United States Patent

[11] **3,631,806**

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[33] **France**
[31] **142921**

[54] **CONVEYOR SYSTEM FOR THE INDIVIDUAL TRANSPORT OF VARIOUS OBJECTS**
56 Claims, 20 Drawing Figs.

[52] **U.S. Cl.** ..... **104/89,** 104/148 MS, 104/23 FS, 104/96, 105/150
[51] **Int. Cl.** **B60v 1/02,** B60v 3/04, B61b 13/08
[50] **Field of Search** ..... 104/23, 89, 91, 96; 105/148, 149, 150; 214/1 BS

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Primary Examiner—Arthur L. La Point
Assistant Examiner—Robert Saifer
Attorney—Young & Thompson

ABSTRACT: A conveyor system comprising a track and a row of transporter elements movable along this track and guided by it, each of these movable transporter elements comprising means of guidance with respect to the track and a device permitting a detachable connection with an object to be transported. Each transporter element is mounted to slide along the track, it comprises means cooperating with other means carried by the track to ensure the support by relative attraction to the latter. The device for detachable connection between the transporter element and the object comprises means ensuring a mutual attraction between them.

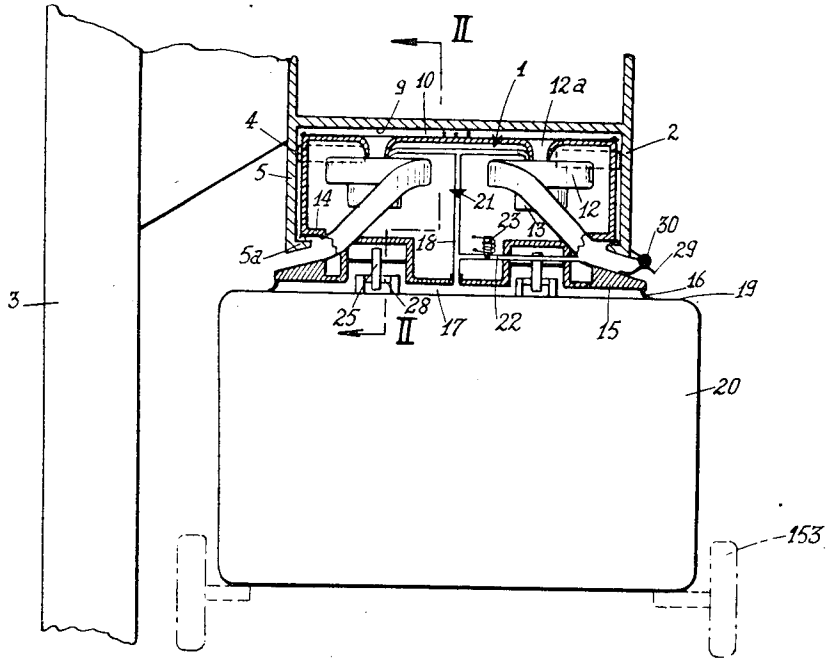

Fig.1

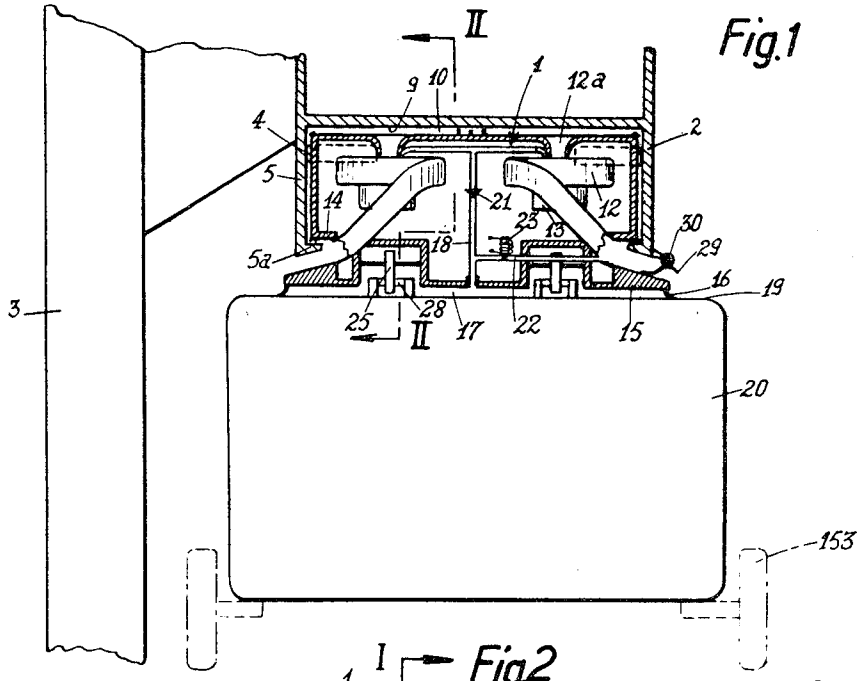

Fig.2

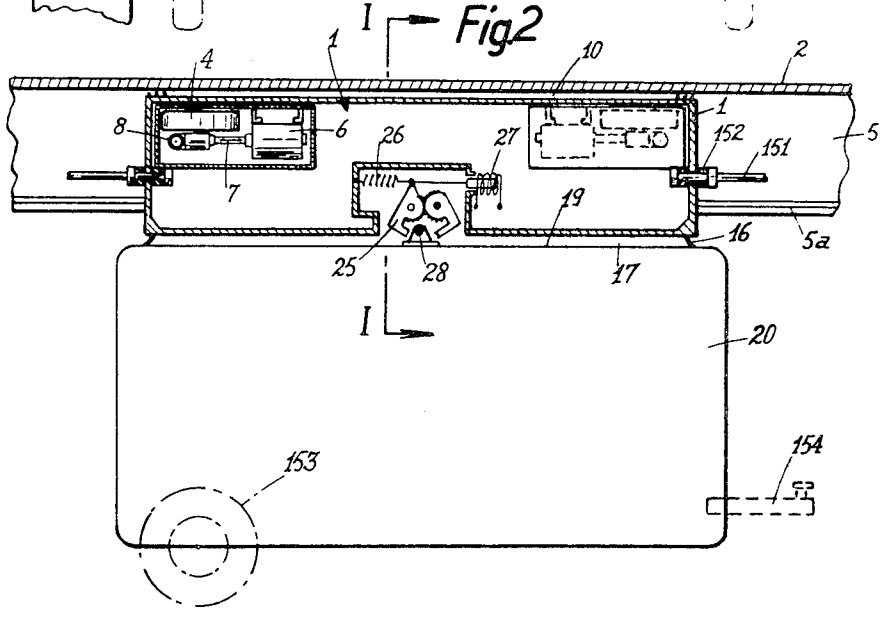

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Fig.3

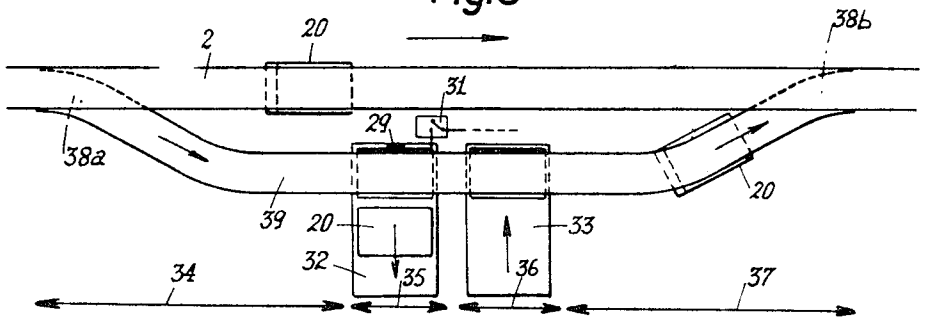

Fig.4

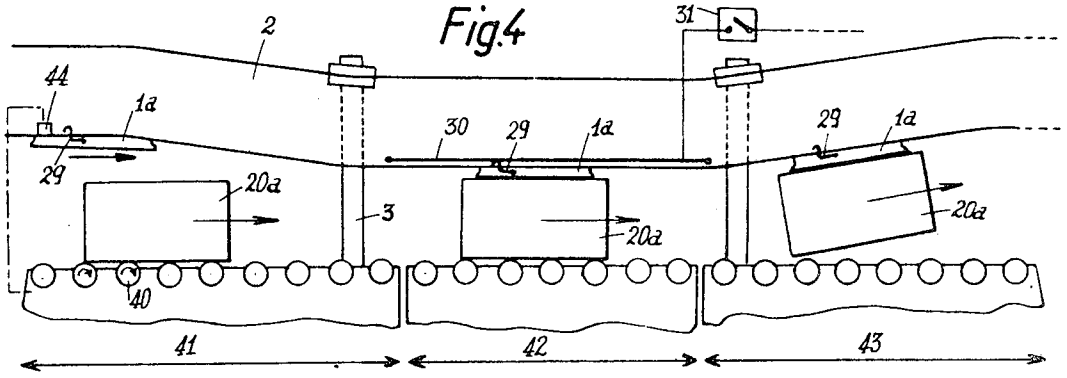

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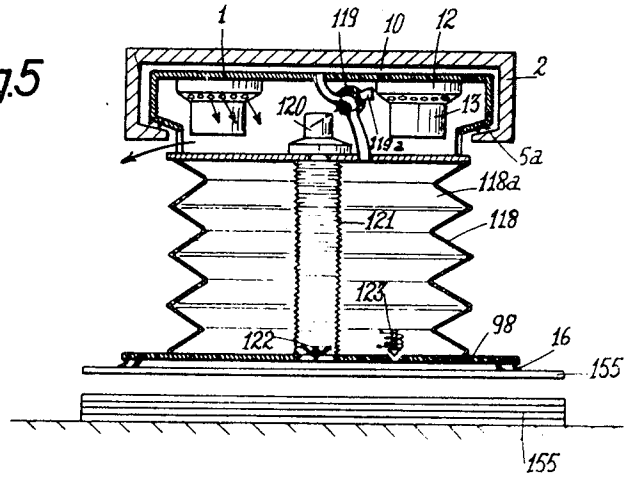
Fig.5



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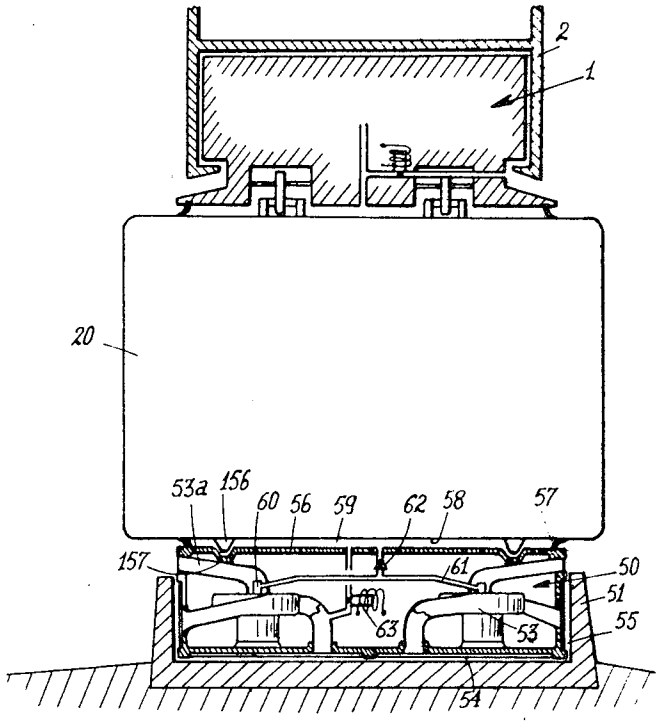

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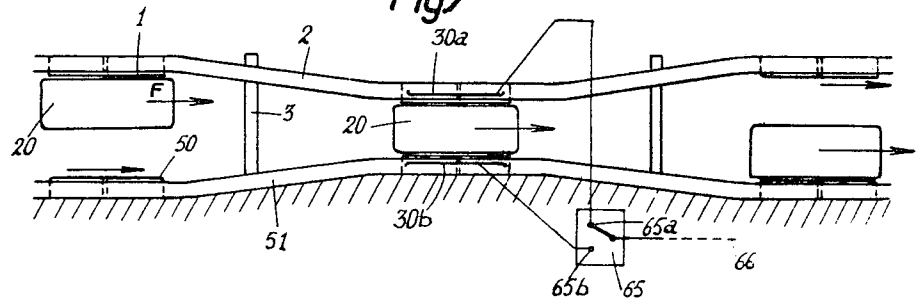
Fig.7



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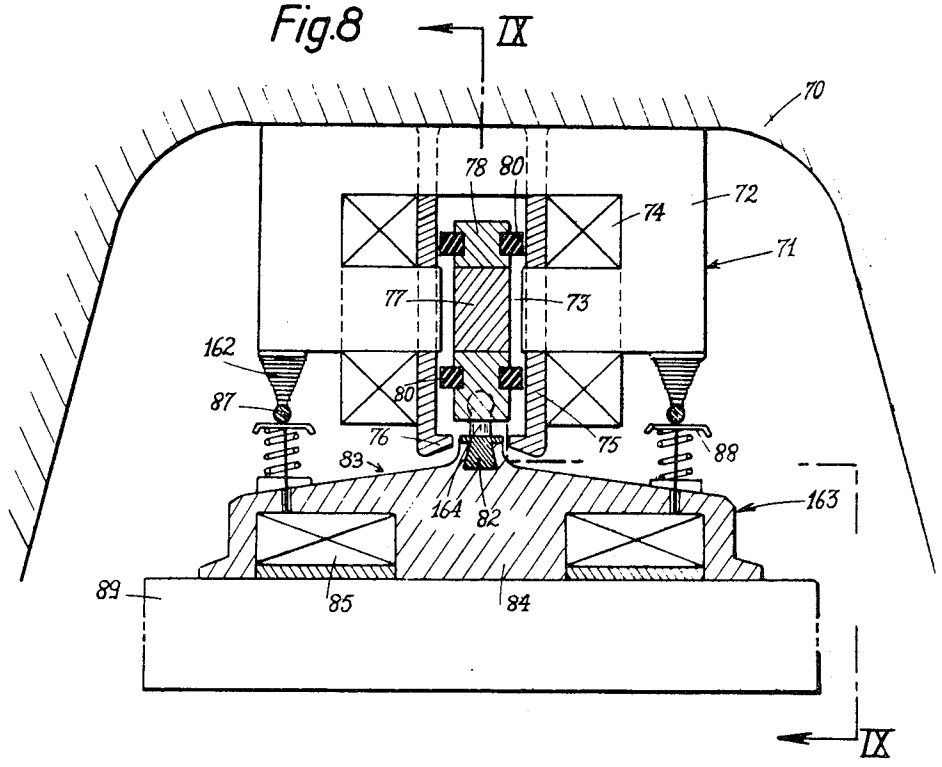

Fig.9

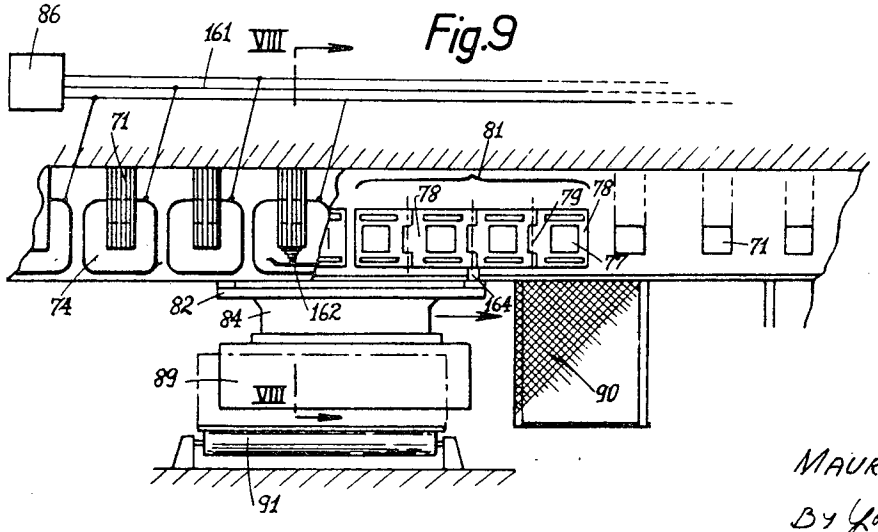

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Fig.10

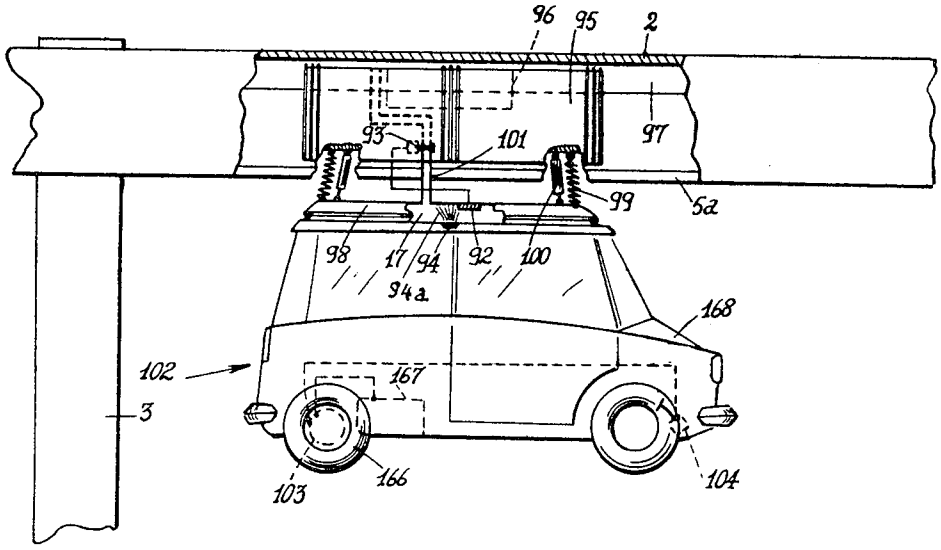
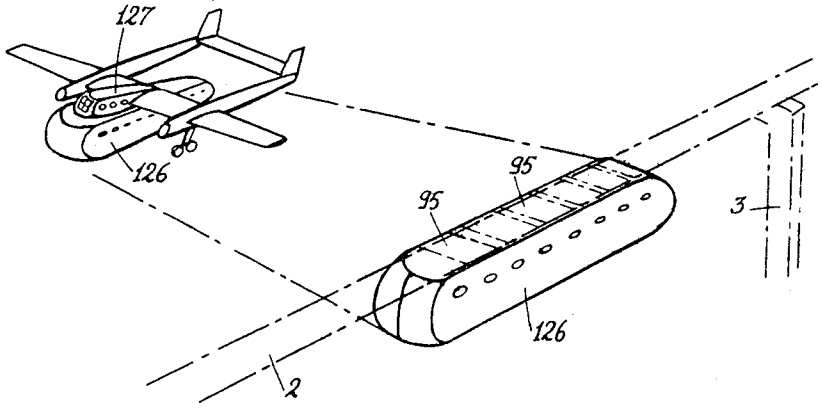


Fig.14



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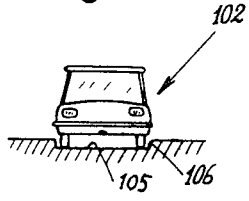

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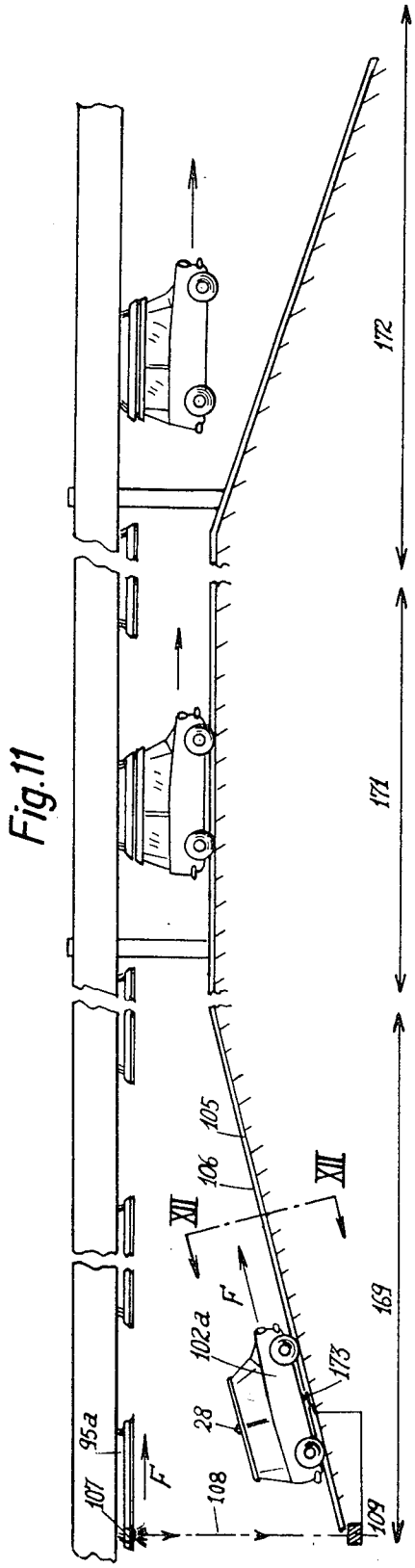

Fig.11

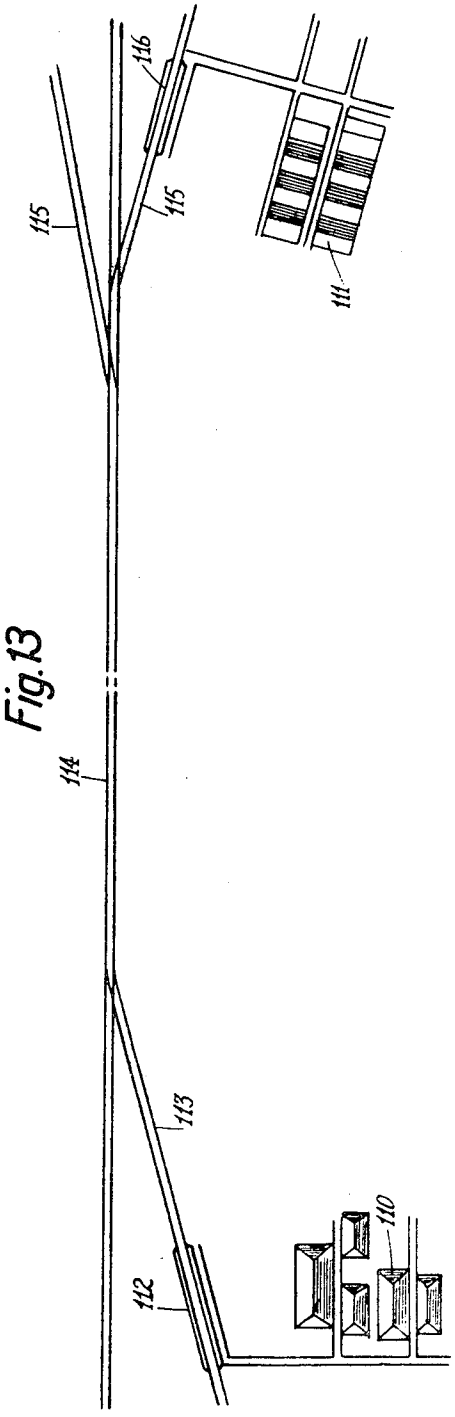

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Fig. 17

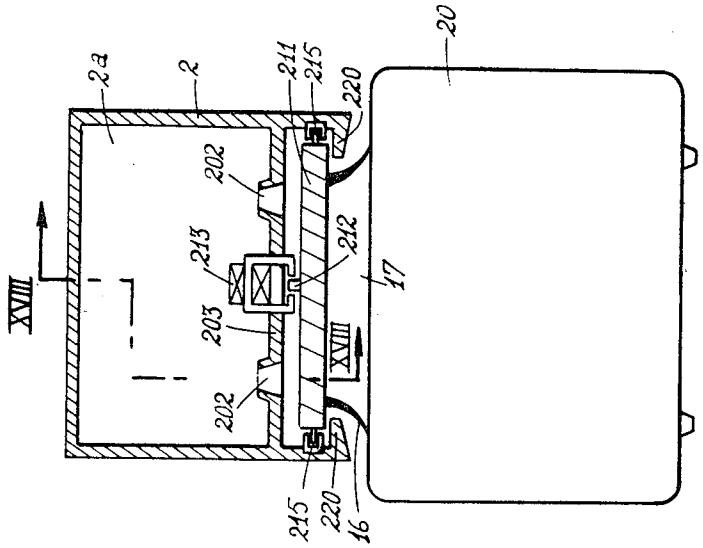
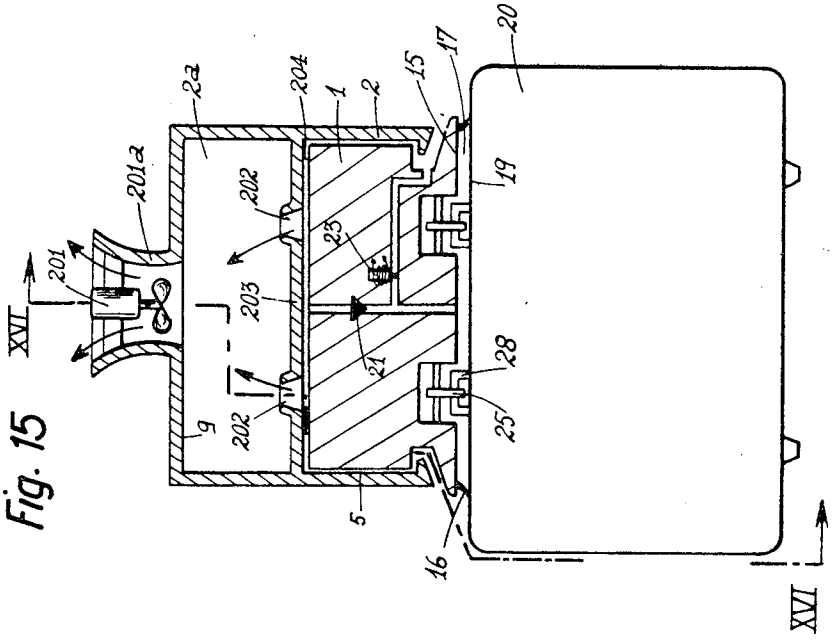


Fig. 15



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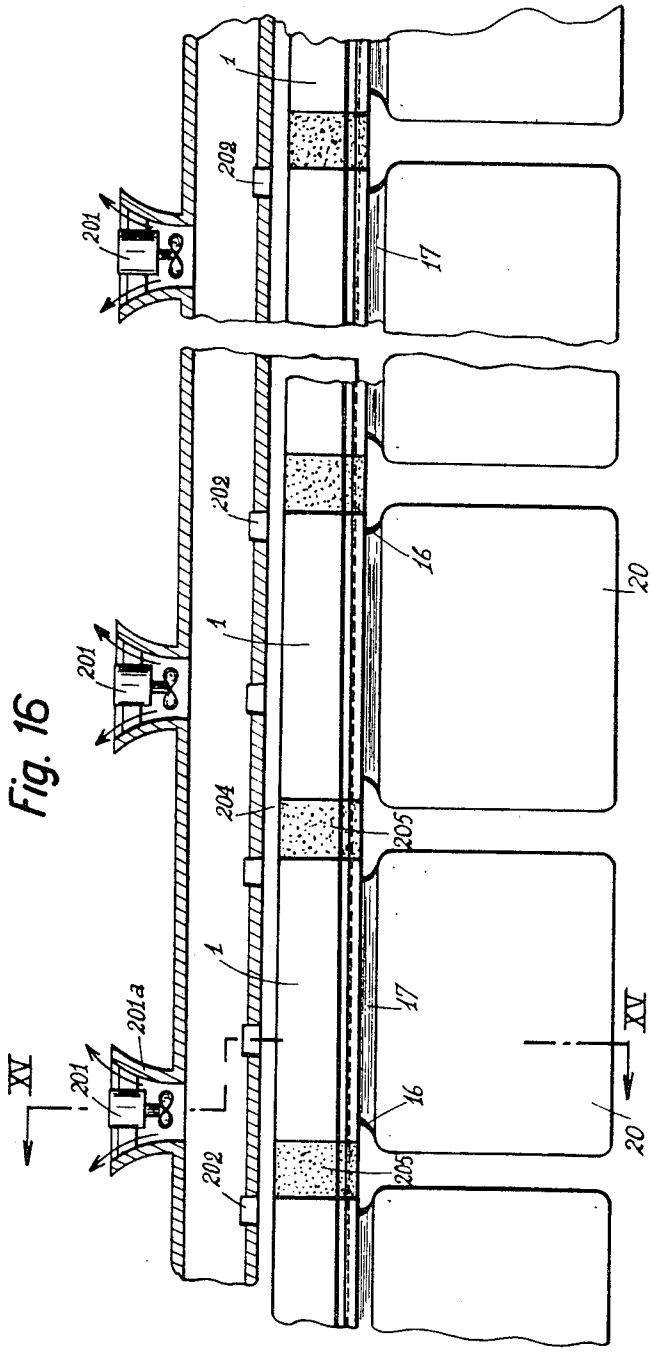

Fig. 16

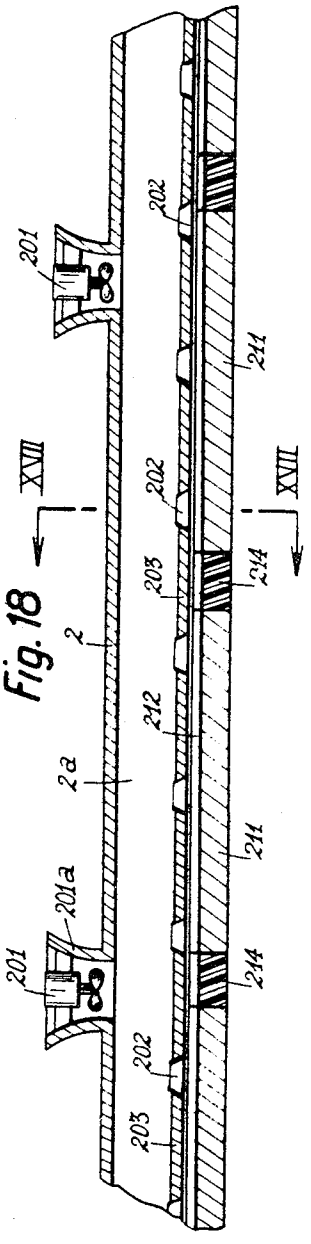

Fig. 18

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Fig. 19

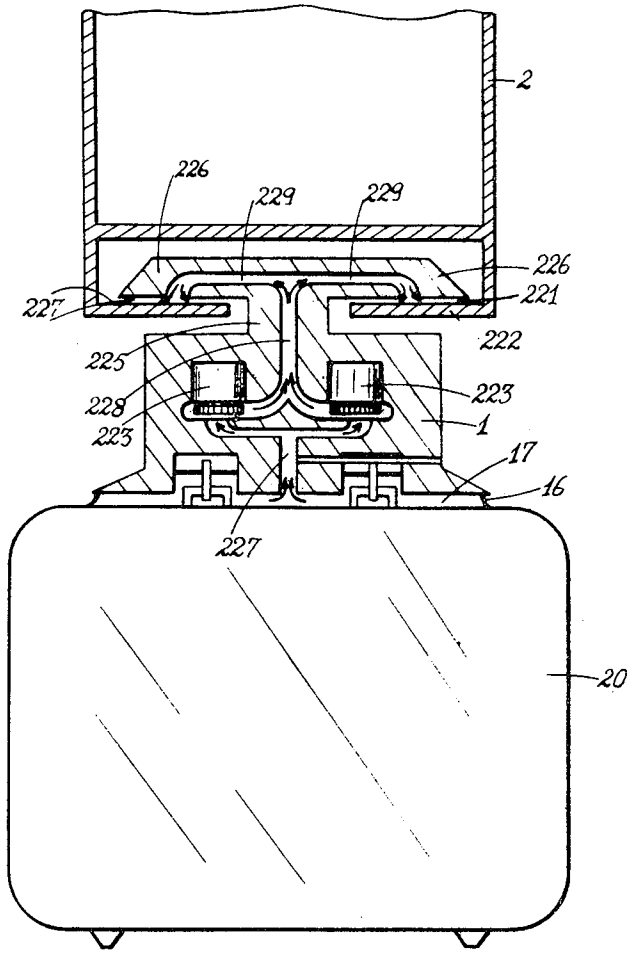
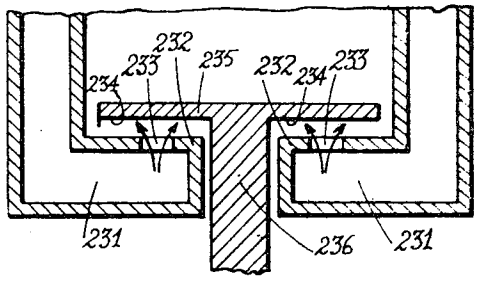


Fig. 20



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CONVEYOR SYSTEM FOR THE INDIVIDUAL TRANSPORT OF VARIOUS OBJECTS

The present invention concerns a conveyor system comprising at least one substantially continuous beam acting as a track and at least one row of mobile transporter elements along this track each equipped with liaison means, and propulsion means. Each of the transporter elements permits the transport of any object, such as an automobile vehicle.

The particularly advantageous properties of the conveyor system according to the invention, notably its simplicity of installation, its characteristics of picking up objects to be transported and of integrating these objects into the general movement of the conveyor, permit handling systems to be realized for industrial premises or for passage over rivers. But the invention may equally well be used to improve the flow through tunnels, under mountains or estuaries, and also for the realization of educational toys.

According to a preferred field of application of the invention, the conveyor system is more especially intended to constitute an integrated system of urban public transport for individual vehicles.

Chain conveyors are already known, comprising carriages mechanically attached to a chain, carrying the objects transported, but as these latter are simply placed on these carriages, or on pans suspended from them, there is a risk of them being displaced and falling off. Furthermore the chains give rise to frequent troubles and the absence of a springing system between the object and the transporter causes direct transmission to the object of shocks arising from the operation of the conveyor, which, in particular, excludes movement at high speed.

These conveyors can be improved by equipping the carriages with a mechanical or pneumatic system of picking up the objects but this has a tendency to complicate the installation and to make it heavier, while reducing its reliability. Furthermore the shocks arising during the picking up of the object by the carriage attached to the chain, or by friction on the track are appreciable.

Handling or public transport systems are already known which comprise vehicles guided or propelled by devices bringing into play gaseous, liquid, or magnetic means (Bertin, Hovercraft, Barthalon, Polygreen). In these systems the guided vehicles are permanently attached to the track.

Such systems of public transport have difficulty in attracting users of private cars, permitting transport from door-to-door, because such users are used to the comfort, the privacy, the absence of scrimmage and waiting, to the protection against bad weather, and to transport without breakdown and delay which is provided by an individual vehicle.

Also proposed are systems of public transport intended for the transportation of motor cars or specialized vehicles, but the arrangements proposed do not permit rapid picking up of the vehicle by the transporter, nor its easy insertion into the flow on the main track, comfortable springing during the journey or rapid discharge without slowing down the transporter.

The conveyor system according to the invention is intended to remedy the above-mentioned difficulties, especially due to the use of transporter elements of a particular kind so as to obtain a conveyor of high speed and high flow, ensuring the pickup, the transport and the discharge without shock of objects between at least two places connected by the track.

The invention is also intended to avoid slowing down and stopping during normal transport, loss of time due to breakdowns, noise and atmospheric pollution in urban zones.

Another object of the invention is to combine the advantages of independence and handiness of individual vehicles guided along a special track.

According to the invention, the conveyor system, which comprises a track and a row of mobile transporter elements movable along and guided by said track, said transporter elements comprising means to ensure a detachable connection with objects to be transported, is characterized in that it comprises means to ensure lifting and sliding of said transporter elements respectively to said track, said means comprising two walls facing each other and separated by a gaseous medium, said walls being attached to said track and each transporter element respectively, and means to ensure interaction between said walls to develop a lifting force.

The lifting of the transporter elements and their sliding along the track with a very weak friction, together with the detachable connection with the object to be transported result, as will be seen hereinbelow, in a very great operational flexibility, in particular permitting connection between the object to be transported and the associated transporter element while they are moving.

According to a first type of embodiment, the lifting and sliding means of the transporter elements relative to the track are constituted by gas cushions interposed between said elements and the track, these cushions being brought to a pressure which is lower, or, on the contrary, higher, than that in the environment.

According to another embodiment, the lifting and sliding means of the transporter elements relative to the track are magnetic in nature.

In both types of embodiments, the track and the transporter elements are adapted to permit interaction between some of their walls while permitting the displacement of the transporter elements along the track.

According to an advantageous embodiment of the invention, the device for detachable connection between the transporter element and the object to be transported comprises means to ensure a mutual attraction between the latter. Preferably, when the dynamic lifting means (e.g., vacuum or compressed air generators, magnetic flux generators) of the transporter elements are carried by the latter, the means to ensure mutual attraction of the transporter element and the object to be transported are of the same nature, which results in saving means on the transporter elements.

Preferably the transporter elements, mounted to slide along the track, are guided laterally along it by pneumatic or magnetic means.

The absence of maintenance and the reliability due to the connection by attraction according to a predetermined law of force, are major advantages in a conveyor of high flow.

According to an advantageous realization of the invention pickup means, more particularly mechanical and capable of ensuring a rigid safety connection, are provided between the transporter element and the object, other than the means of attraction stated above.

The attraction to and the picking up of the object by the transporter element facilitates the separation between the object and its initial support. Furthermore this arrangement constitutes a reliable connection between the object and the transporter element during the run. At the end of the run it permits an easy discharge of the object.

The connection by pneumatic or magnetic attraction between the track and the transporter element, without contact force, and the low inertia of the transporter element permit the picking up of the object to be achieved without appreciable shock.

In an advantageous realization, the conveyor comprises an arrangement for the displacement and bringing up to speed of the object prior to its being picked up by the slide. Bringing the object up to speed avoids any slowing down in the flow of transporter elements on the main track of the conveyor. The conveyor can thus provide a considerable flow.

According to an advantageous realization, a conveyor comprises a device for bringing the transporter elements and the objects into their correct relative positions during the acceleration. The conveyor also comprises devices for guiding the object, which imposes on it a trajectory which progressively approaches the track along which the transporter elements circulate. This allows the progressive insertion of one object between the neighboring objects already being transported by the conveyor, and the bringing into action of the picking up organs at the moment when a transporter element and an ob-

ject are in the correct relationship as to speed and position, the transporter element being vertically above the object.

The object to be transported is preferably suspended from the transporter element, this providing an inherently stable system, the center of gravity of the whole being below the center of support.

According to another advantageous aspect of the invention, it is intended that the upper and the lower faces of the object should have specialized functions: the upper face cooperates with the transporter element to constitute a part of the connecting means with the transporter element at high speed, while the lower face of the object carries means for movement relative to the ground, such as wheels, tracks, rollers, moving belts and air cushions, which facilitate low speed, self-propelled movement at the ends of the conveyor. It is also possible to achieve rapid and comfortable "door-to-door" transport with vehicles which are simple and of inexpensive construction.

According to an improved embodiment, which is notably intended to improve the reliability of the transporter elements by sizeably simplifying the construction thereof, the guiding and sliding means of the transporter elements with respect to the track comprises a collector secured to the track and having orifices to connect it to the track, and air turbines carried by the track to maintain said collector to a pressure which is different from the atmospheric pressure. The transporter elements thus do not carry any lifting dynamic device.

According to a particular improved version, the conveyor is characterized in that the track is located above the transporter elements and comprises enveloping flanges reaching below the edges of said transporter elements, and in that it comprises means to create fluid cushions at a pressure above atmospheric between said flanges and the lower faces of the transporter elements.

Other characteristics of the invention will become clear or will arise from the following description in which are successively described the utilization of the pneumatic attraction means and of the magnetic attraction means to achieve the detachable connections between the three principal parts of the conveyor; the track, the transporter element, and the object transported.

In the attached drawings, given as nonlimitative examples:

FIG. 1 represents a transverse section on I—I of FIG. 2 of a first embodiment of the invention for transporting containers.

FIG. 2 is a longitudinal section on II—II of FIG. 1.

FIGS. 3 and 4 represent schematically and on a small scale devices for the loading or the discharge of the containers by the conveyor.

FIG. 5 represents a transverse section of a variant intended for the handling of sheets.

FIG. 6 represents a transverse section of a variant of the conveyor for containers.

FIG. 7 represents a switching arrangement in the vertical plane.

FIG. 8 shows a transverse section on VIII—VIII of FIG. 9 of a conveyor utilizing magnetic attraction.

FIG. 9 is a longitudinal part section on IX—IX of FIG. 8.

FIG. 10 is a side view with cutaways of a conveyor for town cars.

FIG. 11 represents schematically the arrangement for loading the conveyor shown in FIG. 10.

FIG. 12 is a section on XII—XII of FIG. 11.

FIG. 13 is a diagram of the installation of the conveyor for town cars.

FIG. 14 shows a scheme in perspective of another variant of the conveyor for the transport of aircraft cells.

FIG. 15 is a transverse section, on XV—XV of FIG. 16, of another embodiment of the invention.

FIG. 16 is a longitudinal section, on a smaller scale, on XVI—XVI of FIG. 15.

FIG. 17 is a transverse section, on XVII—XVII of FIG. 18, of an improved version of the embodiment shown in FIG. 15–16.

FIG. 18 is a smaller scale longitudinal section on XVIII—XVIII of FIG. 17.

FIG. 19 is a transversal section of another version of the embodiment shown in FIG. 6.

FIG. 20 is a partial schematic section of another version of the embodiment shown in FIG. 6.

The first industrial embodiment represented on FIGS. 1 to 4 concerns a conveyor for containers. In this embodiment, there is a row of mobile transporter elements formed by slide blocks 1 mounted to slide along a track 2 of profiled box-girder-type supported by spaced-apart posts 3. The suspended track thus formed avoids intersections with other roads or tracks at ground level.

The slide block 1 is supported under the horizontal face 9 of the beam 2 by lifting chambers 10 of a type already known, which are subjected to a subatmospheric pressure by means of conduits 12*a* and air extractor fans 12 driver by electric motors 13. The lower edges 14 of the slide block 1 cooperate with the interior flanges 5*a* of the side faces 5 of the beam 2 to control automatically the lifting pressure and to act as a safety device in case the extractors 12 cease to function.

The objects to be transported are in this case containers 20 of a standardized type having a flat roof and rounded corners.

On the lower face 15 of the slide block 1 is attached at least one peripheral flexible lip 16 which defines, with the lower face 15 of the slide block 1 and the upper face 19 of the container 20, an enclosed chamber 17 forming a suction cup and constituting a detachable connection means between slide block 1 and container 20 by pneumatic attraction.

A conduit 18 connects the chamber 17 to the extractors 12, a nonreturn valve 21 prevents the chamber 17 becoming pressurized in the case of accidental stoppage of the extractors 12. A conduit 22 normally closed by an electromagnetic valve 23 allows the connection of chamber 17 to the atmosphere.

The safety and the mechanical retention of the containers 20 are ensured by hooks 25 which close automatically under the action of springs 26 on bars 28 attached to the roof 19 of the container 20. The release of the hooks 25 is electromagnetic and is effected by electromagnets 27 acting in opposition to the springs 26. Supply to the electromagnets 27 and the magnetic valve 23 is effected by a side pickup 29 attached to the slide block 1. At certain portions of the track 2 intended for the charging or discharging of containers 20, the pickup 29 comes in contact with a side catenary 30 carried by this beam (FIGS. 3 & 4).

Electrical supply to the catenary 30 is ensured by remote control by means of a contactor 31. This avoids any accidental supply to the electromagnetic valve 23 or the electromagnet 27.

The slide block 1 is a self-propelled and for this purpose includes under a casing four propulsion wheels 4 having a vertical axis and driven by universal joint shafts 7 from electric motors 6. The wheels 4 are pressed against the interior vertical faces 5 of the beam 2 by springs 8.

The electrical supply to the motors of the set of slide blocks of one conveyor system is from the beam 2 by means already known, including power modulation and speed control. Brakes are provided on the wheels 4.

If desired, the spacing between the slide blocks 1 can be carried out simply by coupling links 151 which include an elastic articulation 152. It would not go beyond the scope of the invention to specify mechanical, electrical or electronic spacing means. For example the motors 6 could be controlled by rheostats connected to the feed circuit and acted on by the coupling link 151.

During loading, when a slide block 1 has been positioned directly above a container 20, the lip 16 comes substantially into contact with the roof 19 of the container 20. The slide block 1 rests on the flanges 5*a* of the beam track 2 by means of its lower edge 14.

When the motors 13 and the extractors 12 are switched on, the pressure in the chambers 10 and 17 progressively decreases which slowly lifts the slide block 1 and the container

20 while at the same time binding them together. The bars 28 are automatically hooked between the safety hooks 25. Switching on the motors 6 starts the slide block 1 moving, without any friction.

It is thus possible to ensure economic transport at high speed. Handling times can be as low as possible, this handling being in any case entirely automatic.

The combination of the beam with the transporter elements by means of the intermediate fluid-lifting cushions makes possible very light and simple structures for the track and the slide block. Furthermore, the forces of connection with the track have no horizontal component. The combination of these means with an arrangement for the attraction and the pickup of the object, preferably by a fluid connections means, also facilitates the separation and picking up of the object without any shock and without stopping. Once the object is suspended under the slide block, the center of gravity is lower than the plane of support and the assembly is inherently stable.

It is understood, of course, that containers 20 can be equipped with rolling means 153 and drawbars 154, allowing their movement on the ground by orthodox means.

FIG. 3 shows an arrangement of the track 2 for the loading and unloading of the slide blocks 1. The track 2 comprises for this purpose a side line 39 which is connected to the main tract by two sets of points 38*a* and 38*b*, adapted to the subatmospheric pressure-lifting system and of a type already known.

The track 39 includes a deceleration zone 34, an unloading zone 35 with a moving belt 32 for the removal of the containers 20, an attraction/pickup zone 36 equipped with a moving belt 33 for bringing up the containers 20 to be loaded and an acceleration zone 37. A contractor 31 controls the electrical supply to the catenary 30 and thus permits, when required, the excitation of the electromagnet 27 when a slide block 1 arrives immediately above the moving belt 32. A similar control, not shown, is provided for the moving belt 33.

FIG. 4 shows a variant of the loading/pickup zone comprising means for the progressive approach of the track 2 and the containers to be loaded 20, with means for bringing the latter up to speed before being picked up. Under the main track 2, which descends as it arrives over the zone and climbs again afterwards, is provided a track of motor-driven rollers 40, arranged to give an acceleration in the zone 41, to maintain a constant speed slightly below that of the slide blocks on the main track, in the zone 42, and to give a deceleration in the zone 43. A lever-operated electromagnet contact 44, located at a convenient distance from the loading zone, sets the accelerator rollers 41 in operation. The assembly allows the movement of the container 20 to be synchronized with that of an empty slide block 1, to insert the container 20 between the containers already being transported by the neighboring slide blocks 1 (not shown), and to ensure the pickup of the container without shock, the latter having already been brought up to speed.

For the pickup process, the movement of an empty slide block 1*a* operates the contact 44 having a time advance such that the accelerator rollers 41 bring the container to be picked up 20*a* into the zone 42 under an empty slide block 1*a* but slightly ahead of it and at a slightly lower speed. Since the contact 31 is open, the suction cup for pickup 17 is partially evacuated. As soon as the lip 16 is fully located on the roof 19 of the container 20*a* the latter is raised by the effect of subatmospheric pressure in the suction cup 17 and it is lifted away from the roller train of the zone 42. Inversely on the arrival of a slide block 1 to be unloaded, the closing of the contact 31 causes the electromagnetic valve 23 to be opened while the safety hooks 25 are opened by the electromagnet 27. The suction cup 17 is brought up to atmospheric pressure and the container 20 then rests on the rollers 42 without shock because the latter are at a speed which is substantially equal to that of the slide block. The rollers of zone 43 bring the container to rest. The latter can then be taken in charge by a road tractor and thus reach its final destination.

It would naturally not be beyond the scope of this invention to utilize it for the handling of any other objects, for example baggage at stations and airports, blocks of ore in mines and quarries, parts in workshops, plates of fragile material, etc.

FIG. 5 shows a variant intended for the handling of sheets of glass or window panes 155. In this realization, the pickup mechanism 98, which includes a double suction cup 16 with concentric lips, has a flexible bellows 118 suspended from the slide block 1 and in which the subatmospheric pressure is controlled by a three-way cock 119 which is remote controlled. The bellows 118 forms a secondary suspension. Two of the ways of the cock 119 join the lifting chamber 10 to the chamber 118*a* inside the bellows 118. The third way leads to the interior of slide block 1.

An air extractor 120 communicates via a flexible axial sleeve 121 with the pickup mechanism 98 through a nonreturn valve 122. An electromagnetic valve 123, remotely controlled, permits the pickup mechanism 98 to be brought up to atmospheric pressure by a conduit not shown.

The operation is as follows: the electromagnetic valve 123 being closed, the extractor 120 is started up and creates a subatmospheric pressure in the pickup mechanism 98, which thus adheres to the pane 155. The application of subatmospheric pressure to the bellows 118 by the cock 119 placed in the position shown in FIG. 5 permits the pickup mechanism 98 and the pane 155 to be lifted up. At the desired height the cock 119 is closed. The bellows 118 thus provides a fluid suspension of considerable amplitude, and thus very flexible, for the panes transported 155. Their descent is ensured by connecting the bellows 118 to the atmosphere by the progressive opening of the cock 119 on the orifice side 119*a*. The pane 155 is freed from the pickup mechanism 98 by opening the valve 123.

According to a variant shown in FIGS. 6 & 7, the invention is combined with a conveyor having slide blocks 50 with positive pressure air cushions. The combination of the latter with slide blocks having chambers at subatmospheric pressure of the type described above, makes it possible to realize a system of points in the vertical plane without interruption to traffic owing to displacement means which permit support, at least temporary, on the face of the object opposite that which is attached to the slide block.

The slide blocks 50 slide on a lower profiled track 51 and comprise compressors 53 which provide air for the support cushions 54 and the lateral guiding cushions 55. The upper face 56 of each slide block 50, includes a flexible peripheral lip 57. This, with the upper faces 56 of the slide block and the lower face 58 of the container 20 defines a chamber 59 forming a suction cup for the attraction and pickup. The suction cup 59 is subjected to subatmospheric pressure by the intake of the compressor 53 by means of a venturi 60 placed in the intake duct 53*a*.

On the conduit 61 which brings the subatmospheric pressure to chamber 59, is a nonreturn valve 62 which avoids chamber 59 from being accidentally brought up to atmospheric pressure. A remotely controlled electromagnet 63 allows the chamber 59 to be brought up to a pressure above that of the atmosphere and, consequently, the unloading of the container 20, whose superstructure furthermore conforms to the realization of FIGS. 1 and 2. On its base the container 20 carries ribs 156 located to face grooves 157 of the face 56, which serve to centralize the container 20 on the slide block 50.

In the region of the points (FIG. 7), the upper track 2 and the lower track 51 approach each other to a distance substantially corresponding to the height of the container 20, taking into account the heights of the slide blocks 1 and 50. At this position, the catenaries 30*a* and 30*b* permit respectively the excitation of the electromagnetic valves 23 or 63, according to the position of a two-way switch 65, whose common contact is connected to a source of supply 66, and whose other contacts 65*a* and 65*b* are respectively connected to the catenaries 30*a* and 30*b*. An electronic device, not shown, ensures the synchronization of position and of the speed of the slide blocks 1 and 50 on their respective tracks.

When a container 20 arrives from the left, in the direction of arrow F, on the upper track 2, and is to be transferred to the lower track 51, the reversing switch 65 is placed in position 65*a*, which causes the catenary 30*a* to become live. During the movement of the slide block 1 the electromagnetic valve 23 is thus open, as are the safety hooks 25. The container 20 frees itself from the slide block 1 and places itself, by gravity, on the slide block 50, which is positioned exactly under it. The withdrawal of air from the chamber 59 by the venturi 60 locks the container 20 on the sideblock 50 due to the effect of the subatmospheric pressure created in chamber 59. The container pursues its way on the lower track 51. The reverse operation, transfer from the lower track to the upper track, is carried out by putting the reversing switch 65 into position 65*b*.

Such a points system permits the transfer of an object from an overhead track to another track of the same type, by the temporary passage of the object on a lower track having pneumatic support.

The conveyor shown in FIGS. 8 and 9 is intended to ensure the handling of ferromagnetic parts. Magnetic attraction is here used both for the connection between the vehicle and the track, and for the system of pickup of the objects to be transported.

On the roof 70 of a tunnel are fixed the regularly spaced inductors 71 of a variable reluctance sequentially switched linear electric motor according to the U.S. Pat. No. 697,089 filed by the Applicant on Jan. 11, 1968 for "Electromagnetic device producing a mechanical action." The magnetic circuits 72 of this motor, regularly spaced along the track, are cut by airgaps 73 and excited by pairs of coils 74 arranged around the pole pieces. Two lateral plates 75, which have inward facing flanges 76 on their lower parts, maintain the magnetic circuits 72 in position.

The coils 74 are fed from a three-phase supply 86 by means of a supply line 161, with circular permutation of the supply phases to ensure cyclic distribution of the magnetizing flux along the track.

In the part of the track intended for the loading and the transport of the objects to be handled, for example, containers in ferromagnetic metal 89, the conveyor includes lateral catenaries 87 carried by insulators 162. The catenaries 87 are intended to ensure the supply for the means of magnetic attraction provided on the mobile transporter elements to ensure the pickup and holding of the containers 89. In the same region, there is disposed under the track and orthogonal to it, a roller transporter 91 oriented transversally. The transporter 91 is intended to ensure that the containers 89 are brought up to the correct position for pickup by the conveyor.

The mobile transporter elements 163 of the conveyor are each formed by two groups 81 of nonmagnetic plates 78 articulated relative to each other by hinges 79. Each group 81 is mounted to slide in the airgaps 73. At the center of each plate 78 is mounted a magnetic armature 77 whose surface is greater than that of the pole pieces of the circuit 72.

The plates 78 are guided in the airgaps 73 by shoes 80 in a self-lubricating material, which bear on the plates 75. The clearance between the shoes and the plates is less than half the clearance of the magnetic armatures 77 in the airgaps 73, in order to avoid any perturbing lateral force caused by the armatures 77 being off center in the airgaps.

Each of the groups 81 carries at its midpoint, and mounted on a ball and socket bearing, a shaft 164 which is free to turn, and which supports a beam 82, common to two consecutive groups 81. The beam 82 supports an electromagnet 83, with its magnetic body 84 and its excitation coil 85 which forms the magnetic attraction/pickup device for the containers 89.

Current supply to the coils 85 is ensured by the flexibly mounted pickups 88 capable of making contact with the catenaries 87.

The safety system, in case the electric supply is cut, is formed by the interior flanges 76, on which bear the plates 78, and by a surrounding metal trellis 90, intended to keep the containers 89 on the trajectory of the conveyor.

Operation is as follows: since the sequential impulses received by the coils 74 are the same for all those coils fed from the same phase, there is complete synchronization of the movement of the various slide blocks, and their relative positions remain the same, without the necessity of mechanical connection between them. There is no risk of collision. The armatures 77 are light and do not add appreciably to the weight of the transporter element.

The load on a slide block tends to cause the magnetic armature 77 to extend from the airgaps 73 in a downward direction. This increases the reluctance of the magnetic circuit and creates an upwards force of attraction, bringing the magnetic armature 77 back into the airgap. The lines of force are perpendicular to the movement, whether this be longitudinal or vertical. This arrangement permits the best concentration of flux in the airgap, and a force versus displacement relationship which is very favorable to good suspension.

The container 89 waits on the transporter 91 until a slide block, formed by two groups 81 joined by the beam 82 carrying the electromagnet 83, arrives along the track; the pickups 88 make contact with the catenaries 87 which feeds the electromagnet 83. This latter lifts up the container 89 which is placed immediately beneath it, holds it to its lower face, and carries it away with it. The container 89 is set down at the desired place by interrupting the catenaries 87 which cuts off the supply from the electromagnet 83.

The use of a magnetic suspension of the type described avoids creating noise and dust inside the tunnel 70 or in other places, such as a factory, equipped with such a conveyor.

The conveyor shown in FIG. 10, 11 and 13 is applied to the transport of automobile vehicles 102, in particular of town vehicles, so as to ensure a journey which is comfortable, and without intermediate stops, while permitting independent operation and individual control of the vehicles at the ends of the track, and automatic movement in the intermediate part.

Each slide block 95 of the track 2 is similar to the slide block 1 of the first realization. However the propulsion of the slide block 95 is preferably ensured by a linear electric motor whose field windings 96 are mounted in the center of the slide block and whose armature 97 is attached under the beam 2. This means of propulsion, which is well adapted to high speeds, permits easy synchronization of one slide block to another while ensuring complete silence, an important point for an urban installation. The attraction and pickup device 98, of the pneumatic suction-cup-type, is attached to the slide block 95 by a suspension system comprising very flexible springs 99 and shock absorbers 100. A flexible tube 101 supplies subatmospheric pressure to the pickup device 98 by means of the extraction fans of the slide block. The device 98 is comparable to the similar device described in the first realization.

The natural resonance frequencies of the pneumatic lifting cushions and the elastic suspension are very different, and constitute a very effective two-stage suspension, especially since they are well damped.

The subatmospheric air cushion for the lifting of the slide blocks 95 along the track 2 has a very simple structure, and operates without contact with the track. Very few shutdowns are required for dealing with incidents or for maintenance. The combination of the pneumatic attraction of the slide block 95 with the subatmospheric pressure device for attraction and pickup 98, which is equipped with a very flexible suspension system 99, ensures outstanding comfort for the passengers of the vehicles 102 and exceptional reliability of operation.

In this variant, intended for urban transport, the automobile vehicle 102, of the "baby car" type, comprises an electric motor 103 for driving its wheels 166. The motor 103 is supplied from batteries 167, which avoids any atmospheric pollution. A speed controller 104, controlled both by pedal and by remote control, acts on the motor 103. The vehicle is very light and simple, because it only operates in contact with the ground for local journeys at low speed, and for a very short period of time when being brought up to speed before being

picked up by the slide blocks **95**, as will be seen later. The body **168** is in a plastic material, and is self-supporting both when operating on the wheels **166** and when suspended by the roof. This latter is flat with rounded edges and carries bars **28** for the safety hooks as in the case of FIG. **1**. The suspension between the wheels and the body comprises elastic elements, in a self-damping material, such as rubber, having small amplitude, since this suspension is only intended to operate at low speeds or on a perfectly flat special track for bringing up to speed during the pickup process by the slide block **95**.

The slide blocks **95** circulate at high and steady speed along track **2**. To achieve the pickup of the vehicles **102** without slowing down the slide blocks **95**, an approach and guide track **105**, having a smooth surface, is provided with kerbs **106** (FIG. **12**) on each side, to guide the vehicle **102**. The slope of the track **105** is such that the vertical distance between this track and the beam **2** on the bringing up to speed section **169**, decreases, which facilitates the insertion of the slide block **95** between two slide blocks already loaded. This distance remains constant over the attraction/pickup/lifting away section **171**, then increases over the unloading section **172**. The track **105** thus has a profile of double slope embankment. This conveyor is intended to ensure the loading of the vehicles **102** on to a track on which certain of the slide blocks **95** are already loaded with a vehicle, and to allow automatic synchronization of the movement of the vehicles to be loaded, relative to the empty slide blocks **95**.

To this end, the bringing up to speed device of the vehicle **102** comprises (FIG. **11**), at a sufficient distance before the start of the approach track **169**, a photoelectric cell **109** which remotely controls the starting switch of motor **103**, the vehicle **102** then being in a predetermined waiting position **102***a*. For this purpose a pedal contactor **173** is located between the track **105** and an appropriate contactor on the vehicle **102**. In parallel, each slide block **95** carries a source of light **107** which directs downwards a luminous focused beam **108** whose trajectory passes over the cell **109**. This beam is interrupted if the slide block **95** is already carrying a vehicle **102**. Of course the distance between the vehicle in the waiting position **102***a* and the track **2** is sufficient to permit the free passage of loaded slide blocks.

The masking of the light source **107** by vehicle **102** loaded onto a slide block, prevents any accidental starting up of the vehicle **102***a*.

The system (slide block **95**-vehicle **102**) is also so arranged as to ensure the automatic pickup when the vehicle and the slide block are in the correct relative position and have the same speed. To this end the roof of the vehicle **102** carries a light source **94** (FIG. **10**) just behind its center of gravity, which directs towards the track **2** a light beam **94***a*. The slide block **95** carries a photoelectric cell **92** situated in the same vertical plane as the source **94**, on the same vertical axis as its center of gravity. The cell **92** controls a contactor on the supply to the electromagnetic valve **93** which, at rest, closes a tube **101** for bringing the pickup device **98** to subatmospheric pressure. The coincidence of the centers of gravity improves the stability of the assembly comprising the slide block **95** and the vehicle **102**.

Operation is as follows: when an empty slide block **95***a* arrives, the electric impulse emitted by the cell **109** operates the contact **173**, starting up the electric motor **103** at full power, which rapidly accelerates the vehicle **102***a* on the track **105** just in advance of the slide block **95***a*, up to a speed regulated by the controller **104** (acting under remote control) to a value which is just below that of the slide block **95***a* which is moving in the same direction, following arrow F. The slide block **95***a* progressively overtakes the vehicle **102***a* at a point on the pickup section **171**. At the moment where the beam **94** reaches the cell **92**, the electric current produced by the latter operates the supply contactor to the electromagnetic valve **93** which causes the pickup device **98** to be subjected to subatmospheric pressure.

The vertical distance between the track **2** and the track **105** in the section **171** is such that the suction cup **16** of the pickup device enters into light contact with the roof of the vehicle **102***a*. A subatmospheric pressure is created in the interior **17** of the suction cup **16**, which at the same time attaches the vehicle **102***a* to the slide block **95***a* and also lifts it from the ground. The safety hooks **25** automatically close on the bars **28**, and the journey of the vehicle **102***a* on the main transporter at high speed commences from the disengagement section **172**. Due to the subatmospheric pressure connection between the vehicle and the slide block on the one hand, and the suspension system on the other hand, the pickup and the transport takes place without appreciable shock.

In the disengagement section **172** the distance between the beam **2** and the track **105** increases and if the pickup of the vehicle **102***a* by the slide block **95***a* is not effected for any reason, the vehicle **102** disengages without fouling the other automobiles being conveyed, and will be guided either to a parking lot or to return to the bringing up to speed section for a second attempt. The inverse process is used for unloading the vehicles. In view of the large number of slide blocks, it is intended to allow the slide block thus discharged to make the following journey empty. It may be noted that the loading and the discharging of the vehicle can take place even without a driver on board.

The slide block can be equipped with auxiliary devices, in particular a current connection to be switched on automatically during the pickup of the vehicle, which allows the battery **167** to be recharged during the journey, or to operate an air-conditioning device, thus reducing the weight of the batteries required.

FIG. **13** shows a diagrammatic layout of a possible installation for such a system of conveyor. The vehicles **102**, not shown, are intended to transport passengers from dwelling houses **110** to industrial buildings **111**, passing through the departure station **112**, located on a collecting branch line **113** and equipped according to FIG. **11**. The branch line **113** ends at a common trunkline **114**, which in turn splits up into distribution branch lines **115**, having arrival stations **116**. The points are realized using means already known and habitually used on surface-effect vehicles. The stations **116** are located in proximity of the buildings **111**.

Another variant of the preceding realization is represented in FIG. **14** and shows the ease of adapting the conveyor according to the invention to the transport of aircraft passenger cells **126** which are detachable from the wings, according to arrangements already known.

The cell **126** is detached from the rest of the aircraft **127**, which only comprises the wings, the tail, the engines and the control cabin. The cell is lead, by means of small retractable wheels, not shown, under the neighboring beam **2**. Here several slide blocks **95** (shown diagrammatically in FIG. **14**) take it in charge by means of a pickup/lift device of a type similar to those previously described. The use of several slide blocks **95**, which may be coupled together, facilitates the transport of loads of different lengths, and allows small radius curves to be taken.

The habitual interchange delays at airports, which cause a waste of time, are thus avoided, and the loaded cells may be sent to the center of the town if necessary.

It thus appears that the connection by attraction between the mobile transporter element and the track on the one hand, and between this transporter element and the object to be transported on the other hand, considerably eases the loading of the object without producing shock nor requiring great precision. The device according to the invention thus presents considerable economic interest because it combines the well-known advantages of air cushion vehicles or magnetic suspension vehicles (no shutdowns for incidents or maintenance, a low noise level, simplicity, low capital cost, high speed) with the advantages of conveyors (high flow regularity).

In its application to urban transport, the invention further provides the flexibility of the utilization of automobiles, the

absence of atmospheric pollution, and the high safety-level characteristic of public transport systems. It may be noted that the whole of these advantages are practically indispensable to define a solution truly replying to the problem posed: to transport rapidly millions of people and of objects without noise, nor pollution, nor breakdown, from door-to-door, in comfortable individual vehicles carried by a network which only requires limited investment for its construction.

In the embodiment shown in FIGS. **15** and **16**, the conveyor comprises a row of high power air extractors **201**, e.g. turbine extractors, which are mounted in profiled mouthpieces **201***a* on the upper wall **9** of track **2**. Wall **9** is supported by a box-girder forming a collector **2***a* which is maintained at a subatmospheric pressure. The lower wall **203** of track **2** has regularly spaced-apart orifices **202** which connect collector **2***a* to a lifting chamber **204** formed between the wall **203** and the uppermost part of the transporter elements **1**. Orifices **202** are relatively close to each other while air extractors **201** are relatively distant from each other.

Correlatively, the transporter element **1** does not carry any air extractor. Transporter element is constituted as shown in FIG. **1** and like parts have been given like reference numerals. In particular, element **1** comprises a dovetail section body which slides between the profiled lateral faces **5** of beam **2**. Element **1** carries a nonreturn valve **21** and an electromagnetic valve **23**, to connect the lifting chamber to the atmosphere, and articulated hooks **25** which cooperate with bars **28** carried by the roof of container **20** to ensure a safe fastening of the latter. The element structure is then very simple, light and reliable.

Between each pair of transporter elements **1**, which comprise a rigid framework, a sealing member **205** is provided which has a variable length (being extensible and compressible, e.g. made of rubber) and has the same transverse section as the element **1** to ensure airtightness between the elements **1**. Lifting chamber **204** is thus made substantially continuous and no direct entry of atmospheric air is allowed between elements **1**, which permits of decreasing the power consumption of the air extractors **201**. The airflow from the extractors **201** is high enough for the flow of a broken down extractor to be made up by that of the two adjacent extractors.

A large number of small air extractors in the transporter elements **1** are thus replaced by a few large ones along the track **2**. The efficiency of the latter is higher and the cost is lower for the same total power. The total cost, the number of rotating shafts and the speed thereof are lower in this improved conveyor. The reliability is increased. Furthermore, and air extractor **201** can be replaced or maintained without stopping the conveyor.

According to an improved version shown in FIGS. **17** and **18**, of the preceding embodiment, the transporter elements form a single continuous conveying strip comprising a succession of plates **211** on which is secured the armature **212** of a driving linear electric motor **213**. As before, a variable length-sealing member **214**, e.g. made of a rubber block, having the same transverse section as the plates **211** and of high transverse rigidity, is interposed between each pair of plates **211**. Such member ensures the airtightness continuity between the plates and the track **2** and brings up flexibility to meet the direction changes in track **2** and any small spacing variations between the plates **211**. The lateral guidance of the conveying strip is performed by a succession of wheels **215** carried by the track **2**. To allow the relative displacements of the plates **211**, the armature **212**, secured to the upper face of the latter, is made of a row of elements which are articulated to each other. The track **2**, which is located above the plates **211** comprises enveloping flanges **220** which reach below the edges of plates **211**.

Operation of this version is similar to that of the preceding embodiment. The other features are also similar, namely the arrangement of collector **2***a*, air extractors **201** and flexible lips **16**.

In this version, the plates **211** are of a remarkable simplicity, without moving parts, and can be manufactured at a very low cost. The weight is decreased and the reliability further increased. The sealing members **214** are preferably resilient so that the two transporter elements **211** which are located on each side of an element being loaded can move by a small vertical distance while the object to be transported is being picked up. The sealing members **214** also contribute to the acceleration of the transporter element considered when the latter takes charge of an object.

According to another group of improvements, shown in FIG. **19** and **20**, the subatmospheric pressure suction cup **17** is kept between the transporter element **1** and the object **20** to be transported and so is kept the sliding and guiding system comprising an overpressure air cushion **221**, but the latter is now located above the object **20** and above a flange **222** of track **2**.

To this end, each transporter element **1** comprises a T-shaped central extension **225** projecting between the enveloping flanges **222** of the track. The wings **226** of extension **225** overhang the flanges **222** and are so arranged as to slide freely in a passageway formed underneath the beam **2**.

Each transporter element carries two compressors **223** whose intake duct **227** opens into the suction cup **17** and contributes to maintain the subatmospheric pressure in the latter. The exhaust duct **228** divides into branches **229** which supply compressed air to the lifting cushion established between flanges **222** and the lower face of wings **226**.

In the version shown in FIG. **20**, which also concerns a lifting system with overpressure air cushions, the track comprises two compressed air collectors **231** extending below enveloping flanges **232**. The latter have spaced-apart orifices **233** to allow compressed air to flow to the opposite face **234** of the wings **235** of the T-shaped extension **236** of the transporter element. The latter therefore does not carry any air compressor.

In some cases, e.g. in case of a dusty atmosphere, the overpresssure lifting system is to be preferred to the subatmospheric pressure system and the combination with an object depending from the track constitutes a remarkably simple and stable realization of moving transporter elements.

It is to be understood that the invention is not limited to the embodiments that have been described. In particular some of the means that have been mentioned, such as the continuous row of articulated transporter elements, can be used as well with overpressure air cushions as with subatmospheric pressure chambers.

What is claimed is:

1. A conveyor system comprising:

a supporting structure serving as a track,

a row of transporter elements movable along and guided by said track,

means for supporting and guiding said transporter elements relative to said track, said means comprising at least one wall of said track and one wall of each transporter element, said two walls facing each other and being separated by a gaseous medium, and means developing a field of nonmechanical attraction forces which acts between said walls to develop a supporting force,

means for propelling said transporter elements relative to said track, said means comprising at least one wall of said track and one wall of each transporter element, said two walls facing each other and being separated by a gaseous medium, and means acting between said walls to develop a propulsion force,

each said transporter element comprising means for picking up and supporting objects to be transported, said means comprising at least one wall of said transporter element adapted to face one wall of one object to be transported, and said means for developing a field of nonmechanical attraction forces also acting between said wall of said transporter element and said wall of said object to be transported to develop a pickup force for said object

when said walls are at a distance from each other and move relative to each other in a direction substantially parallel to said walls, and developing a supporting force for said object after the latter has been picked up.

2. A system as claimed in claim 1, said means to develop a supporting force comprising means for establishing gas cushions between said track and said transporter elements.

3. A system as claimed in claim 2, said gas cushions being at subatmospheric pressure, the portion of said track that bounds said gas cushions being disposed above the portion of the transporter elements that bounds said gas cushions.

4. A system as claimed in claim 2, in which said gas cushions are at superatmospheric pressure.

5. A system as claimed in claim 2, in which said transporter elements each comprises at least one air extraction means permanently connected to a lift chamber defined between the track and a said element, and a remotely controlled valve connecting said chamber to a chamber defined between the transporter element and the lifted object.

6. A system as claimed in claim 2, in which the track is located above the transporter elements and comprises enveloping lateral flanges extending below the edges of said elements, said elements comprising T-shaped extensions projecting into a passageway formed in the lower part of the track and laterally limited by said flanges.

7. A system as claimed in claim 6, in which said transporter elements comprise compressors that feed branched ducts that open into a space between the horizontal wings of said T-shaped extensions and the edges of said enveloping flanges beneath said wings.

8. A system as claimed in claim 2, said means to develop a supporting force comprising a fixed collector secured to the track and having spaced orifices to connect it to the track, and means carried by the track to maintain in said collector a pressure that is different from atmospheric.

9. A system as claimed in claim 8, said collector comprising a beam supporting said track.

10. A system as claimed in claim 8, in which said transporter elements comprise rigid frameworks connected by joints of variable length having the same cross section as said frameworks and comprising sealing means to ensure airtightness of relatively movable parts of the system.

11. A system as claimed in claim 8, said transporter elements comprising rigid plates and resilient members forming a continuous flexible transport belt.

12. A system as claimed in claim 8, said track comprising rotatable members mounted on the inside faces of enveloping lateral walls for the lateral guidance of said transporter elements.

13. A system as claimed in claim 8, said track being located above the transporter elements and comprising enveloping flanges extending below the edges of said elements.

14. A system as claimed in claim 13, to which the inside of said collector is maintained at subatmospheric pressure, said orifices being disposed above said transporter elements.

15. A system as claimed in claim 13, in which the inside of said collector is maintained at superatmospheric pressure, said orifices being disposed below the transporter elements.

16. A system as claimed in claim 1, said means to develop a supporting force comprising magnetic means.

17. A system as claimed in claim 16, said magnetic means comprising magnetic circuits having airgaps and being spaced apart along said track, said transporter elements including magnetic armatures movable in said airgaps transversely to the magnetic flux lines of said magnetic circuits.

18. A system as claimed in claim 1, said transporter elements being self-propelled.

19. A system as claimed in claim 1, said transporter elements being independent from each other.

20. A system as claimed in claim 1, said means for developing a field of nonmechanical attraction forces comprising pneumatic attraction means.

21. A system as claimed in claim 20, said pneumatic attraction means comprising means defining a lift chamber between a lower face of a said transporter element and an upper face of the object to be transported, a vacuum source for evacuating said chamber, and means to bring said chamber to atmospheric pressure.

22. A system as claimed in claim 1, said means to develop a lifting force comprising magnetic attraction means.

23. A system as claimed in claim 22, and electromagnets carried by said transporter elements.

24. A system as claimed in claim 1, said transporter elements including detachable mechanical retention means for the objects to be transported.

25. A system as claimed in claim 24, said detachable mechanical retention means being automatically engaged by the approach of the object and the transporter elements to each other, and remote control means for disengaging said retention means.

26. A system as claimed in claim 1, and pneumatic means ro guide the transporter elements transversely along the track.

27. A system as claimed in claim 1, in which said track comprises an overhead beam supported by pylons.

28. A system as claimed in claim 1, and a tunnel in which said track is mounted.

29. A system as claimed in claim 1, and means suspending the objects to be transported below the transporter elements.

30. A system as claimed in claim 1, said means to develop a lifting force comprising means establishing mutual attraction between said transporter elements and said objects.

31. A system as claimed in claim 30, in which said transporter elements comprise pneumatic attraction means for the objects including a lift chamber having two substantially parallel faces one carried by a said transporter element and the other carried by the lifted element, and means for establishing in said chamber a subatmospheric pressure.

32. A system as claimed in claim 30, said means establishing said mutual attraction comprising an upper flat surface portion of said object.

33. A system as claimed in claim 32, said flat surface portion comprising a roof of a container of merchandise.

34. A system as claimed in claim 32, said flat surface portion comprising the face of a window pane.

35. A system as claimed in claim 32, said flat surface portion comprising the roof of a vehicle.

36. A system as claimed in claim 1, and an auxiliary transporter for the loading and unloading of objects onto and from said transporter elements.

37. A system as claimed in claim 36, and current-conducting means extending along the track and having electrically live locations at loading and unloading stations for the objects, said elements having current pickups to contact with said live locations thereby electrically to control the attachment and detachment of objects to and from said transporter elements.

38. A system as claimed in claim 36, and means to guide objects parallel to said track adjacent the loading and unloading positions thereof.

39. A system as claimed in claim 36, and an embankment having a profile with two slopes to permit said objects and transporter elements to progressively approach and recede from each other adjacent the loading and unloading positions thereof.

40. A system as claimed in claim 36, in which there are two superposed said tracks comprising an upper track to which the transporter elements are joined by attraction means and a lower track having additional transporter elements mounted on it and supported by positive air pressure cushions, and means to control said detachable connection means between said upper transporter elements and said objects for the movement of said objects from the upper transporter elements to the lower transporter elements.

41. A system as claimed in claim 40, and vacuum means for establishing subatmospheric pressure between said transporter elements and said objects.

42. A system as claimed in claim 36, and means to accelerate the objects to the speed of the transporter elements, and means to bring a surface of said objects progressively closer to a surface of said transporter elements while said objects are accelerating.

43. A system as claimed in claim 42, and means to bring the speed and position of said objects and of said transporter elements into coincidence with each other.

44. A system as claimed in claim 1, and a main track for circulation of transporter elements and a side track connected to said main track for the loading and unloading of said objects.

45. A system as claimed in claim 1, in which said objects to be transported are hollow.

46. A system as claimed in claim 1, said transporter elements comprising suction cups connected to said elements by extensible bellows, and means to establish subatmospheric pressure in said bellows.

47. A system as claimed in claim 1, and a linear electric motor connected to a source of sequential impulses for synchronizing the movement of said transporter elements.

48. A system as claimed in claim 1, each transporter element carrying the armature of a linear electric motor whose fixed magnetic circuit is carried by the track.

49. A system as claimed in claim 1, and means to damp the relative vertical movement between the transporter elements and the objects being transported.

50. A system as claimed in claim 1, and means remotely controlled by the transporter elements that are not loaded, for bringing said objects up to speed for pickup by the transporter elements to be loaded.

51. A system as claimed in claim 1, and means to self-propel said objects, and a disengagement track for removing said objects that fail to be picked up by said transporter elements.

52. A system as claimed in claim 1, said transporter elements having means to emit remote control signals when they fail to be loaded.

53. A system as claimed in claim 1, and means to detect the vertical alignment of the centers of gravity of said transporter elements and said objects.

54. A system as claimed in claim 1, and auxiliary means on said objects, and means on said transporter elements to supply said auxiliary means to said objects when said transporter elements receive said objects.

55. A system as claimed in claim 1, in which a plurality of transporter elements conjointly transport a single object.

56. A system as claimed in claim 1, and means for regulating the spacing between the transporter elements.

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