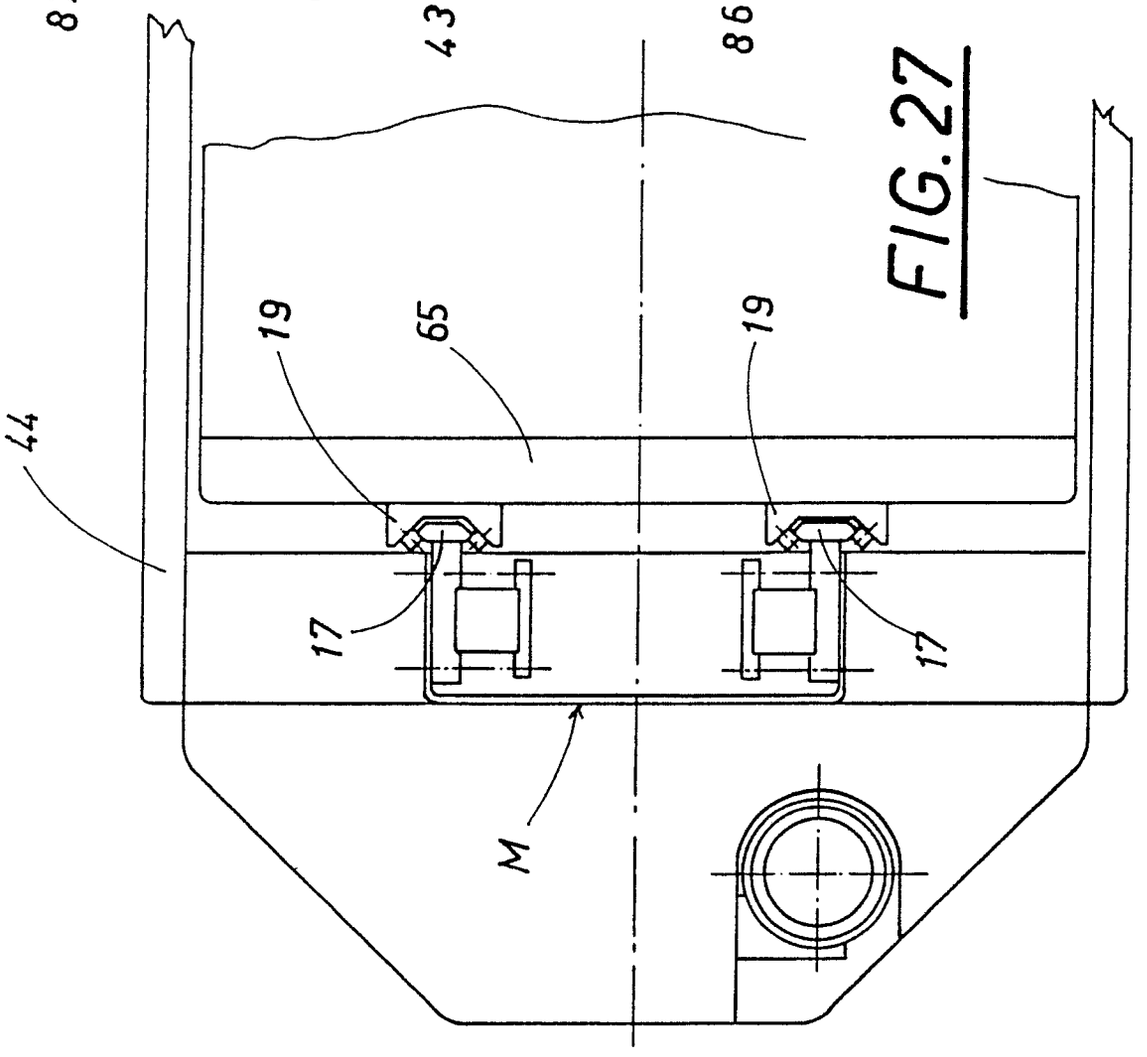

FIG.27

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 88 10 0019

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	DE-B-1 068 882 (MIHAI ALIMANESTIANO et al.) * Whole document *	1,2,4	E 04 H 6/24
A	---	5,8-12	
A	DE-A-1 937 994 (MOTOPARKS LTD) * Page 5, paragraph 3 - page 9, paragraph 2; figures 1,2 * ---	1,2,4,5,9	
A	US-A-3 497 087 (VITA) * Column 9, line 13 - column 10, line 62; figures 1-6 * -----	1,2	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

E 04 H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21-03-1988	CLASING M.F.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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