United States Patent [19]

Schauffler

[11] **3,805,704**

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[54] **TRANSFER SYSTEM**

[76] Inventor: **Peter P. Schauffler,** Bethesda, Md.

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[21] Appl. No.: **164,342**

[52] **U.S. Cl.** **104/88,** 214/38

[51] **Int. Cl.** **B61k 1/00**

[58] **Field of Search** ..... 214/38 CA, 38 BA, 38 D; 213/75 R; 104/18, 19, 20, 26, 27, 28, 29, 30, 31, 88; 105/238, 327, 328, 329; 244/114 R

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Primary Examiner—Robert G. Sheridan
Assistant Examiner—D. W. Keen
Attorney, Agent, or Firm—Woodcock, Washburn, Kurtz & Mackiewicz

[57] **ABSTRACT**

In a transportation system which interconnects multiple origin and destination points, coupled seat and baggage units for individual passengers are carried by different types of vehicles. Automatic sorters at transfer points uncouple and sort and recouple these units for transfer from one type of vehicle to another, so that a passenger and his baggage can travel from his origin to his destination on several different vehicles without leaving his assigned unit.

5 Claims, 36 Drawing Figures

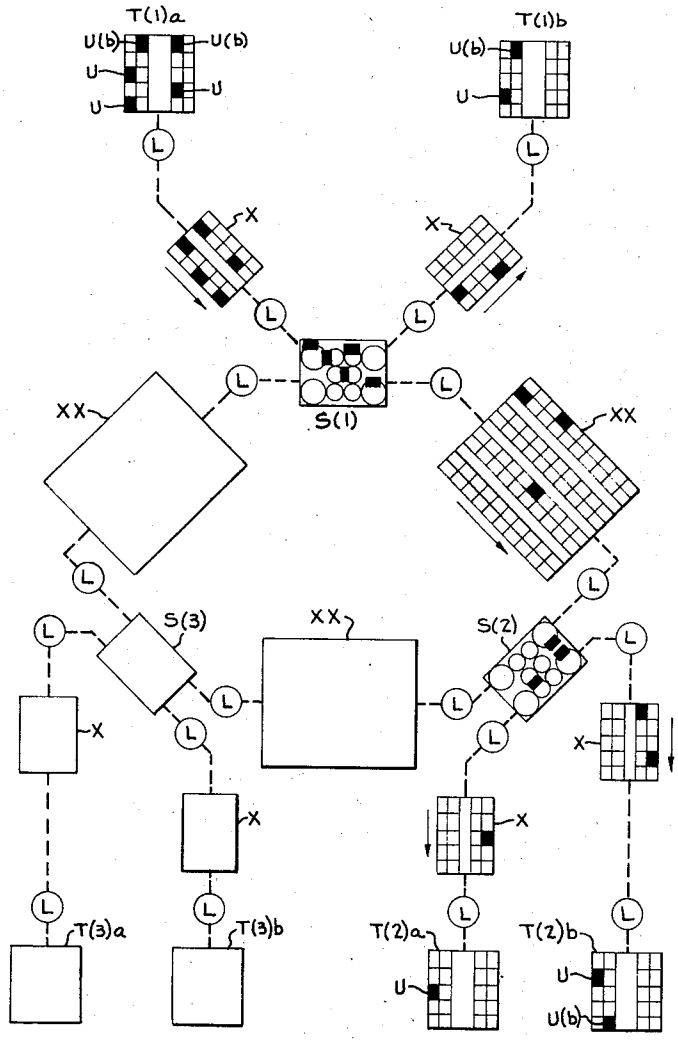


Fig. 1

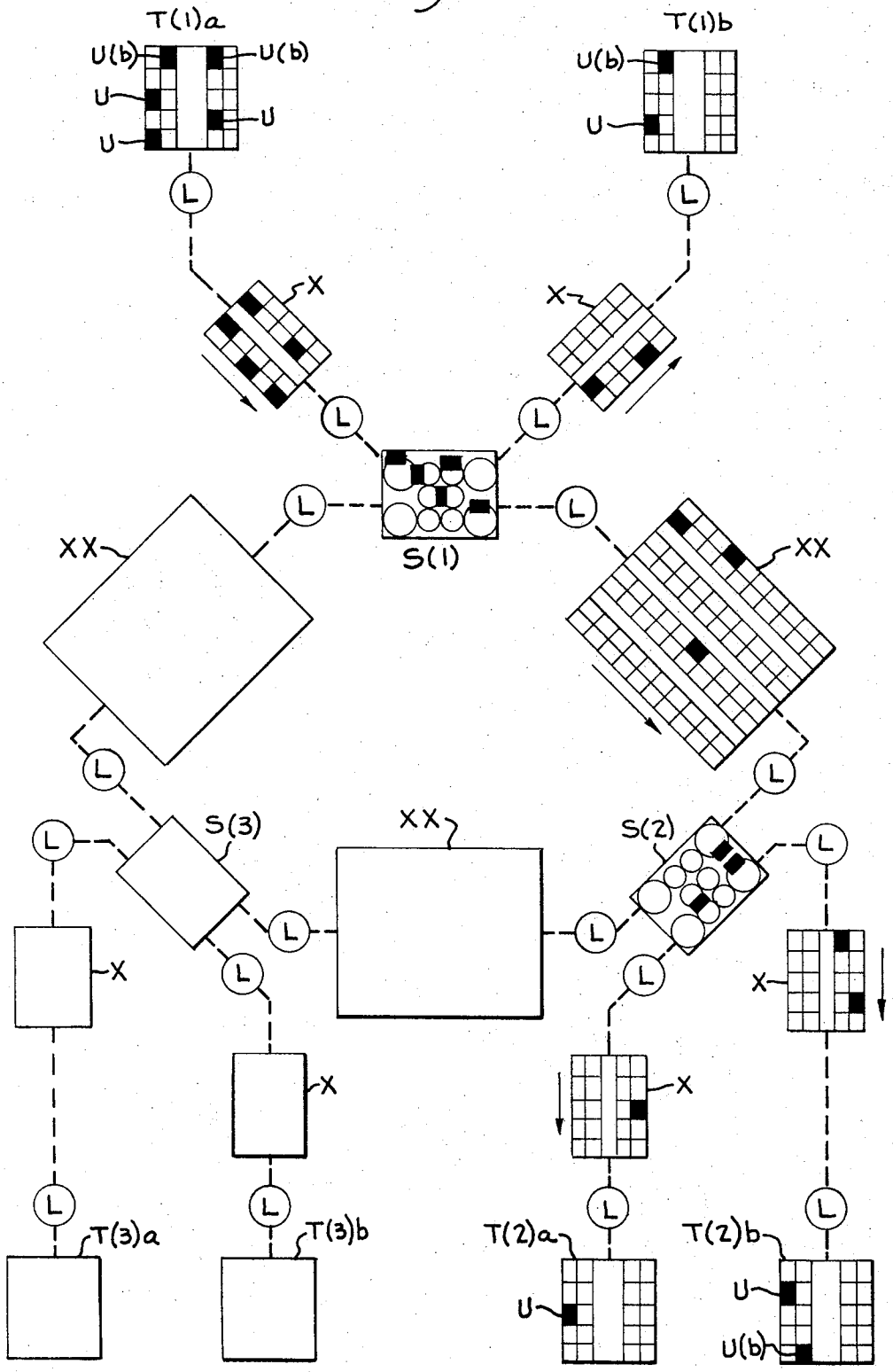


Fig. 2

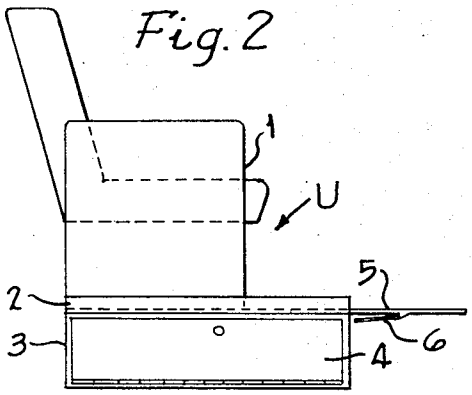


Fig. 3

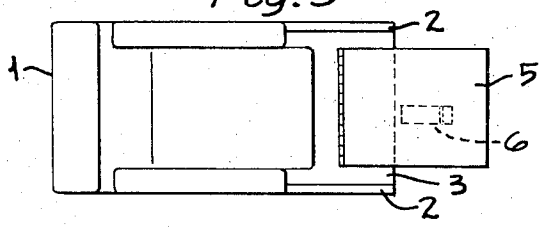


Fig. 4

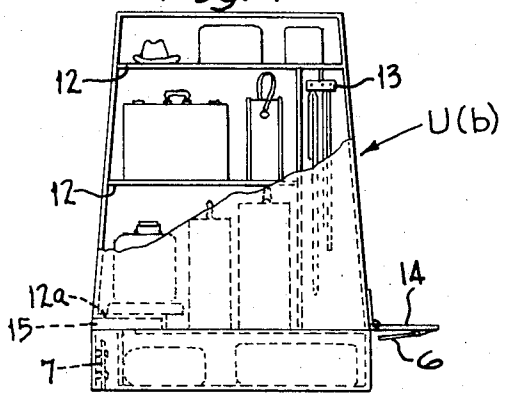


Fig. 5

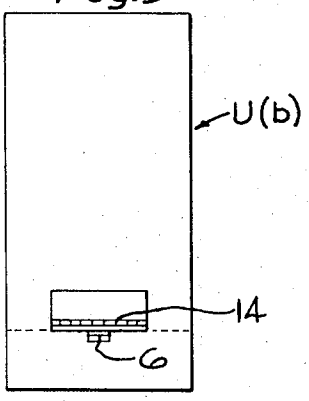


Fig. 6

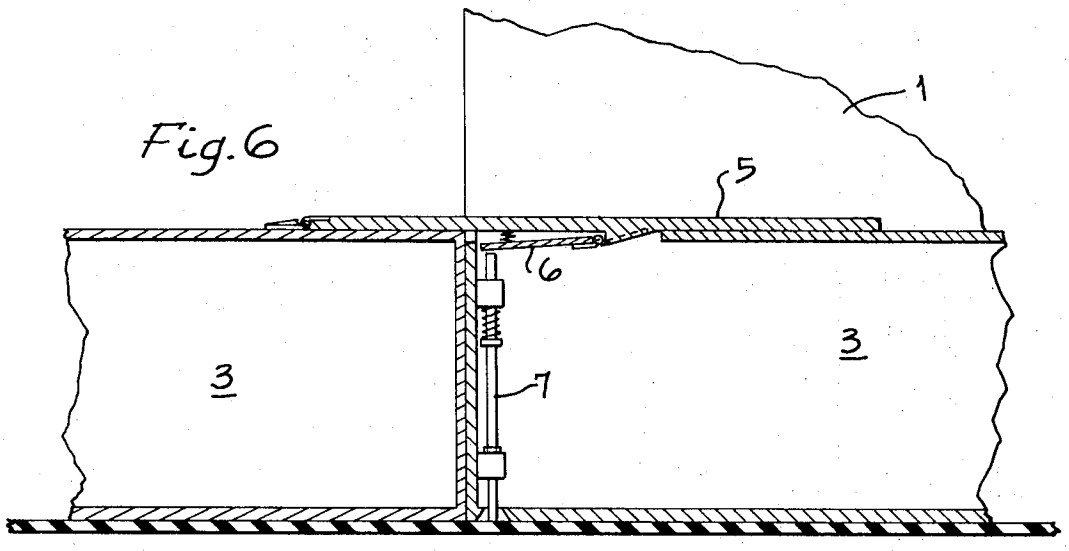


Fig. 7

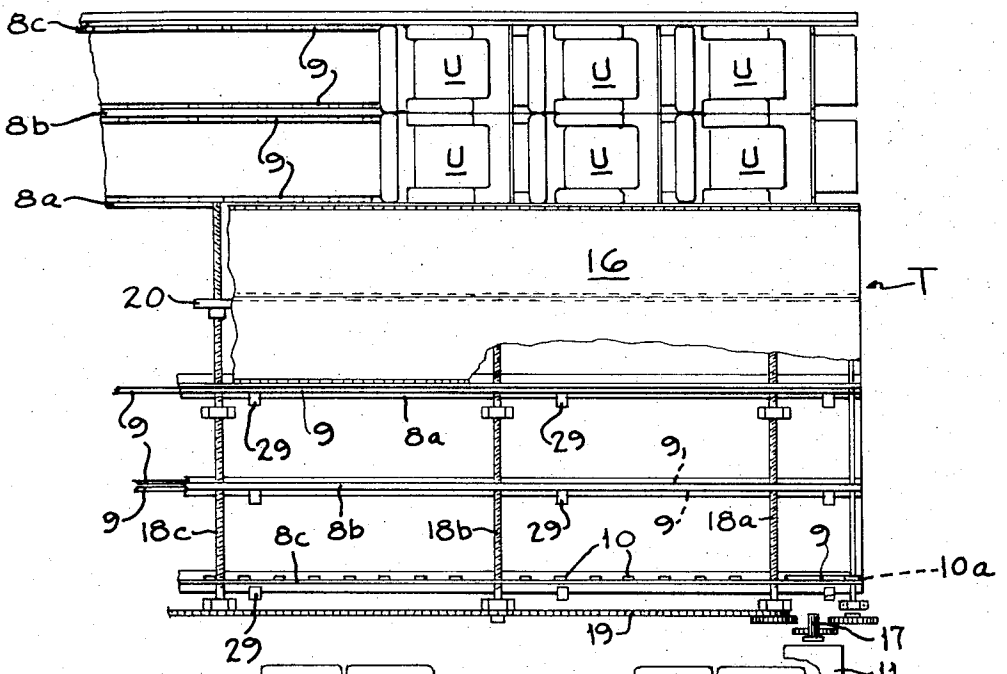


Fig. 8

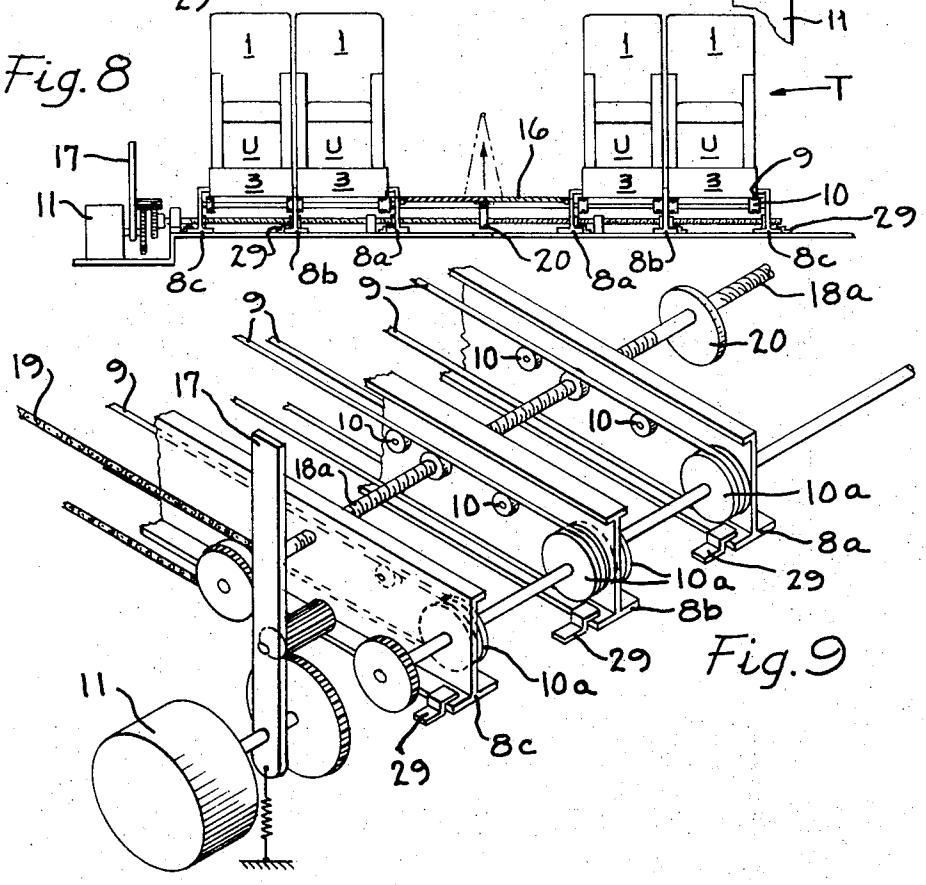


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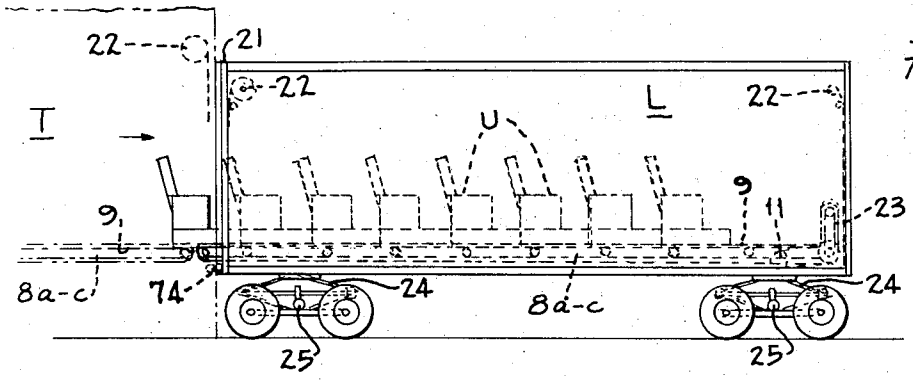


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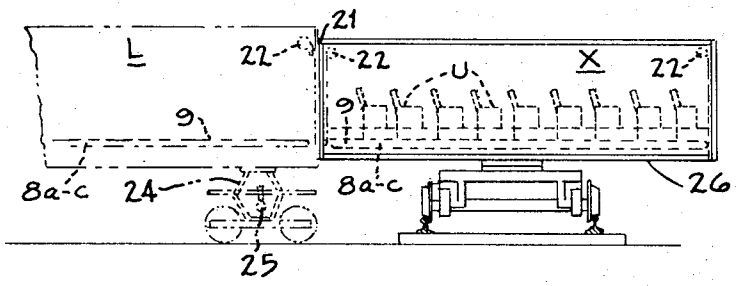


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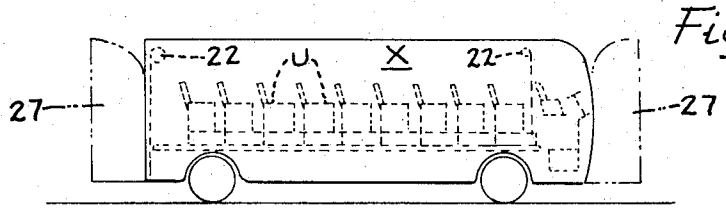


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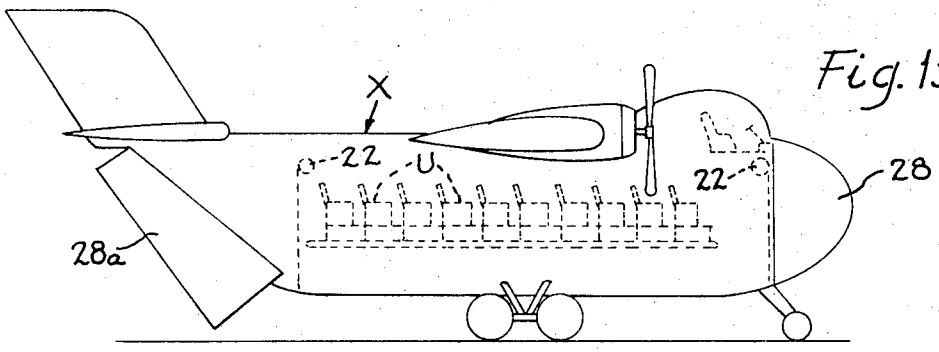


Fig. 13

Fig. 14

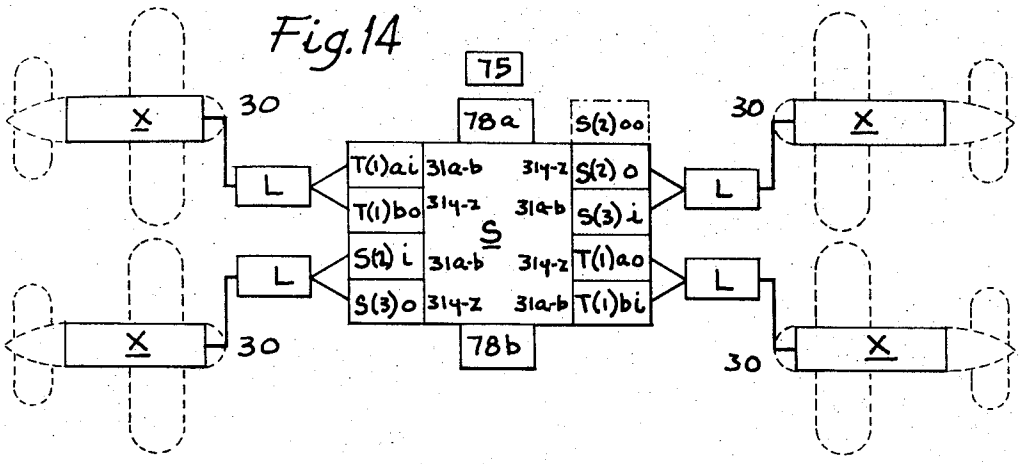


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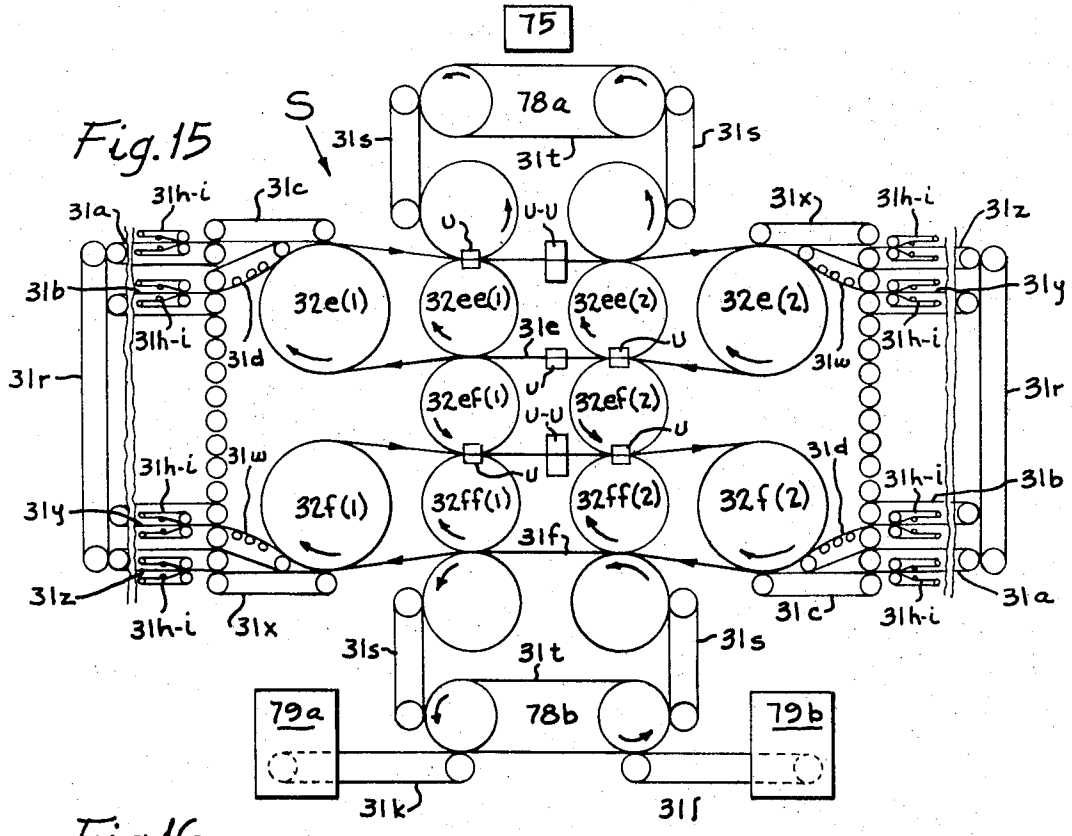


Fig. 16

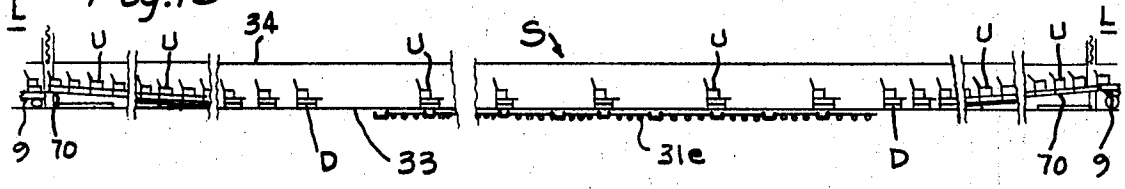


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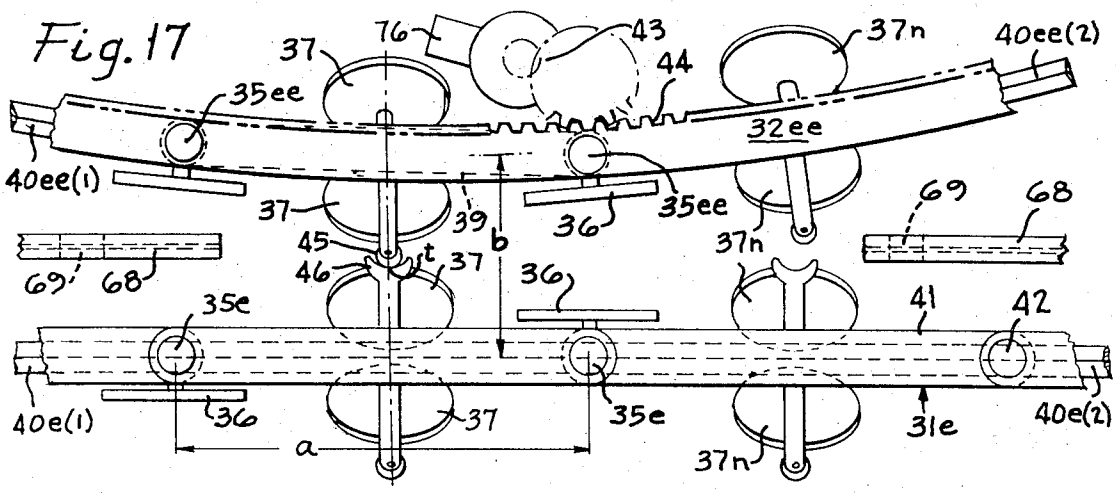
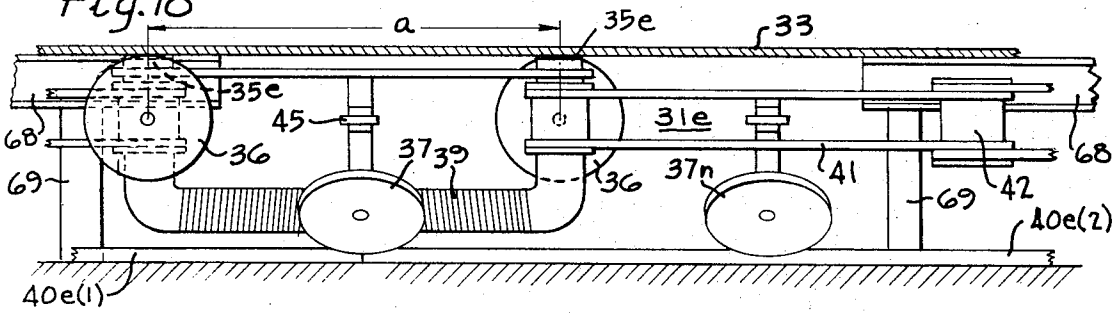


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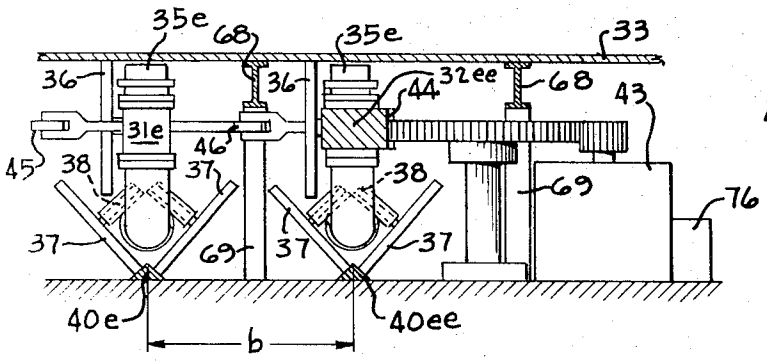


Fig. 19

Fig. 18A

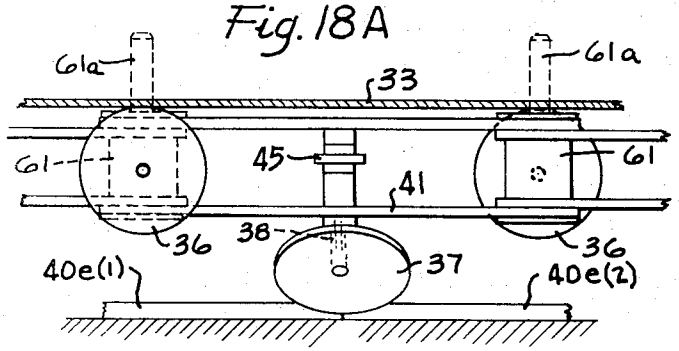
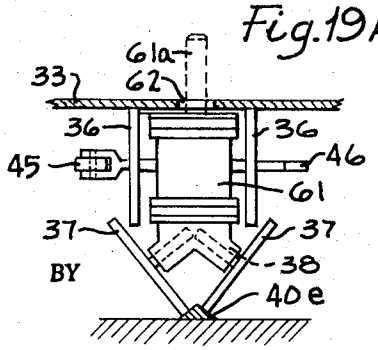


Fig. 19A



BY

Fig. 20

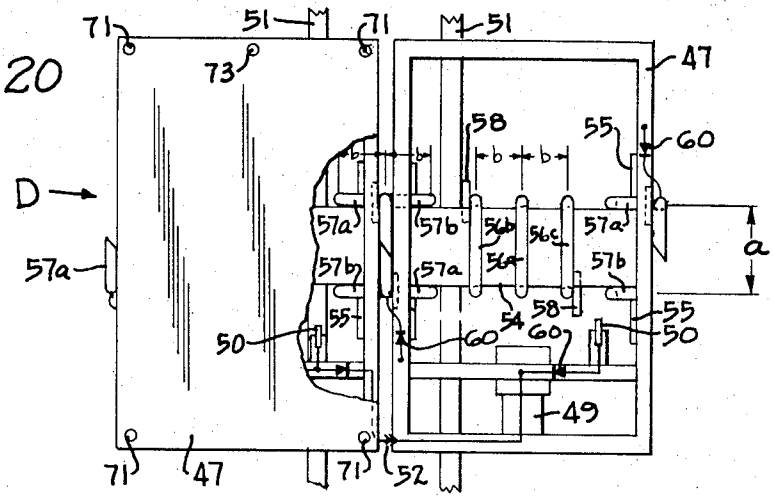


Fig. 21

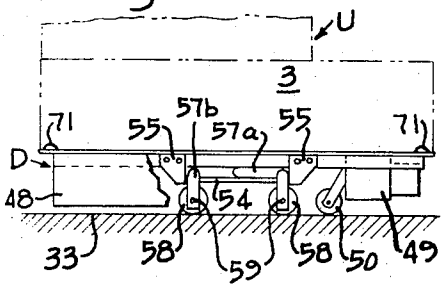


Fig. 22

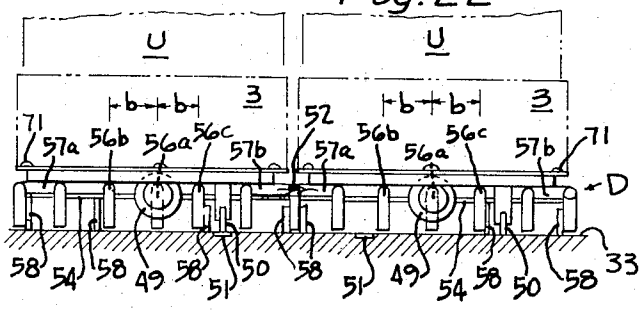


Fig. 20A

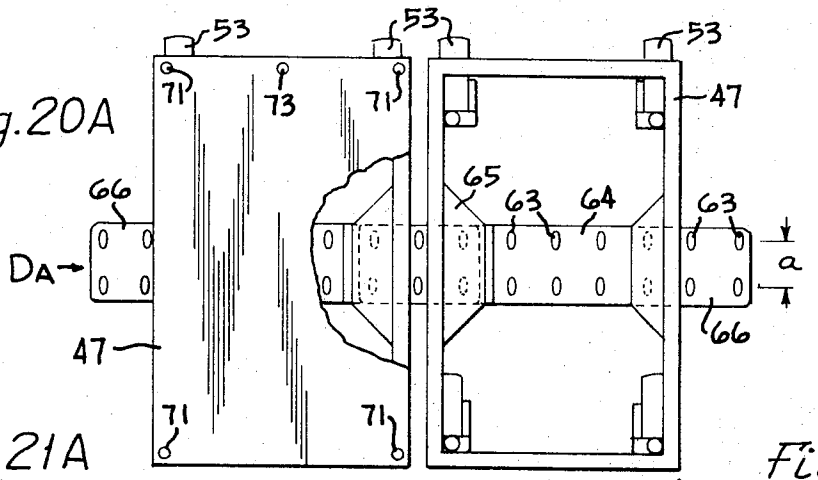


Fig. 21A

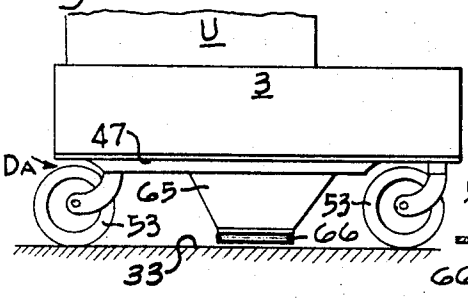
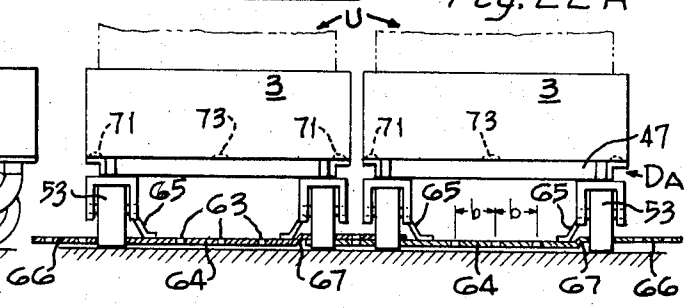


Fig. 22A



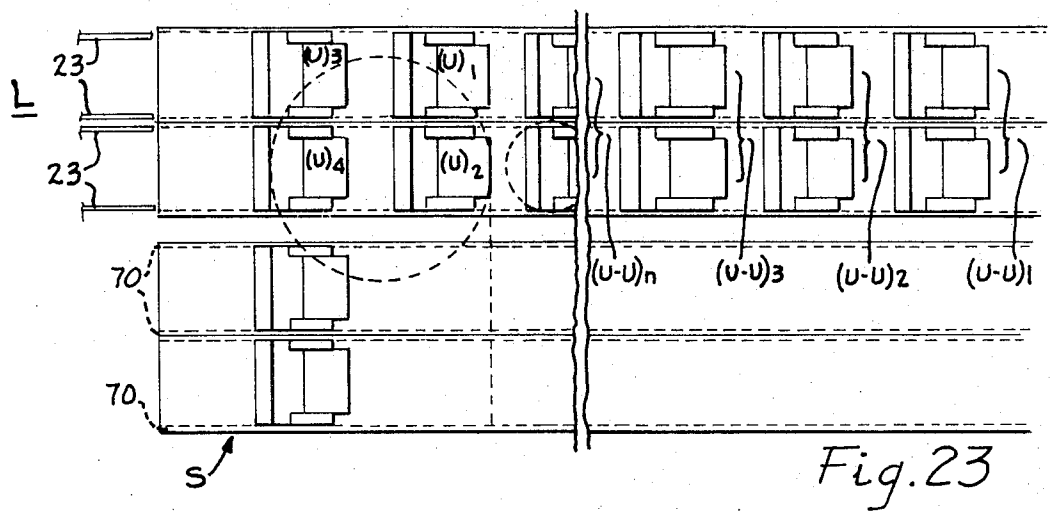
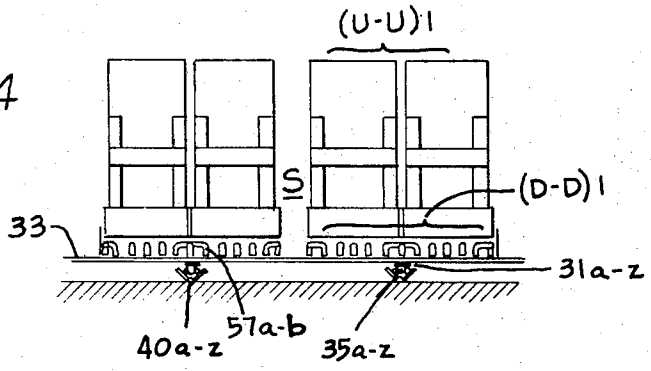


Fig. 23

Fig. 24



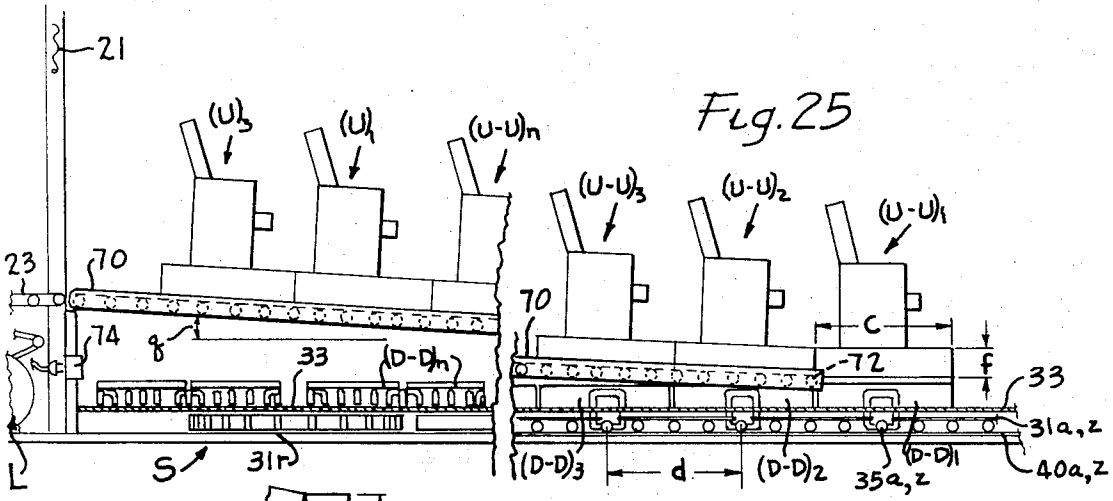


Fig. 25

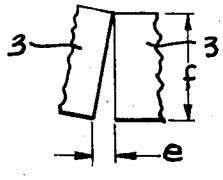
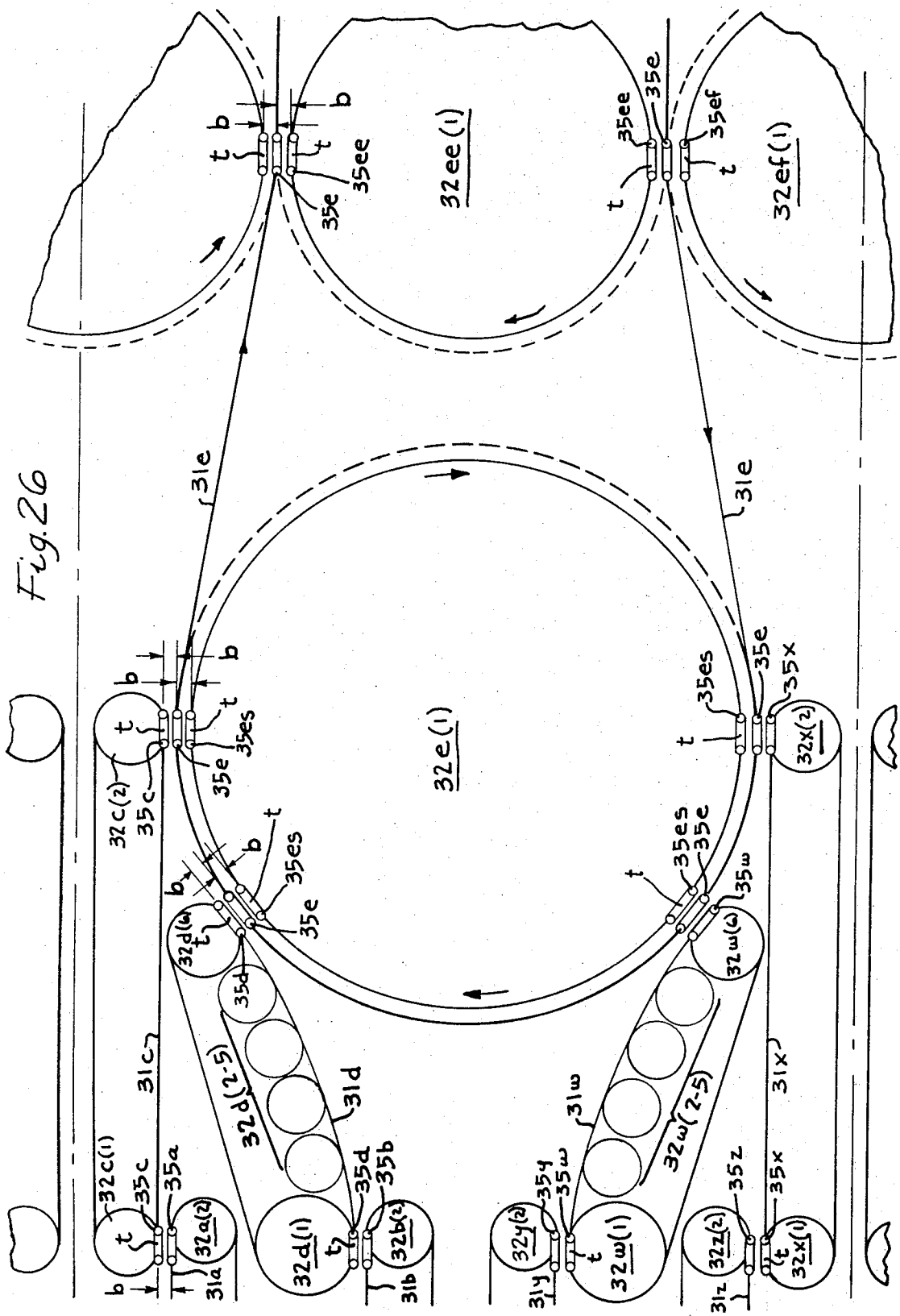


Fig. 25A

Fig. 26


32ee(1)
32ef(1)
32e(1)
31e
32c(2)
35c
32c(1)
35a
32a(2)
31a
31c
32d(2-5)
31d
32d(1)
35d
35b
32b(2)
31b
32y(2)
35y
31y
32w(1)
32w(2-5)
31w
32z(2)
35z
31z
32x(1)
31x
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32d(4)
35e
35ee
35ef
35es
35w
35x
t
b

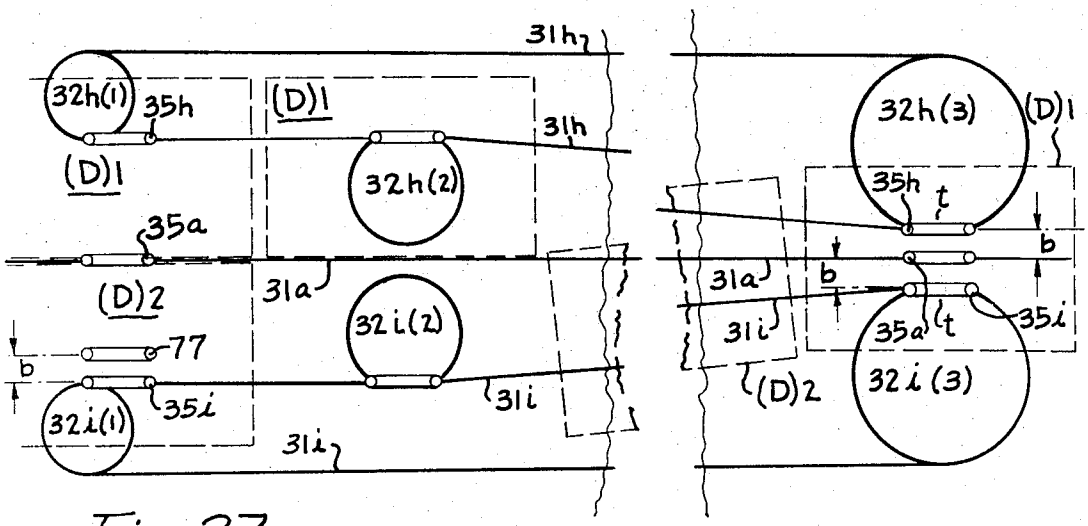

31h
32h(1)
35h
(D)1
(D)1
31h
32h(2)
35a
(D)2
31a
32i(2)
77
b
35i
32i(1)
31i
31i
32h(3)
(D)1
35h
t
b
b
31a
31i
35a
t
35i
(D)2
32i(3)

Fig. 27

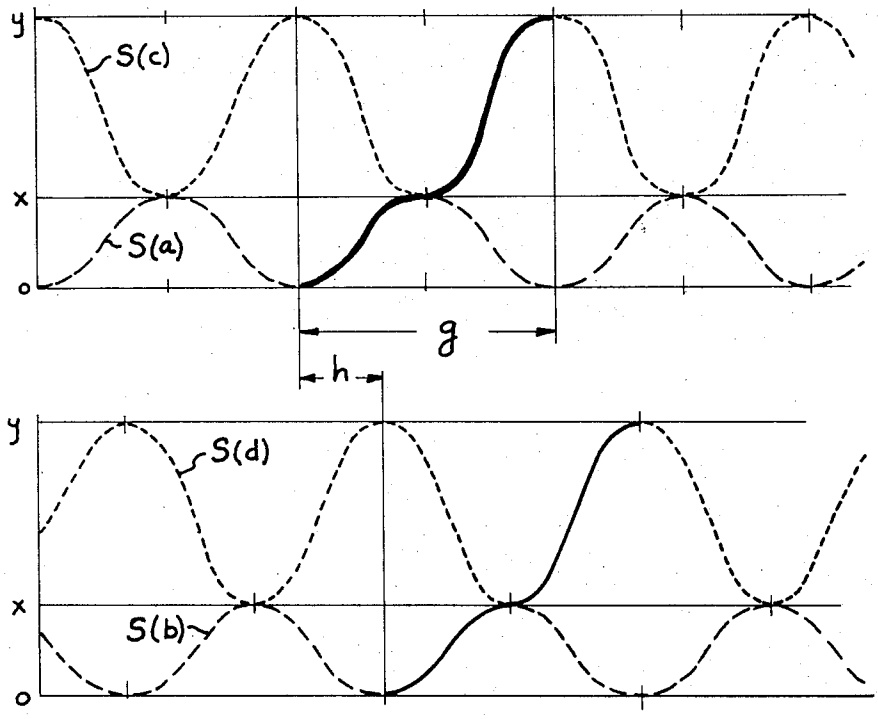

y
S(c)
x
S(a)
o
g
h
y
S(d)
x
S(b)
o

Fig. 28

Fig. 29

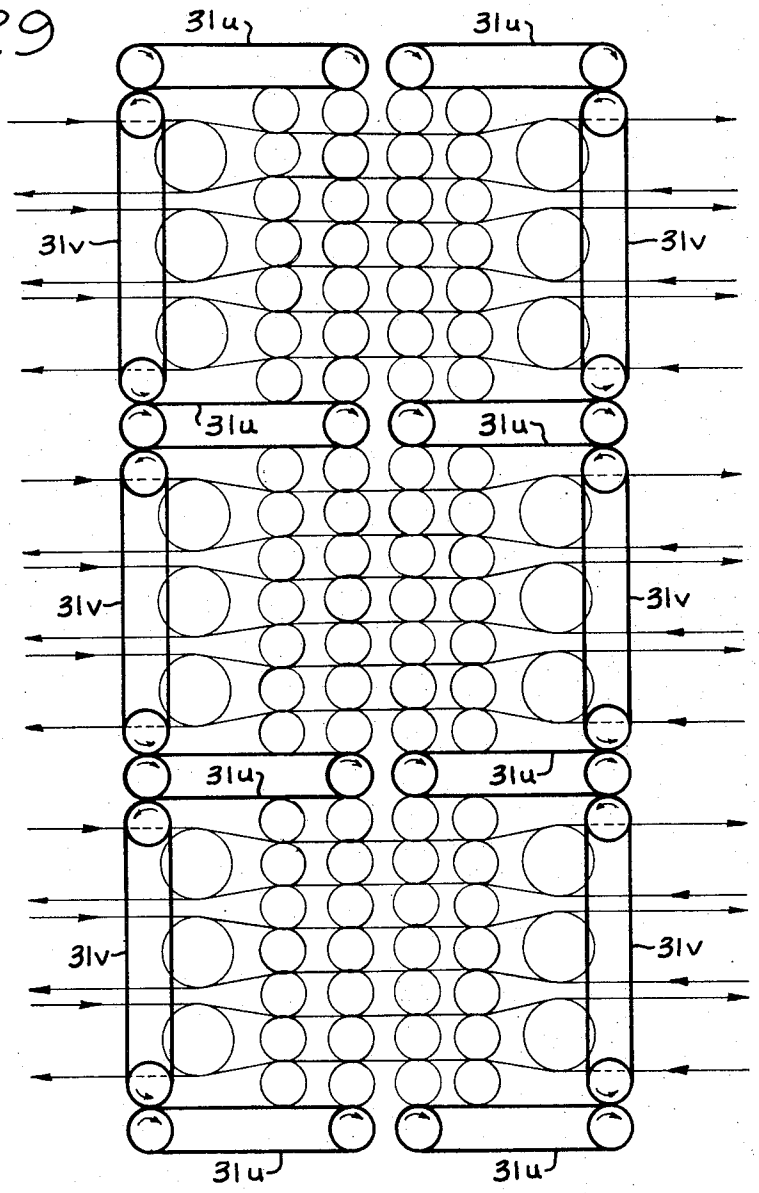
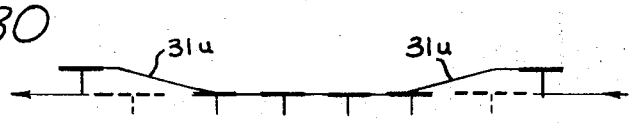


Fig. 30



TRANSFER SYSTEM

SUMMARY OF THE INVENTION

This invention facilitates the high-volume transfer of passengers and freight in a multi-vehicle public transportation system.

There are severe limitations on the capacity of small private vehicles to meet the increasingly heavy demand for mass transportation. Common carrier services offer a much more efficient answer to this need; but public acceptance of these services has been greatly hindered by the uncertainties, delays and discomforts involved in the transfer from one vehicle to another in the typical public transportation trip from initial origin to final destination.

The invention described here is designed to eliminate or greatly reduce these difficulties by the use of a system in which individual passenger-seat/baggage-compartment units and special baggage units, moving in various vehicles from multiple origins, can be uncoupled, sorted and recoupled in appropriate new combinations for movement in different vehicles to multiple destinations - with each passenger staying in the same seat, continuously accompanied by his baggage, throughout the entire multi-vehicle trip. The same system can be used for freight and combined passenger-freight operations.

DESCRIPTION OF THE DRAWINGS

For a description of the objects and embodiments of this invention, reference is made to the attached drawings in which:

FIG. **1** is a basic block diagram of the overall system;

FIGS. **2** and **3** illustrate the individual passenger-seat/baggage-compartment unit in side elevation and plan view;

FIGS. **4** and **5** illustrate a special baggage unit in side and front elevation;

FIG. **6** illustrates the coupling arrangement for these units in enlarged side elevation;

FIGS. **7** and **8** illustrate a local terminal in plan view and front elevation;

FIG. **9** illustrates the terminal drive-gear detail;

FIG. **10** illustrates a loader in side elevation;

FIGS. **11–13** illustrate the loading arrangements for three types of local transports in side elevation;

FIGS. **14–16** illustrate the general arrangement of a sorter in a block diagram and in plan view and side elevation;

FIGS. **17–19A** illustrate, in enlarged plan view and side and front elevation, the sorter chains and sprockets equipped for coupling by magnets and, alternatively, by pins;

FIGS. **20–22A** illustrate, in plan view and side and front elevation, the sorter dollies equipped for support by air cushion and coupling by magnets and, alternatively, for support by casters and coupling by pins;

FIGS. **23–25** illustrate the sorter connector tracks and input/output chains in plan view and front and side elevation;

FIG. **25A** illustrates in side elevation the inter-unit distance in the transition between the sorter connector tracks and input/output chains;

FIG. **26** illustrates a sorter main sprocket (with associated input/output and accelerator/decelerator chains and interior sprockets) in plan view;

FIG. **27** illustrates the sorter side chains in plan view;

FIG. **28** illustrates the waveforms of the input/output and acceleration/deceleration chain speeds; and

FIGS. **29** and **30** illustrate the transverse and transition chains for a complex sorter in plan view and side elevation.

DESCRIPTION OF A PARTICULAR EMBODIMENT

Referring first to FIG. **1** for a general description:

The system employed in this invention has as its basic unit U an individual seat with attached baggage compartment which originates and terminates at local terminals T(**1**)*a–b*. These terminals are situated at commercial and residential centers throughout a region and are served by one or more local transportation services — highway, railroad, short-haul aircraft or watercraft.

Each departing passenger takes a seat in a precoupled unit U at the local terminal T(**1**)a nearest his point of origin — with his coat and bags deposited in the individual compartment underneath his seat and, if necessary, in a special baggage unit U(b) to the rear. At departure time, a loader L places the double-unit columns aboard a local transport X which provides a high-frequency shuttle service to the nearest sorter S(**1**) — located at an intercity highway interchange, railroad junction, major airport of marine terminal or a combination of these.

Here the individual units U, U(b) are unloaded L and automatically uncoupled, sorted S and recoupled according to each passenger's destination.

The local passengers and baggage units are then reloaded L directly into appropriate local transports X for delivery and unloading L at a local terminal T(**1**)*b*— where each passenger takes his coat and bags from the compartment under his seat U or baggage unit U(b) to the rear and proceeds to his local destination.

The long-haul passengers and baggage units are loaded L into high-capacity, long-haul trains, buses, aircraft, or watercraft XX for transportation to the sorter S(**2**) nearest to their local destinations — where they are unloaded L, resorted S according to local destination, reloaded L into appropriate local transports X, and delivered and unloaded L at local terminals T(**2**)*a–b* for termination as described above.

Referring next to FIGS. **2–30** for a detailed description:

The basic system unit U (FIGS. **2–3**) is a conventional aircraft seat **1** supported as by light stiffeners **2** on the top of a nonferrous metal or plastic baggage compartment **3** with front and rear walls but open sides — having hinged doors **4** if desired. (Rollers in the compartment bottom and doors can facilitate baggage loading and unloading.)

The forward end of each unit is equipped with an upward-hinged footrest **5** which fits between the stiffeners **2** of the unit just ahead. As by means of a spring-loaded catch **6** (FIG. **6**) under the rear unit footrest **5**, projecting through a hole in the top of the forward unit baggage compartment **3**, units can be coupled together longitudinally by holding the forward unit fixed and

bringing the rear unit up against it. As by means of a spring-loaded rod **7** on the forward unit, extending downward through guides from the rear unit catch **6** into a hole in the rear bottom edge of the forward unit baggage compartment **3**, the units can be automatically uncoupled whenever the forward unit baggage compartment comes to rest on a boss at the rod location.

The local terminal T (FIGS. **7** and **8**) can consist of a weather-protected room in which one or more levels of units U, coupled together into double columns of any desired length with aisles in between, are supported by tracks **8***a–c* equipped with pairs of longitudinal belts **9** supported by followers **10** and driven by wheels **10***a* powered by a geared electric motor **11**. The vertical track flanges can have lips which fit into low-level notches at the ends of each baggage compartment wall.

Each passenger arriving at the depot places his baggage in the compartment **3** of his preassigned unit U and takes his seat **1**. Where passenger reservations have specified more baggage than the regular unit compartments can hold, the remainder can be deposited in special baggage units U(b) (FIGS. **4–5**) at the rear of the double columns; and these units can be equipped with bag and hat shelves **12** and coat racks **13**. (The forward end of these special units U(b) can be equipped with stub projections **14** which substitute for the passenger unit footrests **5** (FIGS. **2–3**) for coupling purposes; and the rear ends can be provided with a coupling rod **7** (FIG. **4**) and a slot **15** just under a low-level shelf **12***a* to accommodate the stub of a special unit to the rear.) Additional special units can be provided to accommodate freight shipments; and by adjusting the ratio of regular and special units, the system can be operated with any desired mixture of passenger and baggage or freight capacity.

In the at-rest terminal configuration, wide aisles **16** (FIGS. **7–8**) can be provided to assist passengers in depositing their coats and baggage and seating themselves. To conserve transport space and provide ample clearance between the outer unit columns and transport walls when loading and unloading, the double-unit columns when filled can be drawn closer together as by means of a gear shift **17** (FIGS. **7–9**) which connects the belt motor **11** through a lateral shaft **18***a* having worm gears meshed with nuts on the laterally-sliding belt-support tracks **8***a–c*. Additional lateral-shift worm-gear shafts **18***b–c* etc. can be suitably spaced along the aisle **16** and driven by a sprocket and chain **19** on the powered shaft **18***a*.

The shafts **18***a–n* can also drive cams **20** which raise the center hinge of the two-panel aisle floor **16** so that this floor is folded upward as the double-unit columns are drawn together.

At departure time, a loader L (FIG. **10**) is mated to the local terminal T with a weatherproof seal **21** and connected by rolling doors **22**. Like the terminal T, the loader L can be equipped with one or more levels of unit-supporting tracks **8***a–c* and wheel-driven belts **9**. The ends of these tracks can be equipped with foldout extensions **23** which can be lowered in the mated position to connect with the ends of the terminal tracks **8**a-c; and by activating both the terminal and loader belts **9**, the double-unit columns can be moved into the loader. The loader-belt-track extensions **23** can then be folded upward, the doors **22** can be closed, and the loader L can be moved a short distance to a local transport X. (The terminal- and loader-belt operation can be synchronized by a plug **74** on the outside terminal wall through which the loader belt motor **11** can be powered by a control in the terminal.)

The local transport X (FIGS. **11–13**) can be a train or bus or short-haul aircraft or watercraft. The interior of each vehicle is fitted with one of more levels of belt-equipped tracks **8***a–c* (FIGS. **7–9**), spaced to support the unit columns as described above for the local terminals T.

As by means of forward and rear pantographs **24** (FIGS. **10–11**), actuated by motor-driven worm gears **25**, the loader tracks **8***a–c* can be positioned vertically to coincide with the ends of the transport tracks **8***a–c*. When the loader L and transport T hae been mated with a weatherproof seal **21** (FIG. **11**), the two doors **22** can be rolled upward, the loader belt extensions **23** can be lowered to connect with the transport tracks **8***a–c*, and the double columns can be moved into the transport by actuating the loader and transport belts **9**.

Where the local transport is a train (FIG. **11**), use of a special rail car with rotatable sections **26** and rolling end doors **22** will permit unit loading in the fashion described above.

Where this transport is a bus (FIG. **12**), loading in this fashion can readily be performed through hinged end doors **27** and rolling inner doors **22**.

Where this transport is a short-haul aircraft (FIG. **13**) or watercraft, such loading can again be accomplished through hinged nose and tail doors **28, 28***a* and rolling inner doors **22**.

When positioned in the local transport, the double-unit columns can be moved apart laterally to provide the desired aisle **16** (FIGS. **7–9**) in the manner described above for the local terminal. As by reducing the thread pitch on the worm gear shafts **18***a–n* progressively for the middle track **8***b* and the outer track **8***c*, the three tracks can be gradually squeezed together on each double-unit column as it is moved laterally toward the vehicle wall — thus clamping the floor edges of the individual baggage compartments **3** under the lips on the vertical flanges of the tracks **8***a–c*. As by clips **29** positioned on the transport floor to engage the bottom flanges on all three tracks at the outer limit of their lateral movement, these tracks can be secured firmly to the vehicle floor for safety in transit.

(If desired, the loader L (FIGS. **10–11**) serving the local terminal can be provided with the increased interior width and track-separation mechanism **16–20** (FIGS. **7–9**) described above for the local terminal T and can itself serve as this terminal; or such a loader, constructed in the form of a container and incorporating the unit-clamping mechanism **8***a–c*, **18***a–c* **29** described above for the local transport X, can itself be placed aboard the transport and carried to the sorter S for direct unloading. Alternatively, where the distance from the local terminal to the sorter is small, the loader can serve as the local transport; or where the transport is capable of being mated (with suitable alignment and a weatherproof seal) directly to the door of the terminal or to an enclosed extension, the loading of this transport can be accomplished directly by a conveyor-track extension of the terminal tracks **8***a–c*.)

The local transport X (FIG. **1**) operates as a high-frequency shuttle between one or more local terminals

T(1)*a–b* and the nearest sorter S(1). Arriving at this sorter, the transport takes a preassigned input-output position **30** (FIG. **14**) where its units are unloaded in the reverse of the loading procedure described above and are delivered to the appropriate input section T(1)*ai–bi* of the sorter.

The basic sorter mechanism (FIG. **15**) can consist of an arrangement of nonferrous spool-and-flat-link chains **31***a–z* and vertical-axis sprockets **32***a–z* covered by a thin floor **33** (FIG. **16**) and housed in a prefabricated air conditioned building **34** (which can, if desired, provide a rooftop landing area for steep-gradient aircraft or can be placed underground to avoid interference with conventional runways and taxiways or surface transportation lines).

The sorter chains and sprocket perimeters can incorporate uniformly-spaced U-shaped electromagnets **35***e*, **35***ee* (FIGS. **17–19**), each end of each magnet being equipped with a metal-rimmed wheel **36** which positions the magnet face a fraction of an inch below the sorter floor **33.** The magnets can be energized as by means of metal-rimmed wheels **37** slanted inward on each side of the center of each magnet. The shafts for these wheels can be insulated from the magnet bar by plastic sleeves **38** and can be connected to the center of the magnet winding **39** — with this winding being wrapped in opposite directions from the center and being grounded at the ends to the sorter floor through the magnet bar **35** and upper wheels **36.**

The bottom edges of the slanted wheels **37** can provide continuous contact with a beveled coupling-power guide **40***e*, **40***ee* which provides vertical support and horizontal guidance for the magnets; and this guide can be insulated from the building base and can be divided into separately energized sections **40***e*(**1**), **40***e*(**2**), etc.) which transmit the various coupling and uncoupling sequences necessary in the optimum sorting program. (Alternatively, the power for these electromagnets can be obtained through special pick-up and grounding arms and wheels and power strips similar to those **50–51** (FIGS. **20–22**) described below for the sorter dollies.) Additional slanted guide wheels **37***n* (FIGS. **17–19**), with non-conducting rims, can be provided for support and guidance at the midpoints of the chain links **41** which connect the spools **42** between magnets **35.**

The sorter chains **31** can be driven as by appropriately sized main sprockets **32***e*(**1**), **32***f*(**1**), etc. (FIG. **15**) at the ends of the chain runs, supported and held in position by the slanted wheels **37, 37***n* (FIGS. **17–19**) and driven by electric motors **43** geared to racks **44** on the insides of the sprocket rims.

To mesh the main chains **31***e–f* (FIG. **15**) with the main sprockets **32***e–f* and interior sprockets **32***ee–ff*, guide arms terminating in small wheels **45** (FIGS. **17–19**) on one side and sockets **46** on the other side can extend laterally from braces at the midpoint of each magnet **35** and chain link **41** so that they fit together at the point of tangency *t* of the chain magnets **35***e* with the sprocket magnets **35***ee*. (The smaller sprockets **32***a–b*, **32***c–d*, **32***h–i* for the input-output, acceleration-deceleration and side chains described below do not include magnets and can therefore consist of conventional rims equipped with sockets spaced and sized to mesh directly with the chain spools **42.**) (FIGS. **17, 18, 26 & 27.**

Double columns of dollies can be prepositioned in the input sections T(1)*ai*, etc. (FIGS. **14–15**) of the sorter S to coincide with the arriving double columns of units. Each dolly D (FIGS. **20–22**) can consist basically of a nonferrous metal or plastic tray and frame **47** dimensioned to fit the base of the baggage compartment **3** on an individual unit U. This dolly frame can be equipped with a plastic apron **48** and small electric-powered blower **49** which permits the dolly to operate as an air cushion vehicle. To provide blower power, a roller-equipped arm **50** can extend downward from the dolly frame to an insulated power strip **51** along the dolly path on the upper surface of the sorter floor **33** — and a low-level power connection **52** can be provided between adjacent dollies so that when locked together they can both be fed from the same power strip **51.** (In an alternative or supplementary support arrangement, the corners of the dolly frame can be equipped with large pneumatic-tired casters **53** (FIGS. **20A–22A**).)

A spring-loaded nonferrous plate **54** (FIGS. **20–22**) can extend laterally underneath the middle of each dolly frame **47** and can be horizontally restrained at each end by brackets **55.** To this plate can be fastened an array of inverted U-shaped and L-shaped electromagnets **56***a–c*, **57***a–b* (or permanent magnets for the caster-support arrangement) having the same longitudinal pole-to-pole dimension a as the sorter chain and sprocket magnets **35***e*, **35***ee* (FIGS. **17–19**) and being equipped with nonconducting wheels **58** (FIGS. **20–22**) which coincide with the sorter-chain magnet wheels **36** (FIGS. **17–19**) beneath the sorter floor **33** and which position the dolly faces a fraction of an inch above this floor. (To furnish the ground connection for the dolly blower and electromagnets, two of the magnet wheels **58** on each dolly can be conductors — with insulated shafts **59** connected to the dolly frame **47** by wires which lead through unidirectional current-control elements **60** to prevent grounding of the blower-power strip **51** when one of these wheels passes over it — or this ground connection can be provided by additional roller-equipped arms **50** which afford continuous contact with the sorter floor **33.** A similar current-control element **60** can be used in the wires from the power pick-up arms **50** to prevent grounding when one of these arms is in contact with the sorter floor.)

The three interior magnets **56***a–c* are centered on the dolly's longitudinal center line, oriented fore and aft, with a lateral separation b just equal to that between the chain and sprocket magnets **35***e*, **35***ee* (FIGS. **17–19**) at the point of tangency t in the sorter.

The exterior magnets **57***a–b* (FIGS. **20-22** are designed to interlock on adjacent dollies to form three fore-and-aft pairs with the same longitudinal and lateral interpole separations a and *b* as the interior magnets **56***a–c*. Both the double-legged sections **57***a* and the single-legged sections **57***b* of the exterior magnets have lateral connecting bars; and the double-legged sections **57***a* also have longitudinal connecting bars which, for adjacent dollies, are joined on a vertical diagonal face. The flux-path between the poles of any of the three exterior-magnet fore-and-aft pairs will thus flow through this joint and will hold the dollies together both laterally and longitudinally.

This arrangement permits magnetic coupling and switching in accordance with central sorting program signals by alignment of the sorter magnets **35***e*, **35***ee*,

etc. (FIGS. 17–19) in the chains 31*e* and sprockets 32*ee* etc. just beneath the sorter floor 33 with either the single-unit dolly magnets 56*a–c* (FIGS. 20–22) or the double-unit dolly magnets 57*a–b* just above this floor. (In an alternative arrangement, the dolly coupling can be accomplished mechanically as by replacing the sorter magnets 35*e*, 35*ee*, etc. (FIGS. 17-19) by pairs of vertical solenoids 61 (FIGS. 18A–19A) with windings energized in pairs through the slanted wheels 37 at the center of each link 41 (and grounded through the upper wheels 36) and with pins 61*a* which, when actuated by energizing the associated sections of the coupling power strips 40*e*(1), (2), etc., can be inserted through a narrow slot 62 in the sorter floor 33 into properly spaced pairs of elongated holes 63 (FIGS. 20A–22A) in low-level plates 64 suspended by brackets 65 beneath the middle of each dolly tray and frame 47. As through extensions 66 of these plates beyond the dolly frames and a step 67 in one end of each plate to provide a slight vertical clearance, adjacent dollies can be locked together for paired movement when the pins are inserted upward through double pairs of holes by energizing the appropriate coupling-power strip sections.)

(Strengthening of the sorter floor 33 (FIGS. 17–19) to carry the weight of the dollies D and their unit loads U, U(b) can be accomplished as by increasing the thickness of the flooring on both sides of the coupling magnet paths and providing beams 68 supported on columns 69 on each side of the sorter chains 31*e* and sprocket rims 32*ee*, etc.)

The double columns of units U (FIGS. 23–25) arriving at the sorter S are moved by loader L (or directly by conveyor tracks) onto short roller-equipped connector tracks 70 which provide a transition to the double-dolly columns (D—D) *l–n*. (To facilitate unit movement, the loader's rear pantograph 24 (FIG. 10) can be raised sufficiently to slant the loader track extensions 23 (FIG. 25) at the same angle *q* as the connector tracks 70.)

To hold each unit U firmly on its dolly D, the bottom of the baggage compartment 3 (FIGS. 20–22) can be indented to coincide with bosses 71 at the corners of the dolly tray. Placement of the double units (U—U) 1–n (FIGS. 23–25) on prepositioned double dollies (D—D)*l–n* (center-coupled through their interlocked magnets 57*a–b* to sorter magnets 35*a* on each input chain 31*a*) is accomplished when the front of the first double-dolly frame (D—D)1 engages the forward bottom edge of the first double unit (U—U)1 at the lower end of the connector track 70. (To hold each double unit at the end of the track until a double dolly is in position to engage it, the end roller on each rail can be replaced with an adjustable-friction rubber disc 72 of the same size.)

The longitudinal spacing d of the sorter magnets 35*a* on the input chain 31*a*, and hence of the dollies D coupled to them through the sorter floor 33, is equal to the length c of the units U being delivered to these dollies from the loader track extensions 23 plus the interunit distance *e* (equal to the height *f* of the unit baggage compartment 3 multiplied by the tangent of the connector track angle *q*) which develops in the transition of units from the connector track 70 to the dollies D, (FIG. 25*a*). The order of these double units is prearranged by the original seat assignment at the local terminal T(1)*a* to end up with the related-passenger units (U—U)*l–n* at the delivery end of the input chain and the individual passenger units (U)*l–n* (still in pairs) at the receiving end.

Power is supplied to the input-chain drive motor 43 (FIGS. 17–19) in a sinusoidal pattern, producing a chain speed pattern *s* (a) (FIG. 28) running from zero to a level *x* sufficient to advance each dolly one space *d* (FIG. 25) on each input chain cycle *g* (FIG. 28). As each double unit (U—U)1 (FIGS. 23–25) is pulled forward on a double dolly (D—D)1 by the sinusoidal advancement of the input chain 31*a*, bosses 73 (FIGS. 20–22A) centered on top of the back of each dolly tray raise the unit rods 7 (FIG. 6) and interunit catches 6 and uncouple this double unit (U—U)1 (FIGS. 23–25) from the double unit (U—U)2 just behind it. The first double unit (U—U)1 then moves forward on its double dolly (D–D)1; and the next double dolly (D—D)2 is advanced by the input chain 31*a* to engage the next double unit (U—U)2. This process continues until all double units in the column are positioned on double dollies.

(The outer wall of the sorter at each input postion can be equipped with a receptacle 74 into which the loader L can plug and through which a central computer 75 (FIGS. 14–15), by controlling a sinusoidal power supply for the loader-belt drive motor 11 (FIG. 10), can determine the sorter-feeding rate for each loader in accordance with the dolly-introduction program for that input position.)

The double units (U—U)*l–n* on the input chain 31*a* can be introduced into the sorter as soon as required in the optimum sorting program established by the central computer for the particular combination of destinations involved in the units positioned at that moment on all of the sorter's input chains.

To give each unit a comfortable transition from the standstill input-chain condition 0 (FIG. 28) to the standard sorter chain speed y, the sprocket 32(a)2 (FIG. 26) at the delivery end of the input chain 31*a* can be positioned adjacent to a sprocket 32*c*(1) at the pick-up end of an acceleration chain 31*c* — with a separation b equal to the lateral magnet separation on the dollies D (FIGS. 20–22).

The sprocket drive motor 43 (FIGS. 17–19) for this acceleration chain 31c (FIG. 26) is powered to produce a sinusoidal speed pattern *s*(c) (FIG. 28) with a cycle time *g* similar to that of the input chain pattern s(a) but with a 180° phase difference and with minimum and maximum speeds just equal to the maximum input-chain speed *x* and standard main-chain speed *y*, respectively. (The standard main-chain speed *y* is determined by the centrifugal force which can be confortably experienced as a unit travels around the perimeter of an interior sprocket 32*ee–ff* (FIG. 15). For a passenger weighing 150 pounds, traveling on the perimeter of a sprocket 10 feet in diameter, a main-chain speed of 4.4 feet/second (3 miles per hour) will produce a centrifugal force of approximately 14 pounds — which appears to be well within acceptable limits.)

Many different configurations of chains 31 and sprockets 32 can be employed in the sorter to serve systems of varying complexity. The configuration described here, simply as an illustration, provides for each end of each main chain 31*e*, etc. (FIG. 26) to be served by two input chains 31*a–b* and two output chains 31*y–z* — each with an acceleration chain 31*c–d*, 31*w–x*.

The sprockets 32*c*(2), 32*dd*(6) at the delivery end of these acceleration chains 31*c*, 31*d* are adjacent to a main chain 31*e* as it passes around a main sprocket 32*e*(1), with separations *b* equal in each case to the lateral magnet separation *b* on the dollies D (FIGS. 20–22).

In this arrangement, units are fed onto the main chain 31*e* (FIG. 26) alternately by one acceleration chain 31*c* and then the other 31*d*. At the point that an input to this main chain is appropriate in the optimum sorting program, a signal from the central computer 75 (FIGS. 14–15) energizes the coupling power strip 40*a* (FIGS. 23–25) for all of the sorter magnets 35*a* on the first input chain 31*a;* and all units on this chain are gradually accelerated and then decelerated in a sinusoidal pattern *s*(a) (FIG. 28) which advances them one space *d* (FIGS. 23–25). At the point of maximum speed, the center poles of the interlocked magnets 57*a–b* for the first double dolly (D—D)1 are automatically uncoupled from the input chain magnet 35*a* by deenergizing its coupling-power guide 40*a* — while the left poles of these interlocked double-dolly magnets are simultaneously coupled to the adjacent acceleration-chain magnet 35*c*(FIG. 26) by energizing its coupling-power strip. (To overcome any drag effects of residual magnetism, the coupling-power strips in the "off" condition can be energized with a slight negative voltage.) As by the error-signal-actuated governors 76 (FIGS. 17–19) for the input and acceleration-chain motors 43, the two chain-speed cycles s(a), s(c) (FIG. 28) are synchronized so that the cycle low point *x* for the acceleration chain 31*c* (FIG. 26) coincides at the point of tangency *t* with the cycle high point *x* for the input chain 31*a;* and the switching of units from the input-chain coupling 35*a* to the acceleration-chain coupling 35*c* can thus be accomplished smoothly.

As by means of these same governors, the input- and accelerator-chain cycles are synchronized with the movement of the main-chain magnets 35*e* around the main sprocket 32*e*(1) and after the first double dolly (D—D)1 has been gradually accelerated from the maximum input-chain speed *x* (FIG. 28) up to the standard main-chain speed *y*, this double dolly can be smoothly switched from the acceleration chain 31*c* (FIG. 26) to either the main chain 31*e* or main sprocket 32*e*(1) at the point of tangency *t*. This switching is accomplished on a signal from the central computer which, as the acceleration-chain magnet 35*c* for this double unit reaches the point of tangency, deenergizes this magnet through its coupling-power guide and energizes either the adjacent main-chain magnet 35*e* or the adjacent main-sprocket magnet 35*es* through their respective coupling-power guides and shifts the coupling of this double dolly from its left interlocked magnet poles 57*a–b* (FIGS. 20–22) to either its center or its right interlocked poles. (The switching sequence described above can be graphically summarized by a bold line (FIG. 28) which follows the leading edge of the input- and acceleration-chain sine waves *s*(a), *s*(c) from a zero-speed point up to the main-chain speed level *y*.

Introduction of units from the adjacent input chain 31*b* (FIG. 26) is accomplished in the same manner, except that several small guide sprockets 32*d* (2–5) can be employed to give the acceleration chain 31*d* a gradual angular transition between its points of tangency *t* with the input chain 31*b* and main chain 31*e*.

The phase relationship *h* (FIG. 28) between the adjacent input-chain cycles *s*(a), *s*(b) can be determined by the relative lengths of the dolly-travel paths on the associated acceleration chains 31*c*, 31*d* (FIG. 26) and by the perimetal distance between their points of tangency *t* with the main chain 31*e* on the main sprocket 32*e*(1). The cycles for these input chains and their respective acceleration chains can be staggered so that by alternation they feed consecutive main-chain magnets 35*e;* or if the optimum sorting program calls for units on every second mainchain magnet, the cycle time *g* (FIG. 28) for the input- and acceleration-chain cycles can be doubled. Whenever required in the optimum sorting program or because of a malfunction, the feeding of units onto the main chains 31*e*, etc. (FIG. 26) can be interrupted for any desired period by a sustained deenergizing of the coupling-power guides for the input chains 31*a–b*.

As the last of the double units (U—U)n (FIGS. 23–25) approaches the delivery end of an input chain 31*a*, the procedure for single units (U)*l–n* can be commenced as by the use of side chains 31*h*, 31*i* (FIGS. 15, 27) located on either side of the input chain 31*a* and geared to the same cycle *s*(a) (FIG. 28).

When the dollies (D)1–(D)2 (FIGS. 23–25) for the first pair of these single units (U)1–(U)2 reach the zero-speed point (FIG. 28) adjacent to the receiving ends of the side chains, a central computer signal uncouples all the remaining dolly pairs from the input chain 31*a* and (through their left and center interior magnets 56*c*, 56*a* (FIGS. 20–22), respectively) couples the first left dolly (D)1 to a sorter magnet 35*h* (FIG. 27) on the left side chain 31*h* and the first right dolly (D)2 to a fixed electromagnet 77 adjacent to the right side chain 31*i*.

On the next input- and side-chain cycle, the interlocking magnets 57*a–b* (FIGS. 20–22) on these first two dollies are disengaged; and the first left dolly (D)1 (FIG. 27) is pulled straight forward to a guide sprocket 32*h*(2).

On the following cycle, a central computer signal uncouples the first right dolly (D)2 from the fixed magnet 77 and couples it (through its right interior magnet 56*b* (FIGS. 20–22)) to a sorter magnet 35*i* (FIG. 27) on the right side chain 31*i* which pulls it straight forward to its guide sprocket 32*i*(2). On this cycle, and on every other cycle thereafter, all the remaining dolly pairs (D)3–(D)4, etc. (FIGS. 23–25) on the input chain 31*a* are advanced one space *d*.

On this same cycle, the first left dolly (D)1 (FIG. 27) is redirected by its guide sprocket 32*h*(2) onto a side-chain path 31*h* which gradually converges with the input chain 31*a*. This convergence terminates a few cycles later with a zero-speed point at a delivery sprocket 32*h*(3), separated from the input chain 31*a* by the dolly-magnet lateral separation *b* (FIGS. 20–22). At the point of tangency *t* (FIG. 27), central computer signals uncouple this left dolly (D)1 (through its left interior magnet 56*c* (FIGS. 20–22)) from the left side-chain magnet 35*h* (FIG. 27) and couple it (through its center interior magnet 56*a*) to the adjacent input-chain magnet 35*a;* and this dolly and its individual unit (U)1 move forward on the input chain 31*a*.

The first right dolly (D)2 (FIGS. 23–25) proceeds through this same convegence one cycle behind the first left dolly (D)1 (and is followed in turn by the second left dolly (D)3 and second right dolly (D)4, etc.);

and the string of individual units (U)1–n thus travels onward to the acceleration chain 31*c* (FIG. 26) and main chain 31*e* in the same manner described above for the double units (U—U)1–*n*.

(If the caster-support and the pin-and-hole coupling alternative 53, 61–63 (FIGS. 18A–22A) is used for dolly operations, the guide sprockets 32*h*(2), 32*i*(2) (FIG. 27) can be moved outward a sufficient distance to permit clearance between the dolly coupling plate extensions 66 (FIGS. 20A–22A) and the casters 53 on the adjacent dolly; and the two individual dollies, after being uncoupled jointly from the input-chain solenoid pair 35*a* (FIG. 27) and coupled separately to the left and and right side-chain solenoid pairs 35*h*, 35*i*, can be pulled forward together to the guide sprocket before the one-after-the-other advancement sequence is commenced.)

In the sorter configuration used here for illustration, the actual sorting process starts when the first double unit (U—U)1 (FIGS. 23–25) on the acceleration chain 31*c* (FIG. 26) reaches the point of tangency t with the main chain 31*e*. Here, in accordance with central computer signals based on the optimum sorting program for that moment, this double unit can either be switched to a mainchain magnet 35*e* (by coupling with the center interlocked dolly magnet 57*a–b* (FIGS. 20–22) and carried forward on the main chain to the first interior sprocket 32*ee*(1) (FIG. 26) or it can be switched to a main sprocket magnet 35*es* (by coupling with the right interlocked dolly magnet), carried around the main sprocket perimeter to the point of tangency with a deceleration chain 31*x* or 31*w* switched to one of these deceleration chain magnets 35*x* or 35*w* (by coupling with the left interlocked dolly magnet) and then switched to an output chain magnet 35*z* or 35*y* (by coupling with the center interlocked dolly magnet).

If the double unit is carried forward to the first interior sprocket 32*ee*(1), it can be either continued forward on the main chain (by maintaining the coupling with the center interlocked dolly magnet) or, depending on its programmed destination, switched to an interior-sprocket magnet 35*ee* (by coupling with the right interlocked dolly magnet).

If switched, the double unit can be carried half-way around the sprocket perimeter, switched to a magnet 35*ef* on the next interior sprocket 32*ef*(1) (by coupling with the left interlocked dolly magnet), carried halfway around this sprocket perimeter, and switched again either to a magnet 35*f* on the next main chain 31*f* (FIG. 15) (by coupling with the center interlocked dolly magnet) or to a magnet 35*ff* on the next interior sprocket 32*ff*(1) by coupling with the right interlocked dolly magnet).

By a sequence of switching operations, with the spacing of unit coupling on the chain and sprocket magnets programmed to avoid intersection conflicts, the sorter can rapidly deliver the units to the deceleration and output chains 31*x*, 31*z*, etc., for the various local and long-haul destinations in the system.

To minimize unit travel in the sorter (FIG. 14), the output position o for any particular connecting service can be located diametrically opposite the input position i; and to eliminate transport or loader travel around the sorter, each transport can alternate its service between two different origin/destination points T(1)*a*, T(1)*b* or S(2), S(3) (FIG. 1) — with the sorter input position T(1)*a*(i) or S(2)*i* (FIG. 14) for one such point adjacent to the sorter output position T(1)*b*(o) or S(3)*o* for the other and vice versa T(1)*a*(o), T(1)*b*(i), and S(2)*o*, S(3)*i*.

The typical sorter S(1) illustrated here (FIGS. 1, 14–15) serves a combination of local and long-haul origins and destinations. The input procedure for units U arriving in local transports X from terminals T(1)*a*, T(1)*b* throughout the adjacent regions has been described above. The input procedure is the same for units arriving in long-haul transports XX from other sorters S(2), S(3) in the system — except that these long-haul transports (large airplanes, trains and perhaps buses and watercraft) will typically carry several hundred units, possibly in multiple levels, and will require the use of larger loaders (possibly with multiple levels or with pantographs 24 (FIGS. 1–11) adequate to reach the upper transport levels) and perhaps the assignment of multiple output and input positions S(2)*o*, S(2)*oo*, etc. (FIG. 14) for each such transport.

The output procedure for the units U (FIG. 1) sorted for local transports X serving local terminals T(1)*a*, T(1)*b* in the regions adjacent to this sorter S(1), and for long-haul transports XX serving other sorters S(2), S(3) in the system, is simply the reverse of the input procedure.

After discharging its double-unit columns onto loader tracks 8 (FIG. 10) (or conveyor tracks) for delivery to input chains 31*a–b* (FIG. 15), each transport is loaded — by just the reverse of the process described above — with the units (assembled in double-unit columns on output chains 31*y–z*) which have arrived a few moments earlier on other long-haul or local transports and have been sorted for destinations served by this particular vehicle and delivered to the appropriate output positions. (The loaders used to deliver arriving units from incoming transports to input positions can, if desired, be shifted immediately to adjacent output positions as by means of lateral belts so that they can load departing units for delivery to outgoing transports.)

The operation at the output positions follows the above-described input procedure, but with the direction and movement of the units reversed. The output-chain magnets 35*z* (FIGS. 23–25), coupled to the center interlocked magnet 57*a–b* on each double dolly, move the double units (U—U)1–n in sequence onto the inclined connector track 70 and up the rollers to loader track extensions 23 (or conveyor tracks). As the first double unit (U—U)1 leaves its double dolly (D—D)1, the spring-loaded unit rods 7 (FIG. 6) return to their at-rest position and, by lowering the catches 6 on each half of the double unit (U—U)2 immediately to the rear, couple the two double units together. (Once the first double unit (U—U)1 reaches the loader track extension 23 (FIGS. 23–25) at the upper end of the connector track 70, the loader belts help to pull the following mechanically-coupled double units (U—U)2–n onto the connector and loader tracks; and this pull from the double-unit column on the belts will be sufficient to load the last few double units which have no push from units on dollies behind them.)

The double dollies on the output chain 31*z*, after having their double units unloaded in this manner, are advanced to a transverse distributor chain 31*r* (FIGS. 15, 25) where (in accordance with coupling-power-guide signals from the central computer 75) they are circulated in the above-described sinusoidal pattern and de-

livered as necessary to accommodate double-unit columns arriving at adjacent input chains **31***a–b*.

(Where a special baggage unit U(b) (FIGS. **4–5**) arriving at a sorter S (FIGS. **14–15**) contains bags for more than one destination, these bags can be placed on empty dolly trays on the input chain and delivered through the sorter to the output chains for their respective destinations. Here they can be consolidated in special baggage units arriving from other transports or fed into the sorter at appropriate times by the central computer **75** from a special-unit storage circuit **78***a* consisting of connector chains **31***s* and a storage chain **31***t* with the same sinusoidal speed patterns *s*(c), *s*(a) (FIG. **28**) described above the acceleration and input chains, respectively. If desired, special seat units can also be used in the system, equipped with swivel chairs, desks, or other equipment meeting special passenger desires; and these units can be kept in similar storage circuit **78***b* (FIGS. **14–15**) in the sorter for assignment as needed. Special food and beverage units can be received from incoming transports and cleaned and restocked to meet the needs of outgoing transports in a kitchen **79***a* connected to this storage circuit by an input-output chain **31***k;* and special lavatory units can be emptied and cleaned in an additional facility **79***b* with a similar connection **31***l*.)

As soon as a local or long-haul transport X, XX (FIG. **1**) is loaded L at a sorter S(**1**), it departs. When a local transport X arrives at one of its local terminals T(**1**)*a*, the units U,U(b) for the local destinations served by this terminal are unloaded L by the exact reverse of the loading procedure described above, and as soon as these units have come to rest in the terminal, each passenger takes his coat and bags from the baggage compartment beneath his seat U or the special baggage unit U(b) to the rear and proceeds to his destination.

When a long-haul vehicle XX arrives at one of its other sorters S(**2**), the units for the local terminals T(**2**)*a*, T(**2**)*b* served by this sorter are unloaded L, sorted S by local destination, and loaded L into local transports X for transportation to these terminals as described above.

The basic combination of chains and sprockets in the sorter arrangement described above can be expanded to accommodate any necessary degree of system complexity.

In a system with a large number of local terminals and sorters, the long movements of units perpendicular to the sorter main chains can be expedited as by an arrangement of upper-level transverse chains **31***v* (FIGS. **29–30**) served by strategically located transition chains **31***u* — with the power in the transition-chain magnets increased as necessary to provide the coupling strength for the transition slopes and with the chain links articulated vertically (as well as horizontally) to accommodate the upward and downward curves of these slopes. Alternatively, these perpendicular unit movements can be accommodated by providing additional columns of interior sprockets **32***ee–ff*, etc. (FIG. **15**) and by programming unit inputs on alternate magnets on each main chain **31***e–f*.

To achieve extremely large sorters, this arrangement can be expanded vertically by the addition of a second sorter floor — with units in the local and long-haul transports positioned so that the loaders can serve the upper and lower levels consecutively. Operations in a complex system of this kind can, if desired, be further facilitated by providing an intermediate level of subsorters between the main sorters and the local terminals.

For continuous operation of a 36-position sorter of the configuration illustrated here (FIGS. **29–30**), with a sorter speed of 4.4 feet/second (3 mph) as described and assuming that half of the units to be sorted involve individual passengers, the internal travel time from the input to the output connector tracks will range from 1½ minutes for the shortest movement to 3 minutes for the longest movement. With belt-actuated loading and unloading of the shuttle-operated transports as described, the typical turn-around time at the sorter will be 3 to 5 minutes. The total transfer time at this sorter for a typical passenger will thus average approximately 6 minutes.

The convenience of this system can be further increased, if desired, by a pick-up and delivery arrangement between the local terminals and the origins and destinations of passengers at their homes or places of business or congregation.

This arrangement can make use of special local vehicles which can be shortened versions of the loader L described above (FIGS. **1**, **9–11**), with the unit-clamping track arrangement described for the transports **8***a–c*, **18***a–c*, **29** but without pantographs.

In the departure movement, such vehicles can provide individual units or small groups of units for boarding by passengers and baggage at the passengers' actual points of origin and carry these units to the nearest local terminal. Here they can be coupled with other units in any desired order by mating the vehicle and terminal tracks and, by actuating the vehicle belts, engaging the unit-footrest catches with units already on the terminal tracks.

In the arrival movement, units received at a local terminal from a sorter or from another local terminal can be uncoupled as by a solenoid plunger which is centered between the tracks 8a,b for each unit column and which, when actuated by a signal in the terminal, lifts the coupling rod **7** and catch **6** (FIG. **6**) on adjacent units as the first of these units is advanced by the terminal belts **9** (FIG. **9**) to a mated vehicle with a slightly higher belt speed. This vehicle can then carry a single unit or small group of units from the local terminal to the passengers' actual points of destination, where they take their baggage and alight.

What is claimed is:

1. A transportation system providing a no-seat-change movement of individual passengers and baggage from their true origin to final destination through any desired sequences of diverse transports and transfers which comprises:

transportation units each including a single passenger seat which is at least partially open and baggage carrying space, the necessary covering of the partial opening being provided by said transports, said units being capable of being grouped together longitudinally and laterally; transport means for said units which may be simultaneously loaded and unloaded;

means at local terminals by which grouped units can be filled and emptied;

means for loading and clamping said grouped units into said transports for transportation thereof, the partial opening of said units providing communication between them; and

automatic sorters having means for unloading, sorting by destination, regrouping said units in a desired seating arrangement, and loading said units into other transports for transportation to other sorters and local terminals.

2. The system recited in claim **1** wherein certain of said units further comprise special baggage compartments to accommodate passengers' additional requirements.

3. The system recited in claim **1** wherein certain of said units further comprise freight compartments to permit effective utilization of said system during off-peak periods.

4. The system recited in claim **1** further including special local vehicles which can transport said units individually between said local terminals and the passenger's points of initial origin and final destination, at which points said units can be boarded and vacated, and means at said local terminals for coupling and uncoupling said units.

5. The system recited in claim **1** wherein said sorters have means for loading and unloading said transportation units through the ends of said transports.

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