

[54] **HIGH-SAFETY COMPLEX LIFT WITH ELECTRONIC COLLECTIVE CONTROL**

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[57] **ABSTRACT**

[21] Appl. No.: **234,004**

Improvements in elevators operated in banks and also individually, in which the equipment may be adapted for the various requirements of apartment houses, hotels, office buildings and business establishments, by the addition of components to a basic control system which in any event will be relatively simple and inexpensive. When operated bankwise, the control system assures a desirable distribution of the workload, and also accommodates full loading of any individual elevator. The individual elevators have improved safety locks, improved brakes, improved sheave construction, improved speed control, improved load-limiting mechanism, and improved guide structure.

[30] **Foreign Application Priority Data**

Mar. 11, 1971 Hungary LI 217

[52] **U.S. Cl.** **187/29 R**

[51] **Int. Cl.** **B66b 1/18**

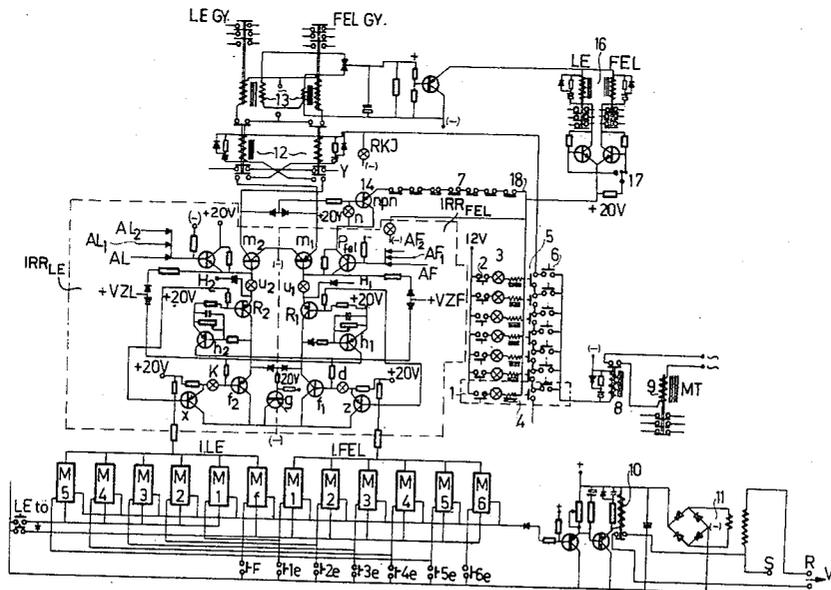
[58] **Field of Search** 187/29

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1 Claim, 32 Drawing Figures



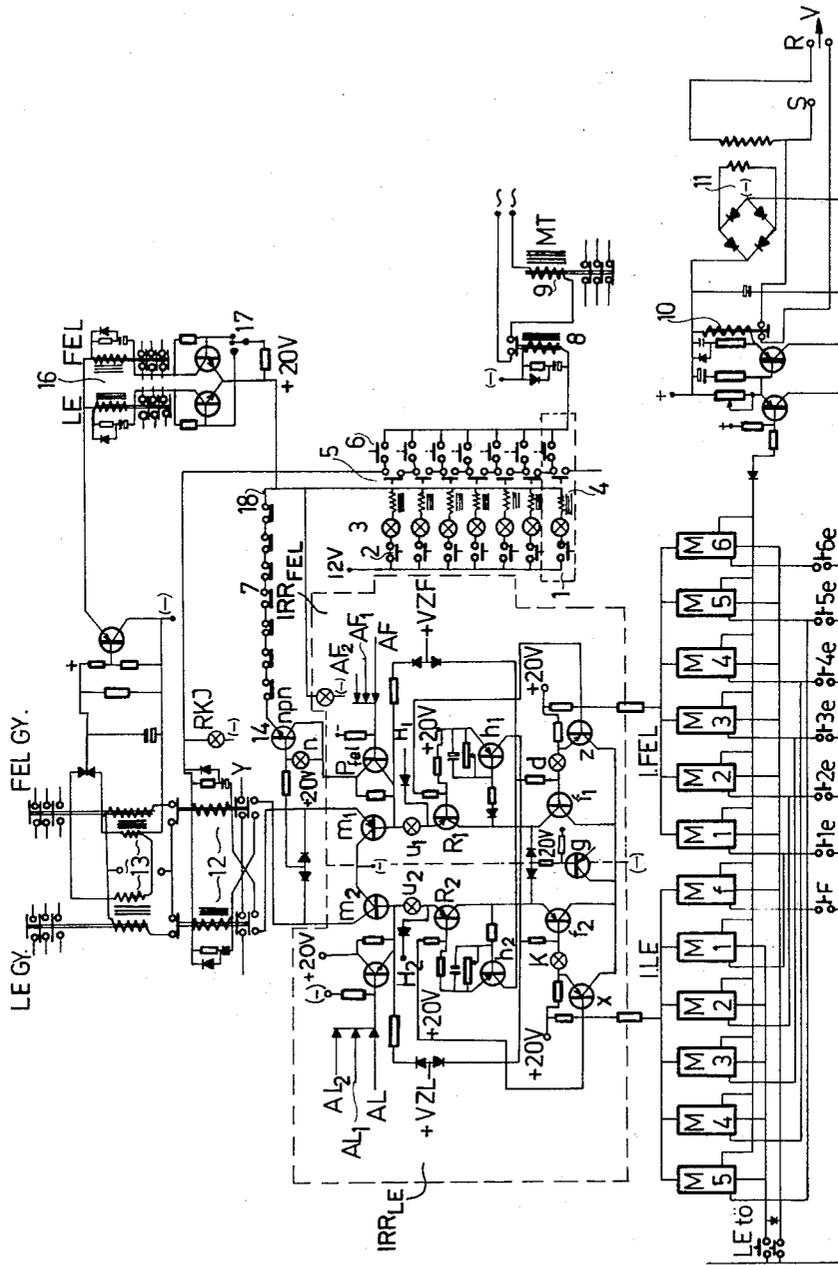


Fig. 1

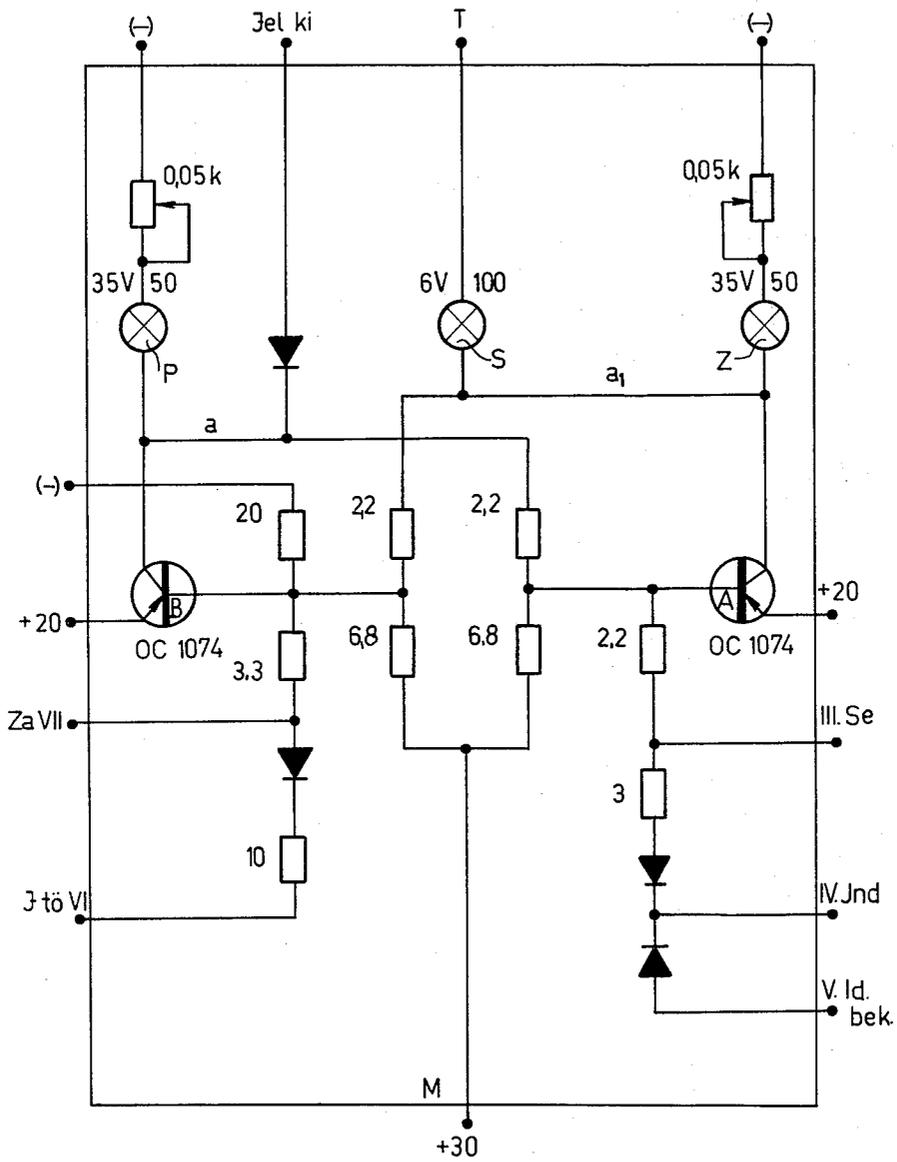


Fig. 2

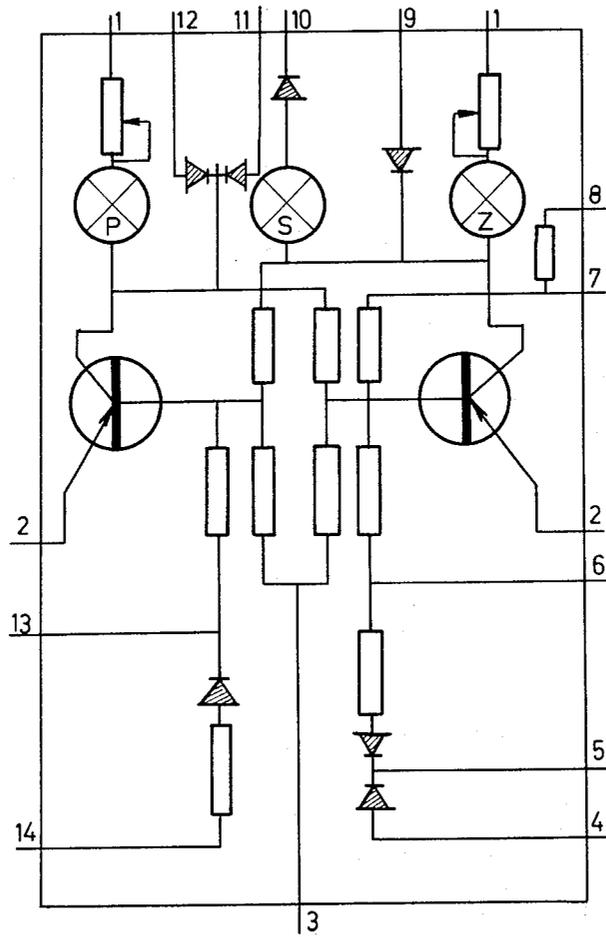


Fig. 2a

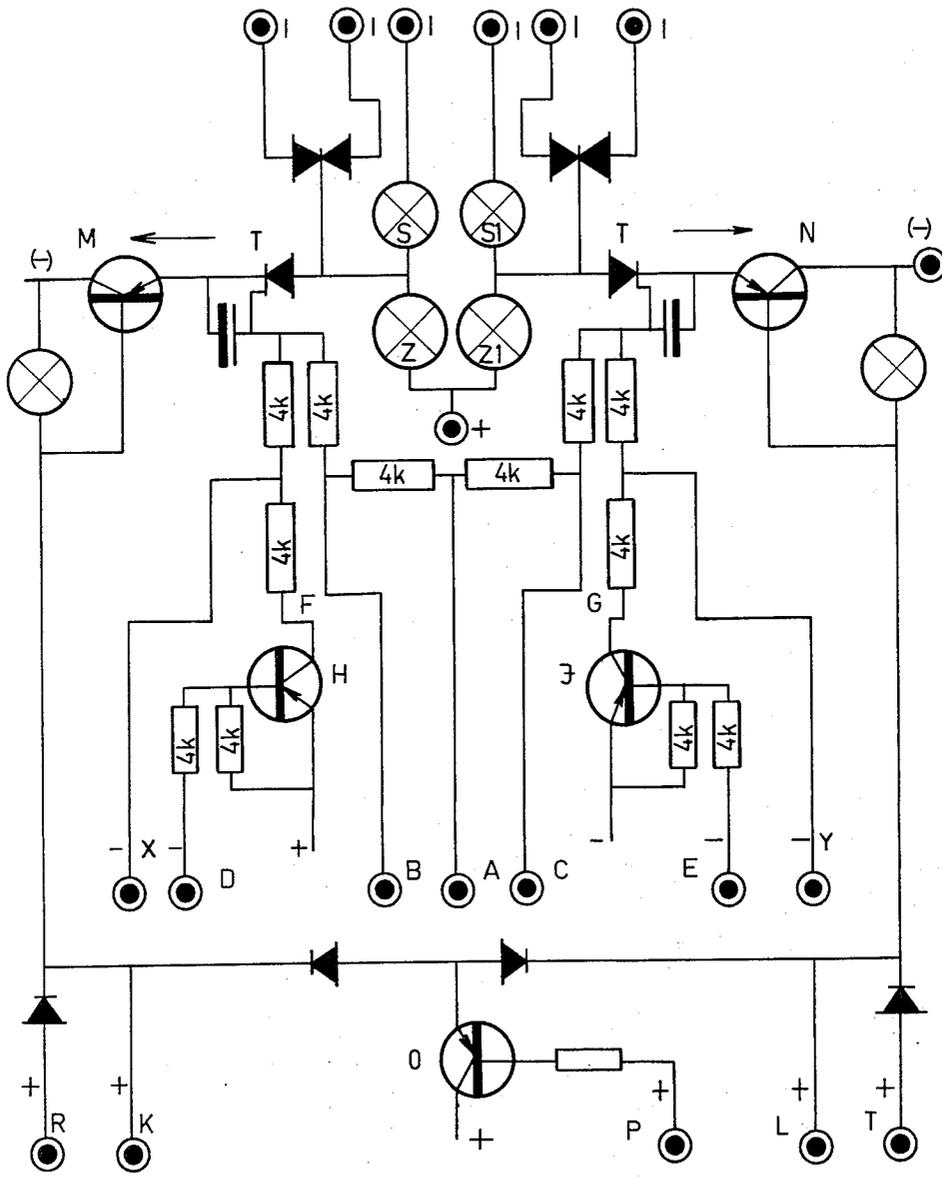


Fig. 2b

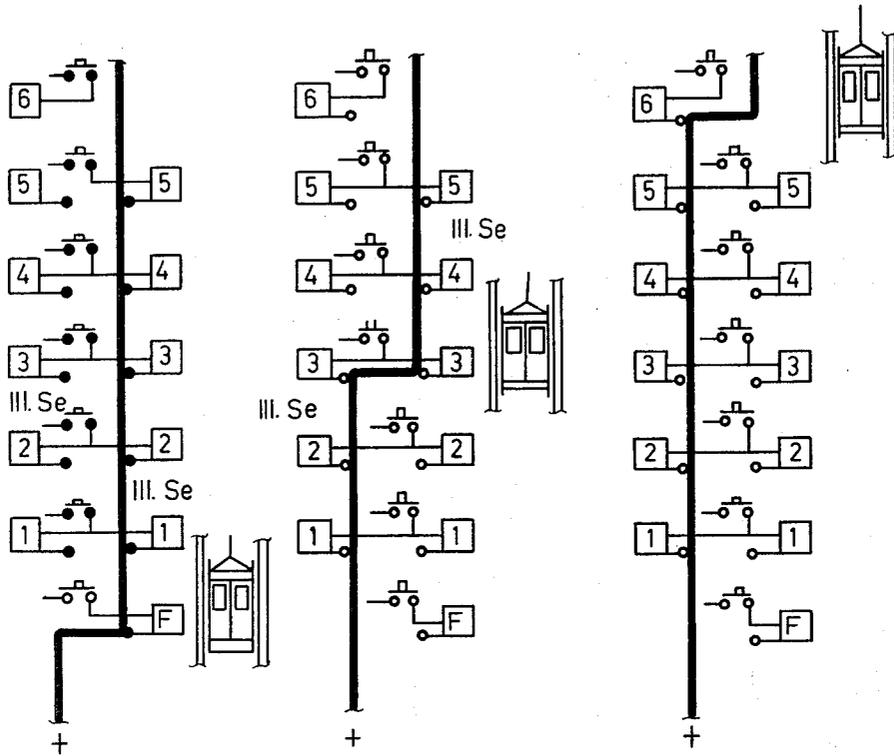


Fig. 3

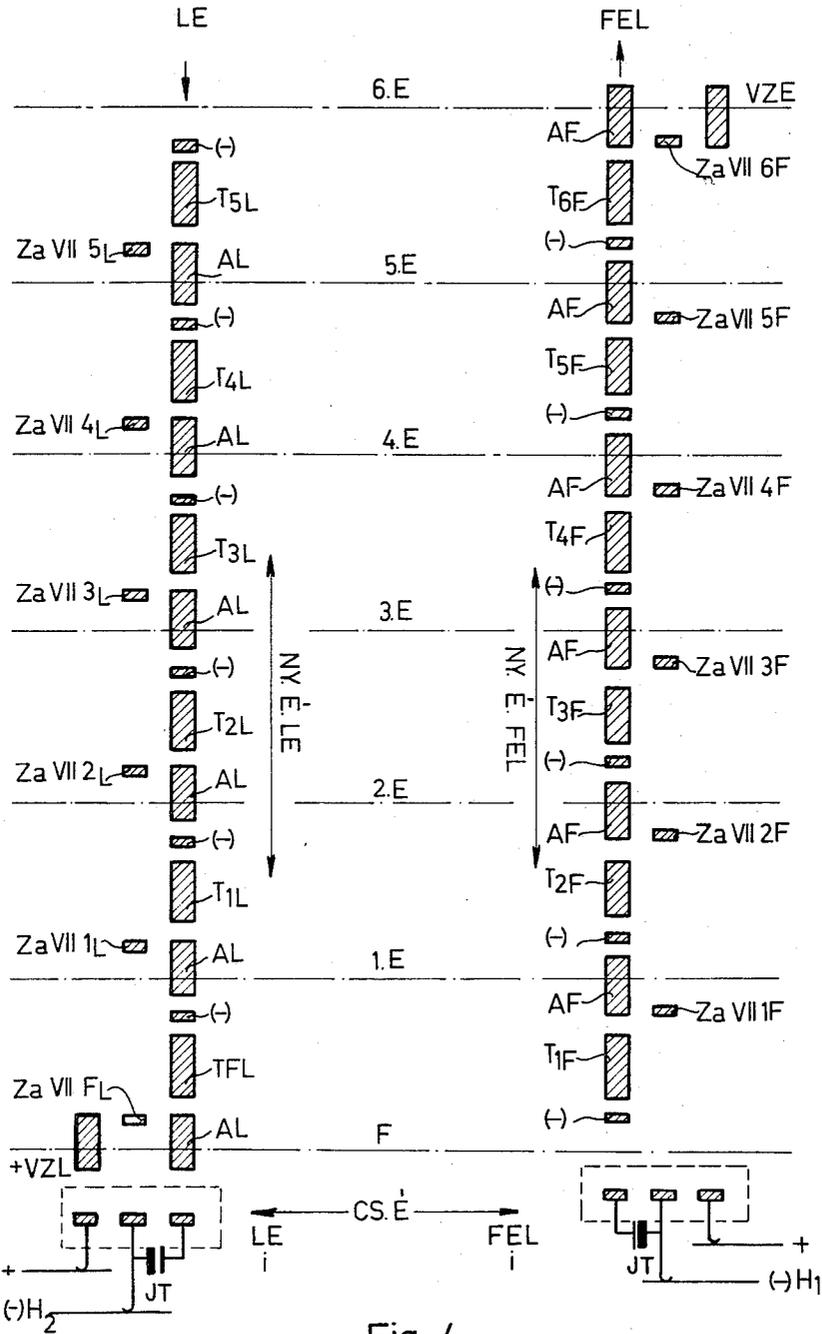


Fig. 4

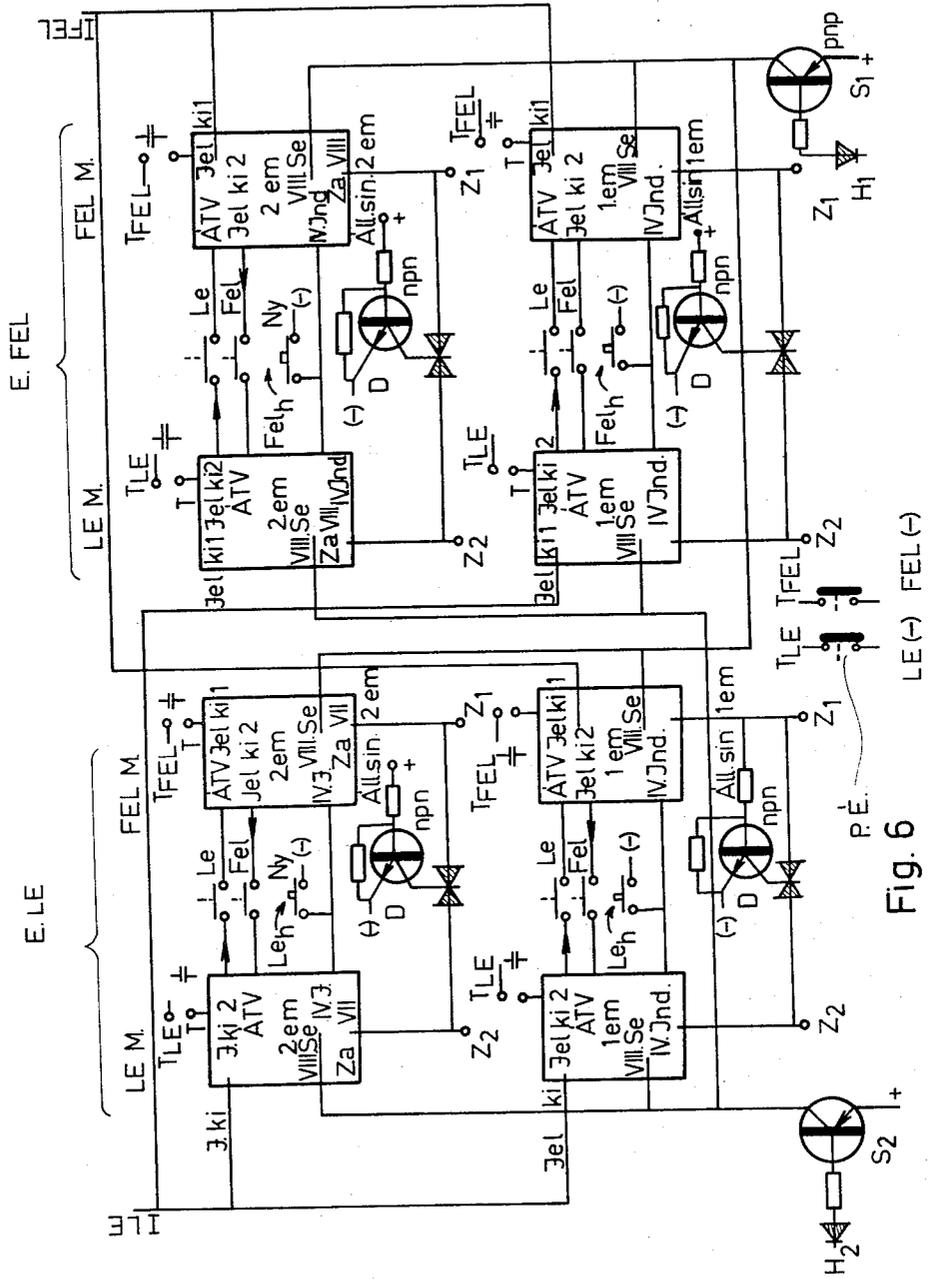
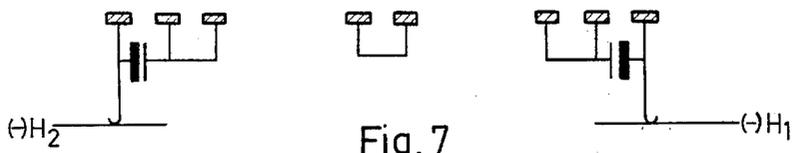
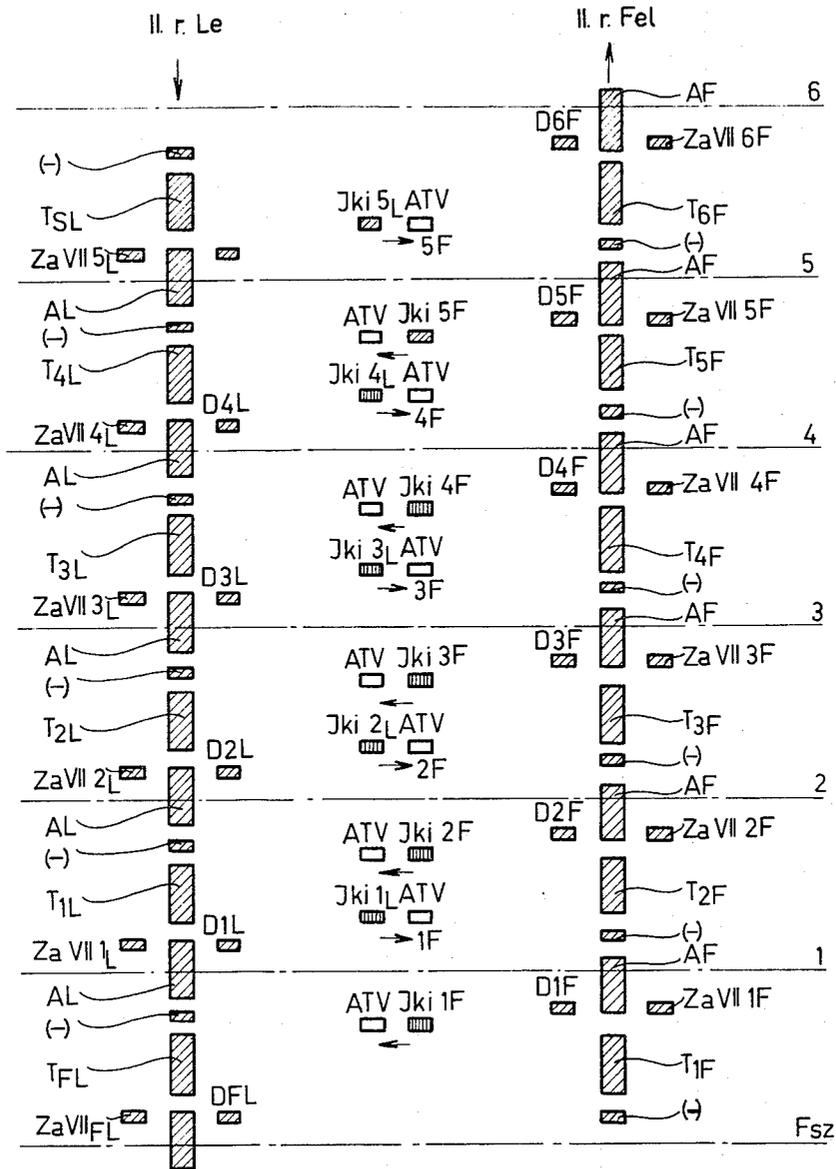


Fig. 6



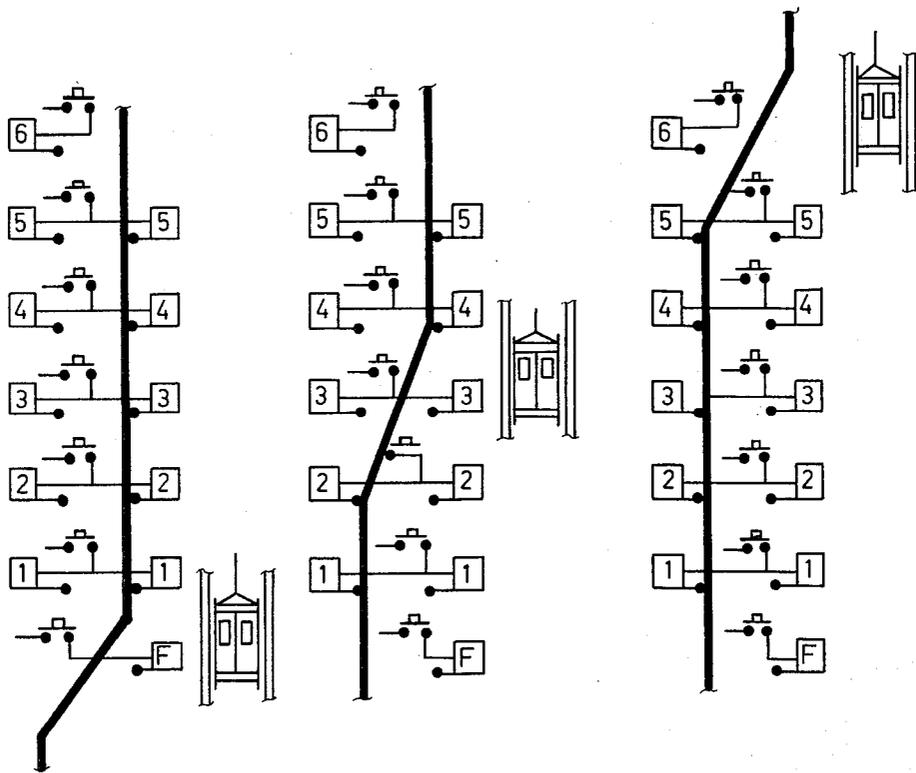


Fig. 8

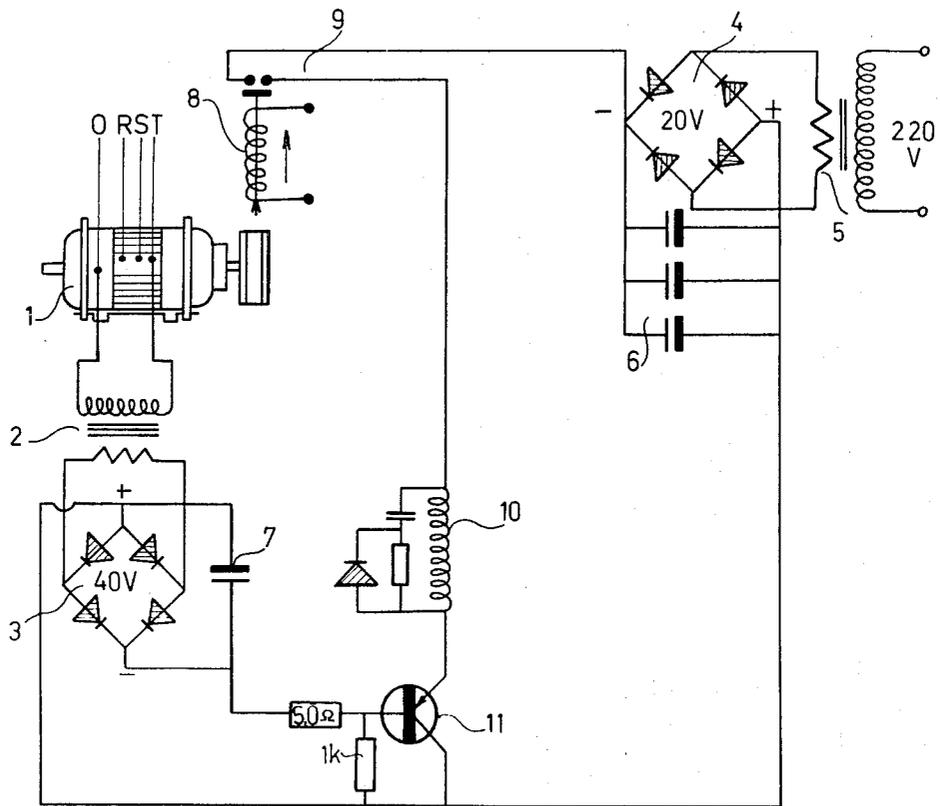


Fig. 9

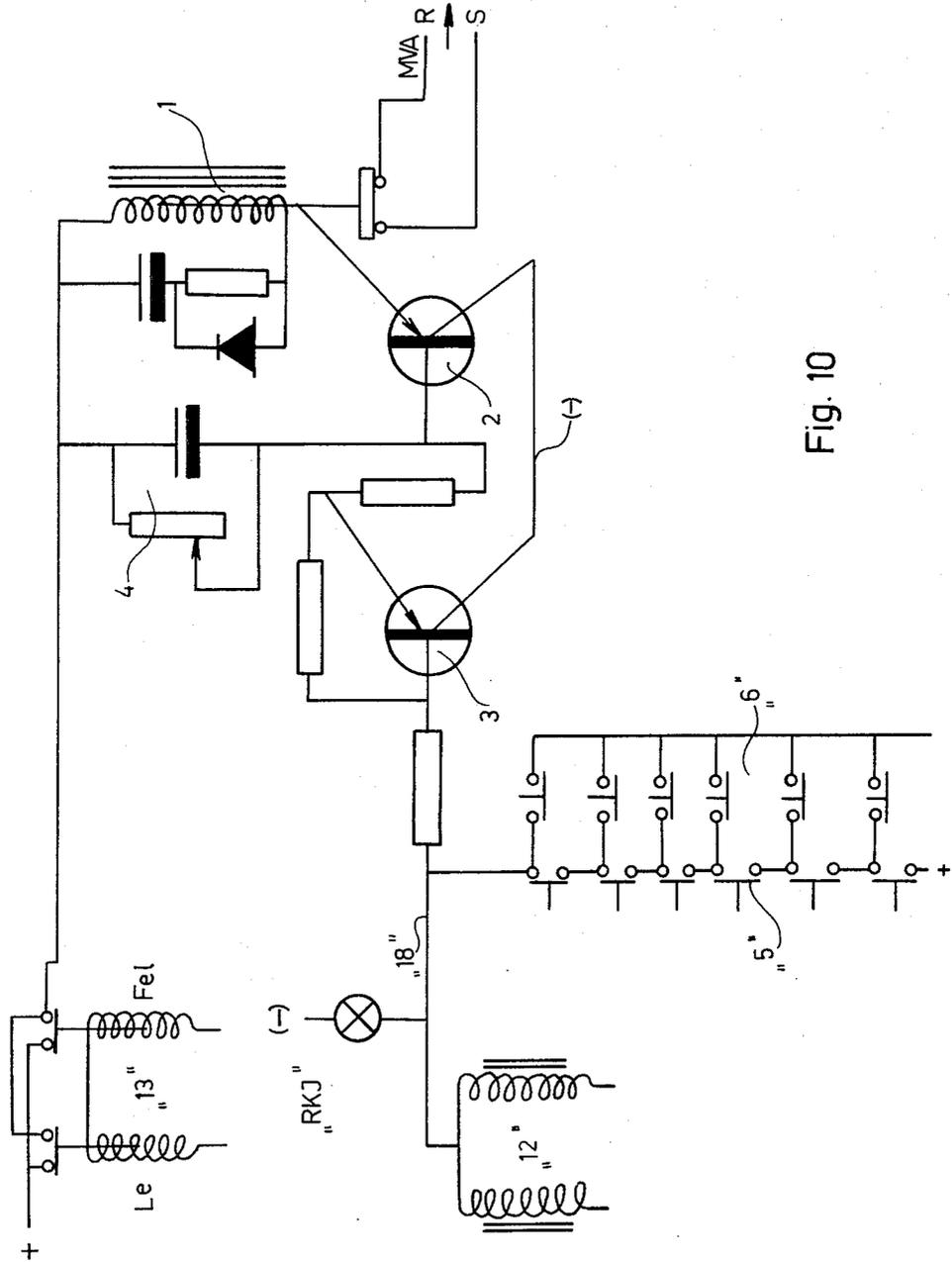


Fig. 10

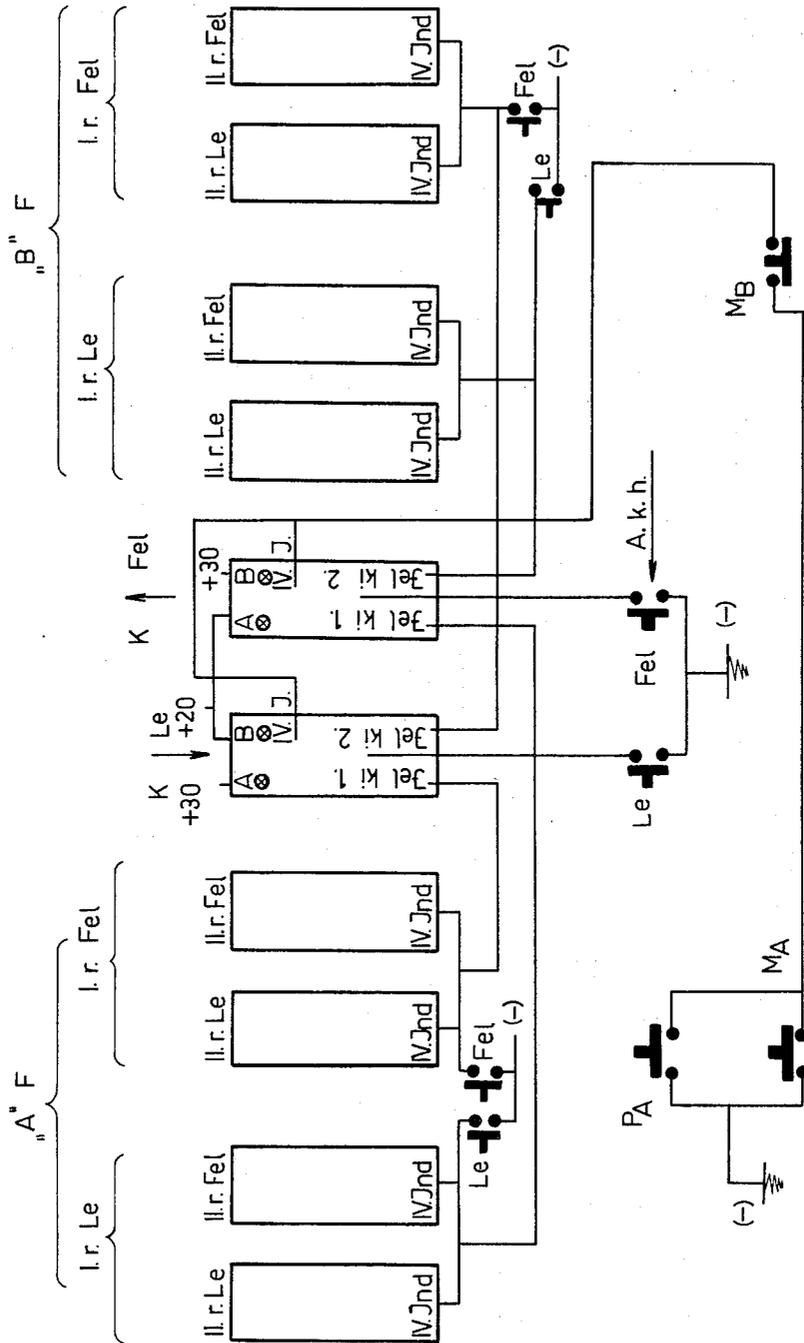


Fig. 11

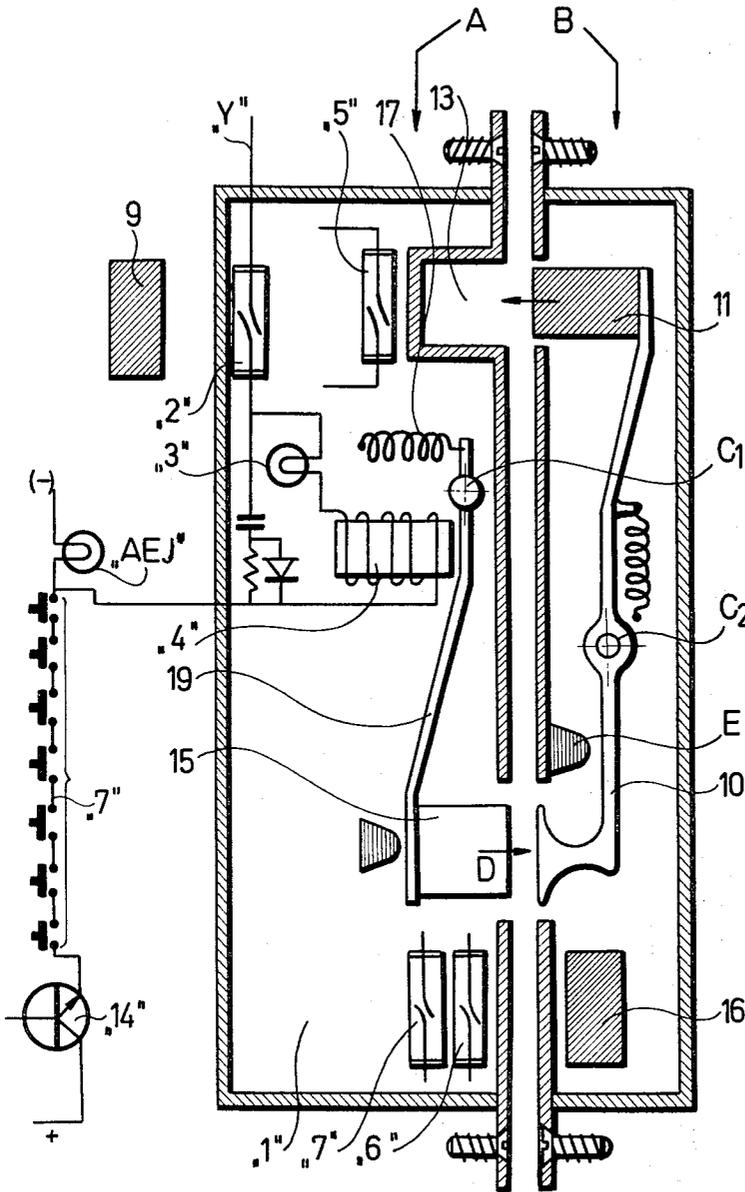


Fig. 12

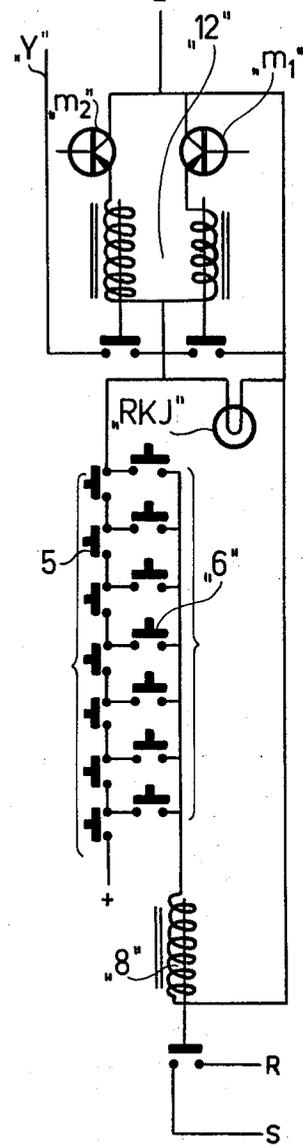


Fig. 13

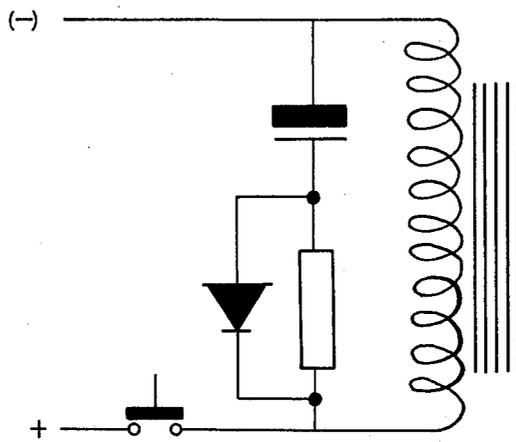


Fig. 14

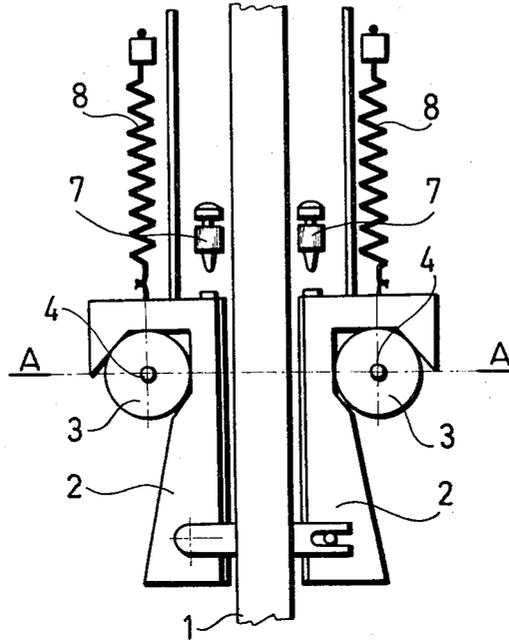


Fig. 15

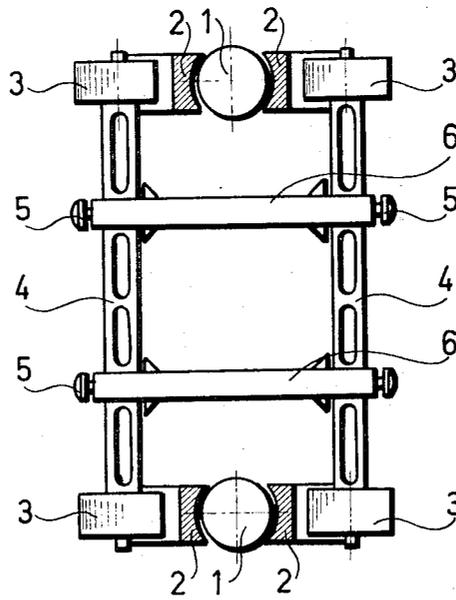


Fig. 16

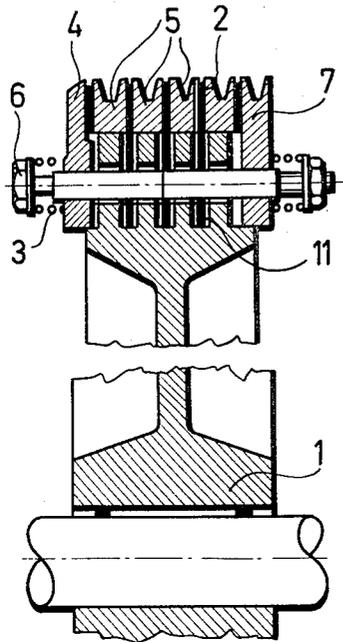


Fig. 17

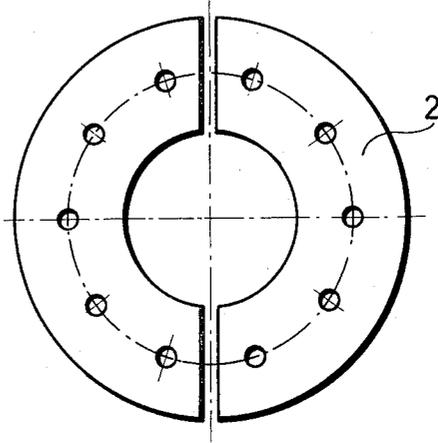


Fig. 18

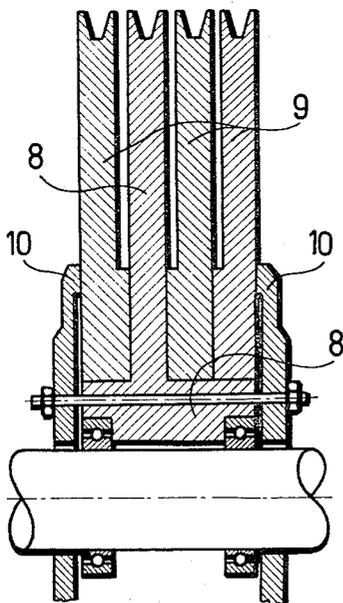


Fig. 19

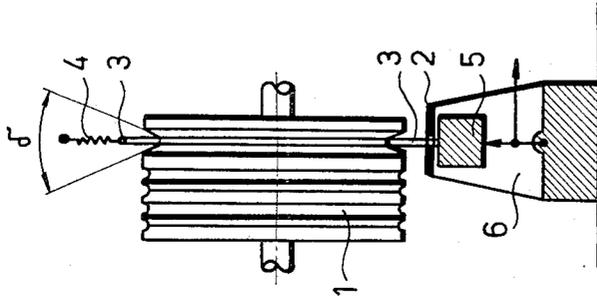


Fig. 21

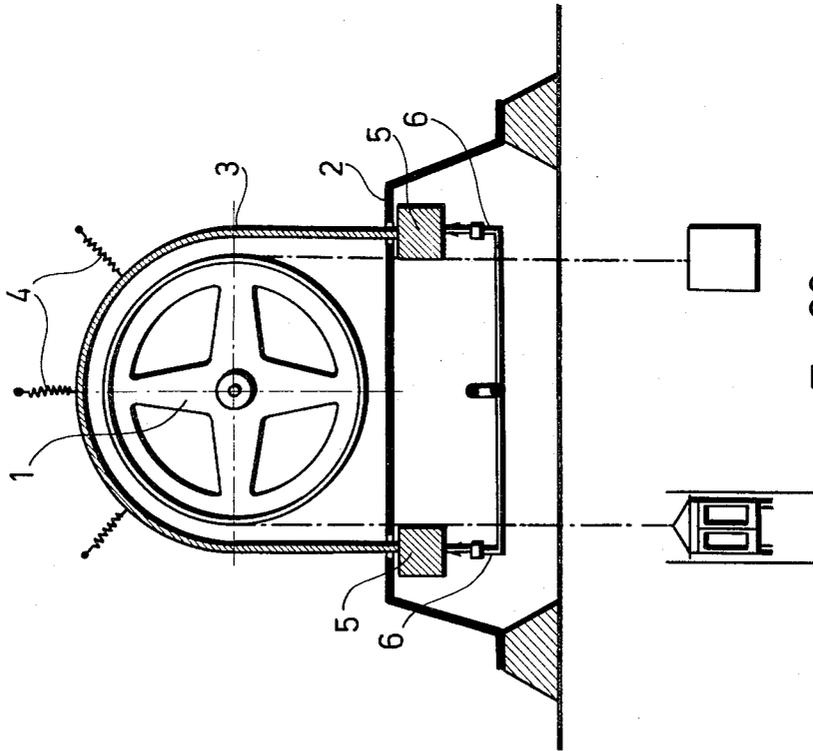


Fig. 20

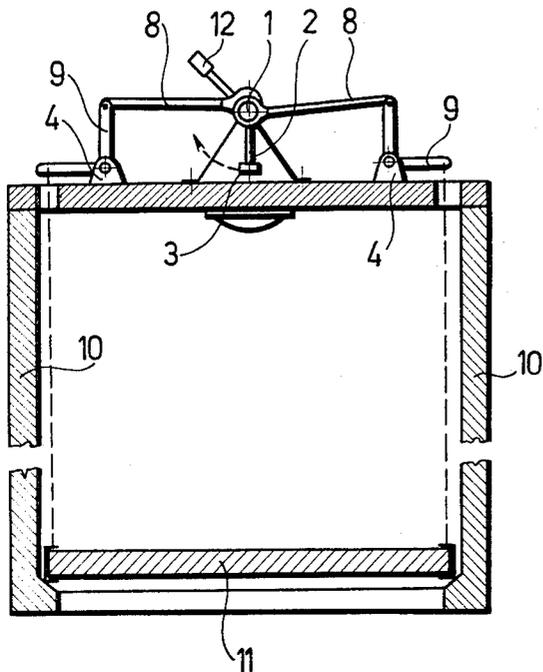


Fig. 22

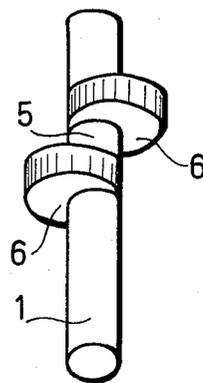


Fig. 24

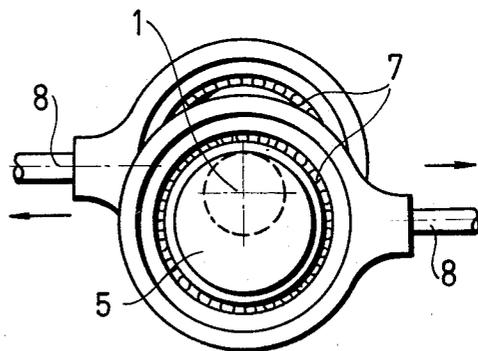


Fig. 25

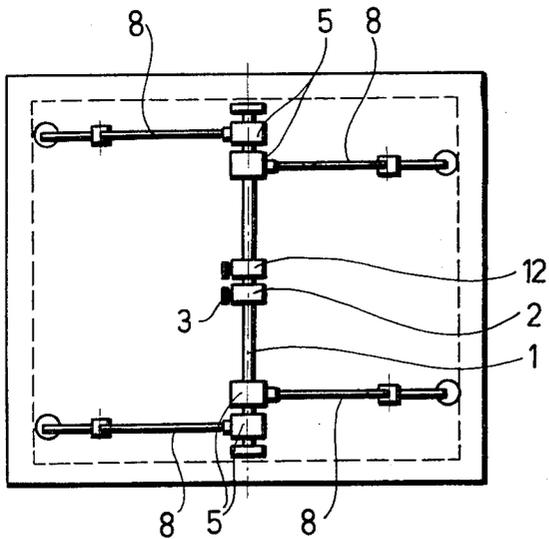


Fig. 23

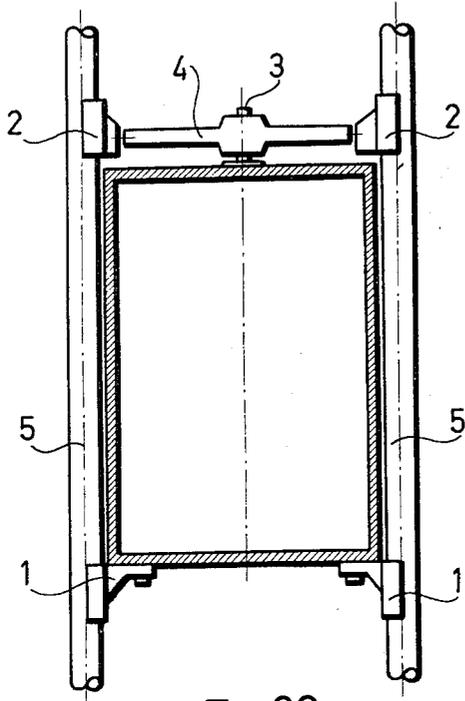


Fig. 26

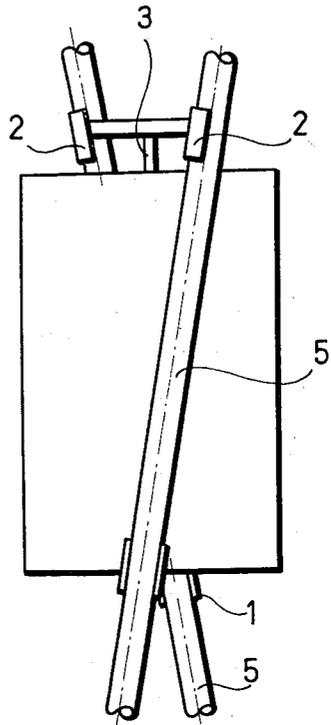


Fig. 28

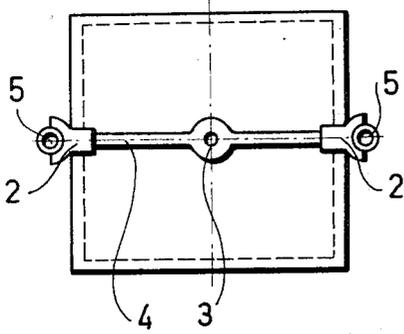


Fig. 27

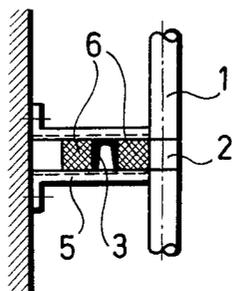


Fig. 29

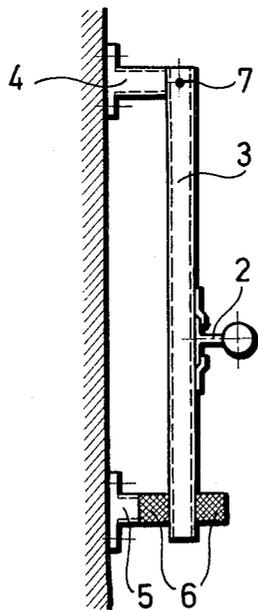


Fig. 30

HIGH-SAFETY COMPLEX LIFT WITH ELECTRONIC COLLECTIVE CONTROL

The control and safety equipment of elevators is of extreme complexity, sensitive to defects, expensive, and its parts are very largely not interchangeable. It requires increasingly careful maintenance and consequently installation and maintenance personnel of high technical and professional competence.

Elevator equipment according to the invention meets the needs of modern comfort and eliminates the shortcomings referred to above.

Its principal structural units conform to modern principles of elevator technology and the practical solutions embodied by it are simpler than those of the known systems. It operates with d.c. and electronic collective control.

The principal advantages of the system of the present invention are as follows:

1. Independence

Owing to d.c. operation, the equipment does not respond to electromagnetic pulses (lightning, electric discharges, sparks, etc.) originating externally, and causes no interference with broadcast or TV reception.

2. Optimum Satisfaction of Traffic Needs

From the standpoint of traffic, three types of elevator systems are generally employed, namely, those for apartment houses, those for hotels, and those for office buildings.

All three types may have components in common, in the present invention, and may be built up of the same structural and electrical elements. Only the number of units will change according to the type of system, increasing in the sequence of enumeration hereinafter.

3. Economy and Inexpensive Maintenance

Space requirements and costs of the electronic control unit of the type for apartment houses do not exceed those of a television set. All units characteristic of each of the three types of control, and the control that is common to all, are interchangeable, plug-in type units. Lights indicate the "standby for service" condition of the elevator. Possible breakdowns or faults may be localized by means of these and other lights. Fault tracing and repair do not require any special professional training.

4. Shock-Proofness; and Operational Safety

The control system operates with very low voltages and with currents of the order of magnitude of milliamperes. Therefore, for shock-proofness there are no hazards, and owing to the length of the control leads and their resistance, no disturbances are likely to arise.

5. Weather-Proofness

The control system is not sensitive to environmental air conditions. It will operate with safety within temperature extremes ranging between -20° and $+50^{\circ}$ C, and in extremes of relative humidity.

6. Long Useful Life

The built-in semi-conductors also operate at very low voltages and although some of them supply induction consumers owing to their special protection, no voltages in excess of the permissible advance to them. For practical purposes all contacts and switches are spark-proof, so that their useful life is unlimited.

7. Short-Circuit Protection

In general in the operation of elevators, a short-circuit of electrical safety contacts constitutes the gravest of risks. In this case it may occur that the elevator

operates even with the doors open, which is apt to cause accidents. Therefore, attempts have been made to eliminate contact current breakers apt to become faulty, by the substitution of induction devices, etc. However, these solutions could never become popular owing to the complexity of their design and high cost of manufacture. In the equipment according to the invention, the control system senses a breakdown of the contacts from a short circuit, and thus in the event of short circuit prevents the equipment from operating. The same will occur also when a short circuit occurs in the machine room, in the shaft, or in any other conductor of the contacts, further when any one of the starting remote-controlled switches fails to switch off, or when a switch is turned "ON" forcibly, by manual force.

8. Safety Locking of the Doors

The electrical safety locking system of the doors differs from the conventional solutions in that there is no mechanical connection between the locking system and the elevator car, and with its adoption the earlier noisy electromagnetic apparatus apt to break down frequently can be eliminated.

9. New Gripping or Braking Apparatus

The gripping device, by retaining the effect of the mechanism of the earlier braking-gripping apparatus, operates also on the principle of gravitation, so that it may come into action irrespective of a breakdown in the suspension system, rupture of the cable, and even in a manner independent of the speed limiting device. This device has made possible the elimination of the highly delicate so-called rocking lever needed for the operation of the earlier gripping apparatus.

10. Non-Skid Driving Sheave

The new driving sheaves and driven sheaves permit a considerable extension of the useful life of the suspension cables and, for all practical purposes, uniform distribution of load in the counterweight cables. In addition to sparing the cable, a far higher load ratio has become possible between counterweight and elevator car, i.e. a better cable loading ratio can be achieved. This permits an appreciable reduction of the weight of the elevator car.

11. Automatic Safety Brake

A brake operating in both directions comes into action automatically immediately when connection between the driving motor and the driving sheave is interrupted, or when no current flows to the driving motor (e.g. owing to power failure, power line rupture, bad contact making, etc.) and owing to breakdown or forcible interference the operating brake remains open.

12. Simple R.P.M. Control

A simple and inexpensive control feature of the d.c. supplied driving motor, irrespective of the direction of rotation of the motor, permits an infinitely variable control, in effect similar to the Ward-Leonard systems, from neutral to the maximum operating speed of rotation.

13. Load Limiting Device

The load limiting device operating on the principle of weight sensing, irrespective of the fluctuations of the force due to the speed variation in either direction of travel of the elevator car (at start and braking), and without any damping device, will sense the standard load of the elevator car only.

14. Differentiated Guiding System of the Elevator Car

The slides and guide rollers preventing the seizure of the elevator car will not even in the event of inaccurately installed guide rails transmit a load higher than that resulting from the stress owing to eccentric load to the guide rails. Consequently, installation and mounting of the guide rails is simplified.

15. Special Guide Rail Brackets

The guide rail brackets of the invention permit the use of the least expensive and most appropriate guide rail sections. Their use at the same time supersedes the known spring type slide or roller guides of the elevator car.

Other objects, features and advantages of the present invention will become apparent from a consideration of the following description, taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a circuit diagram basic to all types of control of elevators according to the present invention;

FIGS. 2, 2A and 2B are the circuit diagrams of the memory units of the control system;

FIG. 3 is a set of diagrammatic representations of the story tracers at various levels;

FIG. 4 is a diagrammatic indication of the UP and DOWN story tracers, for apartment buildings;

FIG. 5 is a diagrammatic control circuit for hotels and office buildings;

FIG. 6 is a diagrammatic control circuit for business establishments;

FIG. 7 is a view similar to FIG. 4, but for business establishments;

FIG. 8 is a view similar to FIG. 3, but for business establishments;

FIG. 9 is a circuit diagram for the control of the automatic emergency brake;

FIG. 10 is a circuit diagram of the control of the safety automatic circuit breaker;

FIG. 11 is a block diagram of the collective control of a bank of elevators for business establishments;

FIG. 12 is a diagrammatic view of the safety door bolt and its actuator;

FIG. 13 is the circuit diagram of the door opening control;

FIG. 14 is a fragmentary circuit diagram of the circuit breakers with their non-sparking arrangement;

FIG. 15 is a schematic side elevational view of the inertial brake for the elevator of the present invention;

FIG. 16 is a cross-sectional plan view of the brake of FIG. 15;

FIG. 17 is a fragmentary cross-sectional view of a cable drive sheave of the present invention;

FIG. 18 is a side elevational view of elements of the drive sheave of FIG. 17;

FIG. 19 is a view similar to FIG. 17 but showing a fragment of a cross-sectional view of a guide roller for the cables of the elevator of the present invention;

FIG. 20 is a schematic view of automatic drive sheave braking mechanism of the present invention;

FIG. 21 is a side view of the structure shown in FIG. 20;

FIG. 22 is a somewhat schematic elevational view of the load-sensing assembly of the present invention;

FIG. 23 is a top plan view of the structure of FIG. 22;

FIG. 24 is an enlarged fragmentary perspective view of a portion of the structure of FIGS. 22 and 23;

FIG. 25 is an enlarged fragmentary elevational view of a portion of the structure of FIGS. 22 and 23;

FIG. 26 is a somewhat schematic side elevational view, partly in cross section, of elevator car guidance mechanism according to the present invention;

FIG. 27 is a top plan view of the structure shown in FIG. 26.

FIG. 28 is a side elevational view of the structure shown in FIG. 26;

FIG. 29 is a somewhat schematic side elevational view of elastic guide rail bracket structure according to the present invention; and

FIG. 30 is a top plan view of the structure shown in FIG. 29.

The circuit diagram of FIG. 1 is basic to all three types of control. For apartment houses the control system may be that shown in FIG. 1. For the other two types (hotels and office buildings, and business establishments) the control system is provided with further supplementary units (FIGS. 2A, 5, 6, 7 and 8).

FIGS. 2A and 2B represent the circuit diagram of the memory units M (in the following relay units) as used in the control system. The following elements are needed for assembling these units:

2 — transistors Oclo 79

2 — 35-volt 50-mA dial lamps

1 — 6-volt 100-mA dial lamp

1 — 1-watt, 3-kilohm resistance

8 — .25-watt resistances of various values

4 — germanium carbon diodes AY101

2 — appr. 50-ohm variable resistances.

The unit is of the plug-in type, and has a 10-pin socket. The resistances are harmonized in such a way that when the relay unit or the elevator equipment as a whole is placed under load in all relay units transistor B will be conducting and consequently lamp "p" (red) will glow. This is the "normal" position. When a negative pulse advances to the junction IV.Ind. control tilts over the opposite side (multivibrator), so that transistor A will be conducting and lamp "Z" (green) will be glowing. At the same time lamp "P" goes out. The situation will remain the same until a negative pulse advances to junction Za.VII. Starting from normal, when a positive voltage advances to junction III.Se, it will be in vain to apply a negative pulse to junction IV.Ind., no tilting-over will take place. Lamps "p" and "z" are partly working resistances, partly light signals, because then inform of the signal storage of the relay unit, or of possible faults.

For control from within the elevator car, except for the bottom and top stops, a relay pair consisting of "Down" and "Up" unit will be needed for each stop level. For the apartment house type, this device at the same time serves also outside calls. The single "Down" relay unit associated with the top stop and the single "Up" unit associated with the bottom stop provide both inside and outside control for all three types.

The IV.Ind. junctions of the relay pair units of each floor are interconnected. Consequently in response to the negative pulse applied to the common lead both relay units will tilt over from normal (and store a signal).

Since one of the relay units so paralleled will store the Up commands and the other the Down commands (these cannot, however, operate simultaneously), a positive voltage will advance to the junction III.Se of the inactive relay unit. By this the relay unit may be prevented from tilting over or storing a signal, i.e. the relay unit is "neutralized." If a positive voltage is ap-

plied to the junction III.Se of both units associated with the relay pair, then neither relay unit will respond to the start signal. This is essential when the elevator car is exactly on the calling lever.

The push buttons advance the negative pulses to the common junction.

When load is placed on the control system, lamp p of all relay units will glow, signalling the "stand-by" position of the equipment, i.e. its position of waiting for a command. In this case (FIGS. 2A and 2B) there will be a maximum positive voltage in line or conductor "a," owing to the conduction of transistor B. On the other hand in line a_1 there will be a positive voltage of a few tenths of a volt.

Compared to the highest positive voltage this voltage is of a negative nature. No current flows in the diode connected to line a , the unit connected to it being connected to a positive pole. It in response to the negative pulse applied to junction IV.Ind. the relay unit tilts over (stores a signal), the conducting polarities of a and a_1 will be reversed. In this case lead a will become relatively negative. This is sufficient to make a p-n-p transistor conducting at an appropriate value. Line a will be of full-valve positive potential, and by this through the 6-volt 100-mA lamp a (amber) it will be able to provide a condenser of a capacity of 1000 to 2000 microfarads and calculated for 20 to 30 volts with an electric charge of adequate amount within 0.2 to 0.3 second. Lamp a performs a dual function: first it is a working resistance, which at the beginning of condenser charging protects the transistor of the relay unit against current surges; secondly, it indicates the regular progress of condenser charging, or possible breakdowns in the condenser. The relay unit will on carrying through the command in response to the negative pulse applied together with the control to junction Za.-VII or by direct interference to junction Jtö.VI. return to normal, when again lamp p will be glowing.

The negative pulse applied by the push buttons to the junction IV.Ind of the relay units (FIGS. 2A and 2B) will proceed between two inversely connected diodes. Consequently the pulse will perform two operations without the risk of a mutual interference between the relay units connected in parallel. Namely, in response to the operation of the pushbutton a negative pulse leaves the relay unit over junction V.Ind.bek. The negative pulse will, if the control system is not under load, switch it on, then it will cause the relay unit to tilt over (to store a signal).

The relay units (FIG. 1) are split up into two groups, viz. "FEL" (UP) and "LE" (DOWN). Within the group the relay units share their junctions "Signal out," and so also with their (-), +20, +30 and Ind.bek. junctions. The junctions Jtö.VI are interconnected in a group as required by the operation (e.g. if at full load of the elevator car by means of the floor contact the relay units according to the wanted direction have to be neutralized. This contact is the one marked "Le tö" in the left bottom corner of FIG. 1).

The interaction due to parallel circuitry is prevented by the diodes inserted in the relays.

If, of the relay units belonging to the group, one, or more, or all tilt over (receive a signal) then a negative voltage will advance to the lead "I FEL" or "I LE," as the case may be. This voltage will remain until all relay units belonging to the group return to normal.

FIG. 1 illustrates the control of a seven-level, two-speed elevator with fine adjustment. The control system shown in the figure is valid for all three types. The following units are shown in FIG. 1:

1. Combined electrical safety shaft door locks.
 2. Electrical locking contact in lock 1 magnetically operated by the elevator car.
 3. Lamp in lock 1 displaying a "free" signal and at the same time indicating the operativeness of the lock.
 4. Lock-opening electromagnet in lock 1.
 5. "Make" contact in lock 1, operating in response to a magnetic effect, locking the shaft door being closed.
 6. "Break" contact in lock 1 operating in response to a magnetic effect on the shaft door being closed.
 7. "Make" contact in lock 1 operating in response to a magnetic effect to back-lock the lock of the shaft door.
 8. Remote switch with break contact.
 9. Motor protecting remote switch.
 10. Remote switch with make contact connecting the control system supplying current for the period defined by the associated 100-kilohm variable resistance.
 11. Current source supplying remote switch 10, with transformer and full-wave rectifier.
 12. Low-voltage remote switches connecting the directions UP and DOWN controlling the starting switches of the low-voltage driving motor.
 13. Remote switches starting the driving motor.
 14. NPN transistor in normal position adjusted for conduction, advancing a positive voltage to the electrical safety shaft door locks when there is no signal stored in the equipment, or if there is one, it is locked in the sense of operation (e.g. when the elevator is stopped).
 15. Transistor at normal permanently regulated for conduction, advancing current to one of the (common) poles of the slow-acting or fine-adjustment UP-DOWN connecting remote switch 16.
 16. Low-voltage reversing remote switches connecting a low-speed course to UP-DOWN and performing fine adjustment.
 17. Two-way make contact accommodated in the shaft and operated by the elevator car in response to magnetic effect, connecting the UP-DOWN directions. It occupies a medium or OFF position when the car stops level.
 18. Conductor attached to the switches of the fine adjustment, where there is a positive voltage when transistor 14 is conducting and all electrical safety door contacts 7 have been made.
- f_1 transistor: the command receiving and transmitting unit in the UP line, connecting transistor "g," further the units h_1 and m_1 to conduction.
- f_2 the same as f_1 but for the DOWN direction, with the difference that it connects units h_2 and m_2 instead of h_1 and m_1 .
- g transistor supplying current for the light signal of the direction when there is a signal fed into the equipment.
- h_1 and h_2 direction control transistors combined with time control.
- k and d signalling lamps, at the same time control resistances of the transistors f_1 and f_2 .

m_1 and m_2 transistors issuing UP or DOWN commands.

Z and X transistors preventing current return from control to the relay units.

P_{up} and P_{down} pre-amplifier transistors for the intermediate stopping of the elevator.

u_1 and u_2 lamps signalling the interlocking of command issuance.

n base resistance of transistor 14, at the same time indicating the correct operation of the transistor.

AF junction of temporary stopping in the UP direction, keeping the direction.

AF₁ and AF₂ the same as AF, needed only for business establishments.

VZF junction of UP setting, when direction keeping drops out of the program. (Terminal lock in UP direction needed at the top station.)

AL, AL₁, AL₂ and +VZL The same as AF, AF₁, AF₂ and +VZF, but in DOWN direction.

R₁ transistor which blocks the transistor m_1 issuing the final UP command by by-passing all other transistors in the event that in the UP direction the elevator has carried out also the last command. Consequently the elevator will be eliminating the delaying effect of the timing units immediately stop, or for two speeds change over to slow speed.

R₂ the same as R₁, in DOWN direction.

H₁ junction point of the control which for UP forwards a negative voltage to the UP setting condenser associated with the level tracer.

H₂ the same as H₁, in DOWN direction.

AEJ lamp signalling the "make" position of the door contacts.

RKJ lamp signalling the "make" position of the locking contacts.

Control of Apartment House Elevator — Type 1 (FIG. 1)

There is a complete pushbutton set in the elevator car, with a pushbutton for each level, further an OFF switch for eliminating outside control, finally a pushbutton for the cancellation of all stored signals (e.g. in the event of rescue operations).

Outside the shaft there are calling pushbuttons in each of the safety shaft door locks or separately by levels, which are connected in parallel to the corresponding pushbuttons in the elevator car.

The elevator will obey both inside and outside commands. The signals may be fed in at any time irrespective of the open or locked condition of the door. The control system requires no "busy" signal, as it will satisfy any command in response to the operation of a pushbutton at any time. The control system arranges the signals and will carry out the commands in an optimum sequence irrespective of the sequence in which the pushbuttons have been operated.

Outside the shaft, on each level there is a UP-DOWN indicating light signal, which shows the appropriate direction of travel to the calling party. Further a "FREE" light signal will appear in the safety shaft door-lock, whenever the elevator car is in "STOP" position on the called level. If the car is e.g. on the ground floor and the call comes from the topmost level, then the relay unit of the sixth floor will tilt over from normal, as shown in FIG. 1. Consequently conductor I FEL will change over to a negative potential. This will, across the 2.2-kilohm resistance, cause transistor Z to become conducting and so across another resistance also transistor

R₁. Transistor Z will, through lamp d , cause transistor f_1 to conduct, which transistor will in turn cause transistor g on the one hand to conduct (this transistor supplies current for switching on all UP-DOWN direction indicators, an operation performed by the level tracer to be described subsequently) and transistor h_1 associated with a time control unit, on the other hand. Thirdly, by transistor R₁ and lamp u_1 it causes transistor m_1 issuing the command to conduct. If transistor h_1 is conducting across a 50-ohm resistance it will block transistor f_2 with a positive voltage. This latter transistor cannot be compelled to conduct as long as transistor h_1 is conducting.

If transistor m_1 is conducting, a negative current will advance to the base of the n-p-n transistor 14 (similarly to transistor g) from the mid-branching of the two diodes connected opposite to each other and inserted between transistors m_1 and m_2 . Transistor 14 will now block and consequently no positive voltage will advance to the electrical shaft doorlocks, i.e. even the safety shaft door will lock, which until then was kept open by means of the magnetic switch of the car resting before the door. At the same time transistor m_1 now conducting advances a negative voltage to the UP direction operating coil of remote switch 12. However, this switch will not come into action unless all shaft doors and the car door are in a closed condition and consequently all contacts of the contact row 7 have "made." This is indicated by a light signal of lamp AEJ. Also all back-locking latches in the safety shaft doorlocks are inserted in the aperture in the door frame, so that also all members of the contact row 5 have "made." This is indicated by a light signal of lamp RKJ. Thus the car may start on its trip to the goal, in the present instance the top floor.

When meanwhile the ground-floor pushbutton is depressed, so that a calling-down command is fed into the system, a negative voltage will be applied also to conductor I LE. This voltage cannot pass the blocked transistor f_2 . Then lamp k will glow, there being a positive voltage on its opposite side. When there are no other commands, the car will rise to the called level. On its arrival, if the shaft or car door has not been opened, the timing unit will for a definite time stop the car. During this period the associated electrical safety shaft door lock will open. On the other hand the relay unit of the 6th floor will by means of the floor tracing apparatus tilt over to normal, so that in conductor I FEL the negative potential will cease. Consequently the complete set of transistors associated with the UP direction will with the exception of transistor h_1 lose its conducting capacity, so that remote switch 12 will drop out. As long as it is dependent on the attached timing unit, transistor h_1 will be conducting, and transistor f_2 will prevent DOWN commands from being transmitted. If the condenser of the timing unit has lost its charge, transistor f_2 will release from blocking and lamp k will go out. By means of the negative voltage advancing through this lamp, transistor f_2 will become conducting, whereas transistor f_1 will be blocked. In response to the DOWN command the UP process will take place on the DOWN line.

Stops Between the Two Terminals

In the UP section (FIG. 1) there are terminals AF and +VZF, in the DOWN section the terminals AL and +VZL. If an UP command has been fed into the system and the car proceeds upward, yet meanwhile a positive

voltage is applied to junction AF, then the n-p-n transistor P_{np} will become conducting and blocks transistor m_1 . In this case lamp u_1 will be glowing, there being a negative voltage on its opposite pole. At this moment the n-p-n transistor 14, until then blocked owing to the conducting state of transistor m_1 , will become conducting by means of a positive voltage advancing through lamp n . Simultaneously lamp n goes out. This lamp also was glowing because of the conduction of transistor m_1 . Now transistor 14 advances a positive voltage to the electrical safety shaft door-locks. Simultaneously these locks will through the auxiliary contact of the reversing remote switch receive a negative voltage from junction Y as soon as the reversing switch has interrupted the drive. In this case the lock of the shaft door will open where the car is actually standing, i.e. where the car causes the corresponding contact 2 to make in a magnetic manner. As long as there is a positive voltage on junction AF the control system will by maintaining the fed-in yet still unfilled commands keep the car standing. After the removal of the positive signal the car starts again in order to fulfill the subsequent commands. However, if a positive voltage is applied to junction +VZF, the foregoing will take place again, and in addition transistor f_1 will be blocked. However, transistor h_1 will with the aid of the timing unit attached to it keep transistor f_2 blocked too until the timing condenser is discharged. Thus both directions will be blocked until the condenser has been discharged. Upon the condenser being discharged, transistor f_2 will release and become conducting. Simultaneously transistor f_1 will be blocked and the DOWN direction will become operative. Junctions +VZF and +VZL will receive a positive voltage only at the terminal stations. The car need not necessarily reach the topmost or bottommost level, as the case may be, in order to change over to the opposite direction, because in the event of the receipt of a command of the opposite sense, changeover will take place at the tilting back of the relay unit storing the last command, after the lapse of the appropriate time.

The position of the car in the shaft is sensed by switches in either the engine room or the shaft. These switches are operated by the car. The switches can in general be called story tracers or story switches. The functions of both are identical. In the following, the term story tracer will be used.

The contacts of the story tracer need conduct only milliamperes. These contacts among others advance a positive, so-called neutralizing voltage to junctions III.Se of the relay units in the appropriate sequence.

The story tracer advances these positive signals by means of a set of sliding contacts to the units of the single-row data storing relay (FIG. 3) in such a way that in the forward direction it neutralizes the relay units of the pair of opposite sense, and so at the same time the units of the relay pairs of the levels passed by the car which are of the same sense as the direction. Both relay units of the pair at the level occupied by the car are neutralized in order that no command might be fed into the level in question. When the car is at the topmost or bottommost station, all DOWN and UP units of the relay row, respectively, are neutralized.

The sequence of glowing of the UP and DOWN light signals arranged on the levels is uniform with the sequence of the neutralization of the relay units. There-

fore both may be connected by the same contacts of the story tracer.

The story tracer tilts back the relay units to normal by means of its corresponding contact in the forward direction when the command has been fulfilled.

Another function of the story tracer is, during travel of the elevator car in either direction, to "ask" the associated relay units before the arrival of the car on the level at the proper moment (by taking into account the braking distance) whether or not there is a "stop" signal stored in them. For this purpose two condensers have been provided (FIG. 4) the one for the DOWN, the other for the UP direction. (ALL.k.fel and ALL.k.le). Each condenser is connected between the two slide contacts of the appropriate direction. The slide contact attached to the negative pole of the condenser is at the same time connected to the point of the control system (FIG. 1 — H_1 or H_2 , as the case may be), which is under a negative voltage only in line with the direction of travel. The slide contacts, in synchronism with the car, pass over the contact row at normal, whose sections each of which is associated with a story contain a short contact of negative potential (-) in the "GO" direction, further a longer so-called charging contact connected to the junction T of the corresponding relay unit, and another so-called setting contact attached to the junction points AF or AL, as the case may be, of the control system (FIG. 1). In accordance with the direction of travel the condenser, connected to the short contact of negative potential, completely discharges, and then the discharged condenser will be connected to the charging junction T of the associated relay unit. If the relay unit in question is at normal (no signal fed into it), the condenser will receive no charge owing to the uniform potential. In the opposite case there is a positive potential on terminal T, i.e. the condenser will be charged. Thereafter before the arrival of the car at the story level, by taking into account the required braking distance the story tracer will (dependent on the direction of travel) connect the positive pole of the condenser to junction AF or AL, as the case may be (FIG. 1). If the condenser has no charge, no "stop" command issue. Otherwise it will stop the car with its positive voltage as described before. The car will be standing as long as the charge of the condenser has been exhausted. This depends on the quantity of charge of the condenser, on the base current consumption of the associated transistor, and on the value of the blocking resistance of the transistor.

The capacity of the condenser is such that transistor m_1 or m_2 remains blocked for a time sufficient for the car to occupy a position of rest; and in addition, there has to be time enough for the manual or automatic opening of the door. In the case of two-speed elevators, the car is stopped in such a way that on the command being issued the low-voltage remote switch 13 connects the drive to low speed. For the purpose of carrying through the command on short notice, changeover is also electronically controlled. There is also a secondary winding on the iron core of remote switch 13, so that by induction a current will flow only if there is a voltage on the magnet coil of switch 13. After rectification the current of the secondary winding blocks transistor 15 with a positive voltage. Earlier this transistor was set for continuous conduction. When conducting, this transistor advances a negative voltage to remote switch 16. A switch accommodated in the shaft and magnetically op-

erated by the car supplies a positive voltage to the remote switches 16 for low speed, as required for the UP or DOWN switching operations. When there is current on any one of the remote switches 13, transistor 15 will be blocked, and by this the second speed, or fine adjustment will be suppressed for the switching time of the remote switches 13. In this system, by means of the magnet mounted on the car, the car will be prevented from stopping between levels when there is a defect or no signal has been fed into the control system. The car will in each case proceed to the next level. Blocking of transistor 15 may be effected also by means of the control current and the auxiliary contact of remote switch 13.

For an apartment house elevator (Type 1), since there is predominantly DOWN traffic in the morning hours, if the car is under full load, for the prevention of superfluous stops, by means of a floor contact of the car, the control system will cancel the signals in the DOWN relay units, and pass on a signal to those desirous to travel DOWN to repeat the call. The associated floor contact of the car (left bottom corner in FIG. 1) is a make contact "Le tö."

When the car is standing for some length of time, there is no car light "on," the control current is disconnected, the shaft doors are closed, including the one before which the car is standing, and there is no directional light signal, or a "Free" signal on, all these are indications of the absence of stored signals in the equipment. If there is a directional light signal, this is an indication of the occupied condition of the car. A command may be fed into the control system at any time irrespective of whether or not there is a directional light signal.

When there is no directional light signal and an outside call is transmitted from any one of the stops, and the car is exactly on the called level, then if there is no control current on, this will become connected automatically, and the "Free" signal will light up. This lighting up of the "Free" signal will at the same time indicate that there is a current in the magnet coil of the electrical safety shaft door lock. At this moment the lock will be unlatched. If the car is not on the calling level, the operation of the pushbutton will at the same time feed a calling command into the control system, and simultaneously also the directional light signals will light up. In this case an already illuminated car will arrive at the calling level and the electrical safety door lock will be unlatched, and the "Free" signal will go out only when the car has arrived at the stop.

The timing units of the remote switch 10 are adjusted in such a way that reckoned from the last command being fed in, there remains sufficient time for fulfilling all UP and DOWN commands.

Control of Type 2 for Hotels and Office Buildings (FIG. 5)

The data storage system is of a two-row design, each row consisting of as many relay pairs as there are intermediate levels, except the bottommost and topmost stops, at each of which, similarly to the apartment house design, there is, respectively, an UP and a DOWN relay unit. The connection of the data storing rows with the story tracer and the control system is the same as the Type 1 apartment house elevator. The row of the two-row data storage formed of UP-DOWN units B is associated with control from the car, and the row of UP-DOWN units K belongs to outside calls. Junc-

tion III.Se or Za.VII of the relay units associated with the same direction and the same level are in common. Consequently the story tracer will be means of junctions III.Se at the same time neutralize the outside or inside relay units, as the case may be, of the same direction. At the same time by means of junctions Za.VII cancellation of the signal will take place simultaneously.

The control signals transmitted from the car advance to the inside relay row B, those originating from outside stops proceed to the outside relay row K, except for a relay B K of each of the bottommost and topmost stops, both of which equally provide outside and inside control.

Terminal T of the outside unit K of the paralleled relay pair through a transistor set for conduction joins the charging conductor T_k in common with the inside units.

The bases on the UP and DOWN relays associated with outside control are in common through appropriate resistances. If a positive voltage advances to this common line, terminal T of all relays K associated with outside control will be blocked and consequently no charging voltage can advance from the outside relay K to the common terminal T_k . A positive voltage will be applied to the shared bases of the transistor when owing to full load the floor contact of the car will "make."

This type of control differs from that of Type 1 apartment house design in that for a full load, unlike the earlier type which in this case can be controlled only at the ground floor station, and which will ignore outside commands, the elevator may be controlled from the car to any one of the levels, however, the system will meet outside commands only when the inside control command for the purpose of alighting is addressed to the level of the outside caller.

Control of Type 3 for Business Establishments

Control from the car, i.e. so-called inside control takes place in conformity with FIG. 1. The only difference is that there is no need for "DOWN" cancellations operated by the load sensing floor contact "Le tö" in the figure. In conformity with the system of Type 1 each call pushbutton associated with the bottommost and topmost stops of the outside control system advances a signal to the relay units of the inside control system respectively serving the bottommost and topmost levels. There is a two-row data storage for each intermediate level consisting of as many relay pairs as there are intermediate levels (FIG. 6). Two levels are shown in the figure, the others being uniform with these.

There are two so-called first-order data storage rows, the one serving for DOWN travels, the other for UP travels. Accordingly on the various levels pushbuttons DOWN and UP are arranged indicating the wanted direction of travel, with code designations Le_h and Fel_h in the figure.

According to the direction of travel by which the car on being called may approach the called level, both first-order data storages have each been equipped with a second-order relay unit DOWN and UP. The calls advanced by the level pushbuttons to the shared junctions IV Ind of the UP-DOWN relay units in the same row of each level will be stored in the DOWN or UP relay units according as the story tracer (in the manner discussed earlier) advances a neutralizing positive voltage

to the junction III Se of the DOWN or UP unit in conformity with the second-order sequence.

The story tracer will tilt back to normal the relay units corresponding to the direction of travel on their arrival at, or passing by, the level (in the manner described earlier), i.e. in the UP direction a negative pulse will be applied to junctions Z_1 , and in the DOWN direction to junctions Z_2 . However, before this has been done the story tracer will, immediately before the arrival of the car on the level, connect the junction Jel ki_2 of the relay units corresponding to the direction of travel to the junction ATV of the relay unit opposing the direction of travel. By this latter operation, when there was a signal in the relay unit corresponding to the direction of travel, also the unit of the reverse direction will be tilted, which unit will then store the still unfilled command. Since the story tracer will "make" the signal transmitting contacts in both the UP and DOWN directions before arrival on the level in the direction of travel, a signal return owing to this latter "making" will have to be prevented. Therefore the control system will advance a positive neutralizing voltage to the junctions VIII Se of all relay units conforming to the direction of travel, and so prevent a signal return. This latter positive voltage will advance to the junctions VIII Se through p-n-p transistors S_1 or S_2 (FIG. 6) now made conducting by a negative voltage from H_1 or H_2 according to the direction of travel (FIG. 1).

The elevator is stopped on the levels in the same manner as a Type 1 (apartment house) elevator. However, as there are four relay rows, four setting condensers will be needed. For setting the setting condensers associated with the first-order UP, second-order UP directions, and first-order DOWN second-order UP rows are connected by their positive poles by means of the story tracer to the junction AF_1 or AF_2 , respectively, of the temporary setting. The setting condensers associated with second-order DOWN of the first-order DOWN direction, and the second-order rows of the first-order UP direction are connected respectively to junctions AL_1 and AL_2 .

For a full load the floor contact of the elevator car absorbs the negative voltage required for charging the setting condensers from both directions. The control system supplies this voltage only in the direction of travel. Since in the direction of travel on the arrival of the car, signal transmission takes place to the relay unit of the opposite direction, for a "stop" command the transmitted signal has to be cancelled. This is effected in such a way that by means of a positive signal applied to the setting contact the setting condenser in the first order (in the manner described for Type 1) fulfills the "stop" command, and secondly, causes the n-p-n transistor D associated with the level to conduct. Consequently in the relay unit opposing the direction of travel the transmitted signal will be cancelled. Transmission of the cancellation signal takes place with the aid of the story tracer. In conformity with the relay rows the story tracer is equipped with four contact rows (FIG. 7). The purpose and sequence of the contacts conform to those of Type 1 (FIG. 4), however, with the difference that contacts +VZL and +VZF have been omitted, and further that, first, with each pair of contact rows of the direction of the first order, a further contact row is associated, each equipped with a pair of contacts per level, performing signal transmission between the relay units of the UP-DOWN directions of

the second order; secondly, each contact row is associated with a further contact D per level, this contact being connected to the base of transistor D of the corresponding level (FIG. 6). The neutralizing signals of the story tracer are distributed among the junctions III Se of the second order relay units in the same way as for Type 1, with the difference that the relays of the stopping position of the car must not be neutralized (FIG. 8). For this time the call buttons of the respective level are inactivated by interruption. Interruption is effected by the magnet switches controlled by the elevator car. The interruption is essential lest for want of neutralization of the relays a call should be effected from the same level. On the level occupied by the car, neutralization has to be eliminated in order that signal transmission might not be prevented.

Hence this type of control meets all requirements of elevators coming within the scope of collective control.

Electrical Control of the Automatic Emergency Brake

The structural details of the automatic emergency brake are set forth hereinafter under the corresponding heading.

The function of the control system, which will now be described, is to guarantee sequence of operation for the mechanical units of the emergency brake and to produce the required effect.

A method of control is shown by way of example in FIG. 9. Here the following units have been shown:

1. Driving motor
2. Reducer, output appr. one W, 220/40V
3. Rectifier, output appr. one W
4. Rectifier, output appr. 3 watts
5. Reducer, output appr. 3 watts 220/20V
6. Set of condensers
7. Condenser
8. Electromagnetic magnet coil for brake opening associated with the motor
9. Brake-operated break contact, breaking in the closed condition of the brake
10. Lifting electromagnetic winding of the toggle clutch raising the automatic emergency brake (driving disc brake)
11. p-n-p transistor regulated for conduction

In case of an emergency, electromagnet 10 will tilt out the toggle clutch keeping the automatic emergency brake out of equilibrium, so that the emergency brake will come into action.

The operating winding of the lifting electromagnet 10 is operated from the electrical charge stored in the condenser bank 6. In this circuit p-n-p transistor 11 regulated for conduction and interrupter contact 9 are connected in series with the winding. The interrupter contact is interrupted when the brake is applied.

The condenser bank 6 is permanently charged from a mains junction independent of the elevator control system, via reducer 5 and rectifier 4.

When a supply current advances from the mains to the driving motor, the secondary winding of reducer 2 supplied from its terminals will with the positive pole of its rectified and damped current prevent transistor 11 from conducting, and will block it.

The capacity of condenser 7 is such that after taking off the current from the motor transistor 11 it remains blocked until, before the opening of the transistor, the

brake kept open by the brake magnet can close, when contact 9 will also "make."

When braking has not taken place, contact 9 will remain "made", and after the discharge of condenser 7 transistor 11 will become conducting. Consequently the amount of charge of condenser bank 6 advances through contact 9 to magnet coil 10, which actuates the brake.

Condenser bank 6 is essential for the operation of magnet 10 in order that the automatic emergency brake might be in an operating condition even in the event of mains failure.

The capacity of condenser bank 6 is such that its charge will suffice for a single shock-free operation of electromagnet 10.

Control of the Safety Automatic Circuit Breaker

In known types of elevators, many accidents occur from breakdown in the motor starting power switch (fused contacts, seizure of the moving parts, forcible manual switching, etc.) As a matter of fact if the power switch fails to stop in response to a "stop" command of the control system, the car cannot be brought to a halt merely by opening the door. When the power switch is turned "ON" forcibly in response to inadvertent manual switching, or to the interference of unauthorized persons, the elevator will start even when the doors are open, irrespective of the control.

The safety circuit-breaker automation serves to prevent this emergency. The control of this circuit-breaker is shown in FIG. 10.

The low voltage remote switch 1 with interrupter contact has been developed for the above purpose. The contact of the switch is inserted in the circuit of the low voltage coil of the contactor. A positive voltage proceeds to its winding from one side from the auxiliary contacts of the power switch 13 when either the UP or the DOWN direction is "ON." A negative voltage advances from the other side to the winding through transistor 2 in series with it, when the so-called preamplifier transistor 3 is conducting. This transistor is connected through a resistor to the common conductor 18 of the low voltage directional switch 12.

If all doors are closed there will be a positive voltage in conductor 18. In this case lamp AEJ will glow and the positive voltage will block both transistors. However, when anyone of the doors is open, there will be a negative voltage in conductor 18. Consequently both transistors will be conducting. Although in this case the negative voltage has advanced to remote switch 1, even so the positive voltage will be interrupted by the auxiliary contacts of the power switches 13, these latter switches being in an "OFF" position.

If any one of the power switches fails to drop out for reasons referred to above, the positive voltage will nevertheless advance to winding 1 through the auxiliary contacts and if a door has been opened, owing to the conduction of transistors 2 and 3 also the negative voltage will proceed to the winding. Hence remote switch 1 will upon operation put out of action the protective automation of the driving motor.

The same will occur also when the power switch is turned "ON" by manual force, or when it is kept "ON" forcibly.

When there is no safety latch on the door of the car (the use of a latch is not obligatory except under special circumstances), or when the members of the maintenance staff with their special keys open any one of

the doors, automatic deactuation of the equipment is not necessary, and moreover can be even harmful.

In this case it will suffice to keep the elevator at rest until the door is open. This end is served by the timing unit 4, which when the door has been opened and transistor 3 is conducting will hold transistor 2 blocked for a definite period. This period is such that the auxiliary contact of the power switch 13 supplying the positive voltage will open the circuit before transistor 2 is conducting.

The temporary blocking of transistor 2 is effected by the short circuit current of the uncharged condenser of the timing unit 4. For setting the timing period the capacity of the condenser must be given the proper value. To this end a variable resistance in parallel to the condenser is used. The variable resistance will cause the charged condenser to discharge within the proper time.

Collectivization of an Electronically Controlled Bank of Elevators

Collectivization consists in the consolidation of a bank of elevators in a common program with the aid of a single call system so that the command will be fulfilled by the elevator which is idle.

The equipment according to the invention prevents the elevators under common control from being used uniformly. As a matter of fact a uniform use of the elevators would result in their requiring general overhaul at the same time. The elevators within the bank are used in an optional sequence in such a way that the elevator next in the sequence will accept the command only when the capacity of the elevators before it in the sequence has been exhausted.

Another advantage of the system is that a faulty elevator automatically excluded from the program, or an elevator deliberately deactivated, will not upset the sequence of control, as the place of the deactivated elevator, provided it is not the last in the sequence, will be taken over by the next one following. If the laid-off elevator is the last, then its place in the sequence will be occupied by the one before it.

Hence any one of the elevators may be excluded from collectivization by means of a single switch or pushbutton, otherwise obligatory for all elevators, arranged at the control station, and may be returned to collectivization by operating the same switch or pushbutton.

Another advantage of the system is that in the event of a breakdown of a single elevator or several (e.g. owing to a short circuit), upon automatic exclusion from collectivization a signal goes out to the supervisor announcing the breakdown and localizing the site of the breakdown.

If any one of the elevators has to be laid off for a longer period (for repair, maintenance, overhaul, etc.), then only the main switch of the elevator will have to be turned OFF, when also the automation of the contactor will be disabled. Without any further disengaging the elevator in question will be eliminated from the collective program until it is restored to it. If required for reasons of repair, then from the control of the excluded elevator the collectivizing conductors may be disabled by a simple plug-in type switch. This will not influence the collective control of the others. The elevator so excluded may then be operated as an independent elevator, provided it has been equipped with a pushbutton of its own.

Finally the system provides a reason for the collectivization in sequence of elevators of various load bearing capacities, and permits the planning of a number of elevators as justified by the traffic, and permits moreover periodic checks of the accuracy of planning.

In FIG. 11 an embodiment of the collectivization of two Type 3 elevators (business establishment) has been shown. Except for the bottommost and topmost levels all other levels are the same as the one shown in the figure.

In the sequence of the figure, elevator A is the first of the two. In the first order this elevator will obey the commands, and elevator B will come into action only when according to the program elevator A is busy.

For the collectivization of elevators of Types 1 and 2 (apartment house, hotel and office building equipment) a row of relay units will be needed for each pair of elevators (FIGS. 2A or 2B). That is, a relay unit or signal divider will have to be installed for each level, including the uppermost and lowermost.

For the collectivization of the Type 3 elevators (business establishments) two rows of signal dividers will be needed for each pair, i.e. each with an UP and DOWN unit per level.

For each of the bottommost and topmost levels an UP and DOWN unit respectively will be needed. The supply current of the signal dividers is independent of the control, and the power consumption of the dividers of about one watt will last only for the duration of pushbutton operation. Besides the supply current leads the signal dividers are connected exclusively to the junctions IV Ind of the relay units belonging to the levels.

If the signal dividers are arranged integrated with the pushbutton on the corresponding level and not in the engine room, then the dividers will at the same time indicate to the caller the elevator meeting the call.

The call signals transmitted from the different levels advance to the corresponding signal divider KLe or KFe as the case may be.

The negative leads of the signal dividers are cut off by the control pushbuttons Fel and Le (UP and DOWN) of the levels, therefore no current will flow in them. The signal dividers have been adjusted in a way such that, like the relay units for similar purposes, on their being placed under load in each case the same side, in the present instance the transistor associated with lift A, will become conducting, when the control pulse advances from the side "Jel ki 1" to the relay units in the manner described earlier. If a negative voltage is applied to the junction IV Ind of the signal dividers, these will tilt over to the opposite side, i.e. the transistor side associated with elevator B.

If no negative voltage is applied to the junctions IV Ind of the signal dividers KLe or KFe, as the case may be, then in response to each operation of the pushbutton the negative pulse will proceed from "Jel ki 1" to the corresponding relay unit of elevator A. If a negative voltage is applied, then the negative pulse goes out from "Jel ki 2" or (T) to the corresponding relay unit of elevator B. On the pushbutton being released in either case the signal divider will store no further information of the transmitted command, because it will be deactivated completely.

For the time of the depressed condition of the pushbutton the lamp will glow in whose direction the signal goes out.

The negative voltage advances to the junctions IV Ind of the signal dividers over the auxiliary contacts in series of the automation of the contactor of both elevators. The auxiliary contacts operate in such a way that with the contactor automation of elevator A "ON" its auxiliary contact M_A will "break," and with the contactor automation of elevator B "ON" its auxiliary contact M_B will "make."

The load sensing floor contact of A is in parallel to the auxiliary contact M_A of A.

If both elevators are in service, i.e. their contactor automation is "ON", and A is not fully loaded, i.e. the floor contact P_A is open, no negative voltage advances to the junctions IV Ind of the signal dividers, i.e. each fed-in signal will advance to A. On the other hand, if the elevator is fully loaded, over the "made" floor contact the negative voltage will advance to the signal dividers, therefore each fed-in signal will control B.

If the automation of B has been deactivated for one reason or another (breakdown, or deliberately), then the negative voltage of junction IV Ind will be broken off, so that all further signals will advance to A. Thus even for the collectivization of two elevators the principle of sequence will prevail. If several elevators have been collectivized then for the inactive one, not the one in sequence before it, but the one after it will come into action, except when the inactive one is the last of the sequence.

High-Safety Electrical Door Bolt

In conformity with the regulations governing elevators on the boarding levels, the shaft has to be closed with doors. Only the door may be opened before which the car stops. Furthermore a car cannot be started unless the latch has been locked.

So far these provisions have been met by using appliances noisy in operation and in addition subject to frequent breakdowns.

The door bolt according to the invention, in the following called a door lock, is safe in its operation, has a long useful life and operates in a noiseless manner. Noiseless operation is guaranteed by the absence of any mechanical connection between car and lock.

There are no parts of the door lock extending into the shaft, and the surface of the lock on the shaft side is perfectly flat and closed. The specified safety clearance between car and door lock is easy to maintain. Because of the elimination of a mechanical connection no breakages or other defects will arise owing to swinging of the car for which inaccuracies of installation or wear and tear of the car guides may be responsible. Another advantage of the invention is that not even the lateral arrangement of the shaft doors requires the observance of the prior art extremely rigorous tolerances. As a matter of fact, inside the door bolt the electrical switching system may be adjusted to the lock opening feature arranged on the car.

The switches arranged in the door bolt are tubular or other tumbler switches operating in response to a permanent magnet. The switches can handle currents of several hundred times those actually arising.

When the power supply of the control system is "OFF," the shaft door cannot be opened even when the car is on the level of the door. However, if on the level the call pushbutton is depressed, current will flow in the control system, the door lock will open, and the "Free" signal light up.

As soon as the latch of the door bolt opens the bolt contact switch opens the common lead of the starting remote switches. When the door has been opened, or it opens, the door contact breaks and lamp AEJ goes out. At this moment the lock opening magnet releases the latch, still on the door being closed the latch closes in the manner of a snap bolt, the door contact "makes" again, i.e. it closes.

The winding of the lock opening magnet on the repeated locking of the door opens the bolt as long as (dependent on the operation according to the program) current flows to it. If this is not the case the bolt of the lock will keep the door closed.

However the elevator cannot start unless the counterbolt has been locked and extends into its nest to a depth such that the lock contact also "makes."

As long as the power supply of the control system is "ON," the shaft door of the level where the car stops may be opened. If the control system marshals the car to another stop, in all cases first the lock will be secured and only then the elevator will start.

The lock equipment is by way of example shown in FIG. 12. The door bolt is of two parts, viz. part A accommodated in the door frame, and part B mounted on the door leaf. In each part of the bolt there is a latch attached to a two-armed lever each of which is kept closed or open, as the case may be, each by a spring 17 and 18. In bolt part A a latch 15 and 11 is attached, respectively, to a two-armed lever 19 with fulcrum C₁ in part A, a two-armed lever 10 with fulcrum C₂ in part B. The effect of the locking spring 17 of arm 19 in part A is at point D greater than that of the opening spring 18 of arm 10 in part B. Locking proper is effected by latch 15 in response to spring 17 through point D of arm 10 against spring 18. Simultaneously with this action the latch 11 with a permanent magnet on the other arm of the lever 10 will be shifted into nest 13. In this way a dual locking will be brought about.

Latch 15 is opened by electromagnet 4 against spring 17, as soon as current is advanced to it. A current will flow to electromagnet 4 when all doors are closed, so that all door contact switches 7 are closed. This is indicated by a lighting lamp AEJ. Furthermore, transistor 14 must be conducting. This will happen, when there is no signal fed into the control system, or when owing to its setting, the system is locked. Secondly a current will also flow to the electromagnet when the remote switches 12 (FIG. 13) are "OFF," further when the permanent magnet 9 of appropriate length and mounted on the elevator car closes switch 2. At this moment lamp 3 in series with magnet winding 4 will flow and display a "Free" signal. This will take place when the car is level within the specified tolerances. At the withdrawal of the latch 15 from the nest in response to spring 18 the part of lever 10 formed in an appropriate manner at point D will follow latch 15 to the stop at point E. At this moment the permanent magnet 11 on the other arm of the lever 10 will be pulled out of nest 13, so that back-locking will come to an end and simultaneously switch 5 will in response to the termination of the magnetic effect open the common circuit for remote switches 12, an occurrence indicated by the extinction of lamp RKJ (FIG. 13). Thus the door can be opened then and only then. When this takes place switch 7 in the closed condition of the door kept closed by permanent magnet 16, will open.

There is a further switch 6 in part A of the door bolt, which opens in response to the magnetic effect. The function of this switch is to open the circuit supplying the elevator by deactuating the contactor on the door being opened when any one of the contacts has been short circuited (FIG. 13).

This system is associated with a remote switch 8 with a break contact. Upon operation this switch opens the circuit for the magnetic coil of the elevator contactor.

The switches 6 and 7 are arranged in such a way that in response to the effect of permanent magnet 16 on the door being closed first switch 6 opens, and then switch 7 closes. Upon the withdrawal of the magnet, i.e. when the door is opened, first switch 7 opens, and then switch 6 closes.

The safety door contacts, i.e. the bolt contacts 5 in FIGS. 12 and 13, are in series with the windings of the remote switches 12. Consequently for a contact bank "made" there will be a positive potential on both junctions of all switches. If either of these on the door being opened breaks, a potential difference will arise between the two terminals, one of the terminals remaining positive, the other becoming negative. To this latter terminal contact bank 6 is connected in parallel. If there is a short circuit in any one of the contacts, on the door being opened, with the making of contact 6, the positive voltage will become connected to the winding of remote switch 8, so that the contactor will be deactuated.

If there is a short circuit in contact 6, then it will deactuate the contactor even for a perfect door contact. The adjustment between the electrical safety contacts and switches is such that in the event of a breakdown in any one of them the elevator will be put out of operation, i.e. there will be no risk of accidents owing to breakdowns. In fact the elevator cannot be started in any case with a door or doors open.

The site of the trouble due to a short circuit can be traced by ascertaining the door at whose opening the contactor has been disabled. If there is a short circuit in the electrical leads of the shaft or the engine room, then the contactor will drop out automatically on any one of the doors being opened.

Complete Non-Sparking Operation of D.C. Circuit Breakers

Protection of the contacts of circuit breakers against sparking or arcing is essential partly to save the contacting surfaces (for the improvement of serviceability), partly for the elimination of the damaging effect of inductive return current surges of semi-conductors, if the contacts are associated with induction consumers in series with semi-conductors. Further electromagnetic waves must not be allowed to arise owing to sparking (radio interference, etc.)

Hitherto several methods have been used, of which one consisted in connecting a condenser in series to an ohmic resistance in parallel to the induction consumer (winding). However, the method eliminated sparking only partially, because owing to the insertion of the ohmic resistance the inductive current surge could not be wholly neutralized.

According to another method the induction consumer (winding) is bridged by, or connected in parallel to, a diode calculated for a higher voltage and connected inversely to the supply current. If the diode is calculated for a voltage generated by the induction, still

it will not suppress sparking arising from the ohmic resistance at disconnection.

The method here disclosed (FIG. 14) for practical purposes quenches any sparking demonstrable on the contacts and the contact will behave at breaking if there were not even current on it.

The solution is similar to the first described here, with the difference, however, that a low-output diode is in parallel to the resistance in a manner such that the peak of the diode points at the positive pole of the supply current.

Upon current being applied to the system no current will flow in the diode. The condenser in series with the resistance will become charged through the resistance. The resistance will define the maximum current arising at the moment of switching. For practical purposes the condenser charged to the voltage of the supply current will at the moment of disconnection become connected to the winding via the diode and by by-passing the resistance.

The condenser will for a time dependent on its capacity maintain on the terminals of the winding a voltage uniform with that of the supply current. Consequently at the moment of disconnection, owing to the uniform potential no sparking will take place on the contacts of the circuit breaker, irrespective of whether the consumer is of an ohmic or inductive type.

Brake Gripping Device

High speed elevators are protected by a braking gripping device against downfall. When the permissible DOWN speed has been exceeded the device comes into action and secures the car to the guide rails by applying a braking effect.

In general the known gripping devices are actuated by a speed limiting apparatus or its cable. However, if the cable of the speed limiter breaks, or the speed limiter becomes inoperative, the fall of the car will be inevitable. Another drawback of the known apparatus is the extreme accuracy required for the machining of the associated car guide rails, the permissible elastic deformation of the parts (clamps) guaranteeing uniform braking being very small.

An advantage of the device according to the invention is that it will come into action in any emergency, independently of the speed-limiting system, for suspending and holding the elevator. During UP travel, on the other hand, it will release automatically. The considerable elastic deformation of the newly designed and accommodated clamping element does not presuppose a high accuracy manufacture of the guide rails, i.e. drawn or rolled; therefore, unmachine guide rails will also suit the purpose.

The braking effect of the apparatus will begin at once at the moment the car loses contact with the suspending or supporting features and the brake shoes will with a predeterminable force be forced against the guide rails. The gripping device will come into action in response to a change of the DOWN speed of the car in excess of the permissible limit. The permissible limit may be set beforehand to any value between the maximum operating acceleration and gravitational acceleration.

By way of example a design of the equipment according to the invention is shown in FIGS. 15 and 16.

The sliding gripping wedges 2, which upon operation come into contact with the guide rails 11 with their smooth surfaces, are suspended on springs 8 of an ap-

proximately constant spring force. Consequently part of the weight of the wedges is compensated, whereas with their balance weight of the wedges prop up against jamming rollers. If the car accelerates downward, dependent on the rate of acceleration the gripping wedges 2 will disengage from their weight. The spring forces are adjusted in such a way that at an acceleration in excess of the permissible, the spring forces will rise to a value higher than the balance weight of the gripping wedges. Consequently the attached springs 8 will pull the sloping gripping wedges 2 between the guide rails 1 and the jamming rollers 3. The sliding gripping wedges 2 will adhere to the guide rails 1, and with the DOWN run of the car the rollers 3 will roll on the slope of the gripping wedges 2 and force them against the guide rails with a gradually increasing thrust.

The jamming rollers 3 are attached to high-elasticity brackets 4. If the car continues down, the adjustable stops 7 reach the sliding gripping wedges 2 clinging to the guide rails 1 and exercise a braking action on the car. The elastic brackets 4 may be regulated by changing the position of the securing elements 6, the value of the braking force, and the elastic shift of the jamming rollers 3 may be adjusted within a wide range. This elasticity of high degree permits the elimination of the extremely delicate machining of the guide rails. The adjustable stops 7 serve for setting the braking force at a constant value.

The equipment according to the invention may with the breakage of the suspending cable or the speed limiter be operated also in the conventional manner without, however, affecting its operation on the gravitational principle here described. Further the equipment permits its being put into action by a manually operated emergency brake in the car, in addition to automatic operation. Secondly, by means of a handle to be pulled downward, or by means of a pedal arranged on the roof of the car (for the maintenance personnel) the gripping wedges 2 may be opened to such an extent that the car by stages slides down the guide rails, so that in the event of a breakage of the cable the car may be allowed to slide to the next stop. Continuous sliding (skidding) is precluded, because upon acceleration of the elevator car the weight of the person operating it decreases at the rate of acceleration, so that the gripping wedges will again be engaged.

Cable Stress Compensating Driving Sheave and Guide Roller

An elevator has to be suspended from several mutually independent cables. For the mutually uniform distribution of the load, the suspending elements secure the cables to the supporting structure by means of a two-armed balance system. To the counterweight the cables are attached united at a single point, as it would be unreasonable to use a compensating balance system on both sides of the cable branches.

The driving sheaves of earlier design do not permit the uniform distribution of the load in the cable branches on the counterweight side, mainly when the cables are wedged into the cable grooves with a force greater than the required force. A certain compensation cannot be brought about unless the load differences of the cable ends across the sheave overcome the friction. In this case the cable will, owing to its exposure to extreme wear and tear, tend to slide in the groove. Harmful results of this kind are mainly due to the differences in the tolerances of the cable diameters

and also to the inaccuracy of the grooves of the driving sheave. Both shortcomings will be responsible for differences of speed in the particular cable branches, which in turn will bring about unevenness in the loads.

This unevenness will be compensated by the sideslip of the cable, or e.g. in the upper position of the counterweight, the uneven distribution of the load will become critical to an extent that the counterweight will be held by a single cable only, whereas all other cables will relax. If the suspending cables are trained across a guide roller, again the compensation of the stress can be achieved only at the expense of the sideslip of the cables. These risks are responsible for the well-known wear and tear of the cables and so of their short useful life.

The driving sheave and guide roller according to the invention permit a uniform distribution of the stress on both sides, in all cable branches without risk of sideslip in the grooves.

An embodiment of the equipment is by way of example shown in FIGS. 17 and 19. In the grooves 11 of the basic body of the driving sheave 1 the lamellae 2 consisting of two half-rings (FIG. 18) alternately surround the driving sheave elements 5. In the grooves, the lamellae 2 are secured to the basic body 1 by bolts 6 driven through boreholes in the lamellae. The disc elements 5 are clamped together by the end discs 4 and 7 through the springs 3. The disc elements 5 jointly carrying the load rest on the cylindrical periphery Y of the driving sheave basic body 1. The optimum value of the necessary friction may be obtained by setting the clamping force adjustable by means of the bolts 6. In this case the complete sheave system will operate in the manner of a multiple disc clutch.

For a driving sheave the groove has to be shaped on the disc element 5 in such a way that in the grooves the cable friction should separately and jointly be greater than the optimum adjusted friction of the sheave element 5. Consequently the sideslip caused by the difference of the cable speeds will arise between the disc elements and on periphery Y and not in the grooves.

In the event of irregular abrupt braking or starting the sideslip will again occur at the same places.

The driving sheave elements 5 come into contact with both the cylindrical basic body and the lamellae over a large surface. Their relative dislocation is negligible, so that because of the small surface loads there will be a minimum of wear and tear only. Consequently the driving sheave elements may be made of inexpensive plastic material of a high frictional coefficient with mass production methods.

The design of the guide rollers is similar to that of the sheaves (FIG. 19), however, with the difference that the sheave elements 9 are arranged on the wheel body 8 in a free-running manner, without the interposition of lamellae. The required compensation is brought about on periphery Z of the wheel body. The further function of the clamping sheave 7 of the driving sheave (FIG. 17) will now be described.

Driving Sheave Brake (Automatic Emergency Brake)

The invention provides a braking or securing assembly exercising a direct effect on the driving sheave of the elevator.

The specifications governing elevators require that, first, upward acceleration or skid should be prevented, and, secondly, if owing to defects the operating brake

remains open, the motor has to keep the elevator out of operation.

Designs so far known meet the first condition by a gripping device mounted on the counterweight and operated by a separate speed limiting device. The second condition can be met only for dynatronic drive, and even in this case only when the supply current of the motor has not ceased to flow. Otherwise even with the doors open the elevator will gather speed up to a value in excess of the operating velocity and before any one of the gripping devices comes into action there will be a risk of grave accidents in particular for high-speed elevators.

The assembly according to the invention meets both conditions simultaneously by means of a simple and inexpensive device and with safety in a manner such that the assembly will come into action instantaneously and independently of the operation of the speed limiter, without waiting for the acceleration of the car even in the event of current failure. The assembly permits the use of an inexpensive V-belt drive, noiseless and non-vibrating in its operation.

An embodiment of the assembly according to the invention is shown by way of example in FIGS. 20 and 21. In addition to the grooves for the cables there is a further small "delta" shaped key slot on the driving sheave 1 (see 7 in FIG. 17), above which, around the driving sheave, there is a flexible element, e.g. a steel wire cable, which has no contact with the disc. This flexible element is kept from the groove at a distance by springs 4. On each of the free ends of the cable 3 a weight 5 of uniform value is suspended, supported by a toggle lever latch 6. Both ends of cable 3 are led through a borehole in the casing 2. The weights 5 are secured to the cable ends directly under the top of casing 2. The latches 6 are supported in such a way that they do not load the cable with their weight.

Upon the release of latch 6 the weights by overcoming the effect of the suspending springs 4 pull the cable fastened to them into the groove. At this moment the cable will become wedged in the groove and dependent on the sense of rotation, the sheave lifts the one weight and lowers the other. The weight moving upward will come into contact with the underside of the casing and consequently secure the end of the cable at that site. The weight at the opposite cable end will depend on the friction arising in the groove and will slow down the driving sheave by pressing the cable into the groove.

Dependent on the angle of the groove, braking may for practical purposes be made self-locking.

Lifting of latch 6 may be brought about in response to a number of effects. E.g. the speed limiter may disengage it mechanically whenever the elevator exceeds the maximum permissible speed in either direction. Secondly, for V-belt drive, a V-belt breakage sensing arm can disengage it directly. Thirdly, in the manner made clear in the description of the control system, for a mains failure and the simultaneous breakdown of the operating brake (10 in FIG. 9) the electromagnet will disengage the latch.

Load Sensing Assembly

A condition which the load sensing assemblies of elevators have to meet is that at starting or stopping the positive and negative accelerations apt to arise should cause no disturbances in the operation of the elevator. Equipment so far in use either is not sufficiently sensitive at the limit of the maximum load, or eliminates the

effects of the inertial forces apt to arise at a change of speed (at start and stop) in a more or less circumstantial manner.

The load sensing assembly according to the invention operates in a perfectly noiseless manner. It is sensitive equally to small and large loads, whereas on the other hand the effect of inertial forces does not influence its operation at all. A design of the assembly is by way of example shown in FIGS. 22, 23, 24 and 25. On the shaft 1 in suitable bearings and mounted on the top of the car the balance weight is secured in a manner adjustable by means of arm 2 around the axis of rotation. There are two eccentric pairs 5 on shaft 1. The eccentric discs 6 of the pair are arranged at an angle of 180° with respect to one another on the shaft. The eccentric discs 6 are clamped by brackets with ball bearings 7, to which transmitter bars 8 are attached. The bars 8 are hinged to the suspending elements 10 by a crank 9 with fulcrum 4. To the lower arm of the crank floor 11 is suspended by its corners.

In response to the floor load over a gear transmission system formed of crank 9 and eccentrics 6 the balance weight 3 fastened to shaft 10 moves away from its normal position in the manner of a scale beam and the equilibrium will be restored. Thus arm 2 will in each case according to the load occupy different positions, so that this arm will perform the connection of the load sensing contacts (for lighting, light signals, control current, etc.)

The weight of the moving floor 11, whose displacement owing to the load is a few millimeters only, and that of the suspending elements 10 is compensated by a counterweight 12 secured in an adjustable manner to shaft 1 so that the momentum due to the useful load will be compensated to a decreasing degree in order that even at the limit of the maximum load the system will be sufficiently sensitive.

Differentiated Car Guidance

For the required high-precision operation in the earlier systems, installation of the car guide rails was a task of extreme delicacy and required high skill. The reason is that the guiding elements can move only in the plane of the guide rails, but never perpendicularly to them. Consequently the car is redundantly guided at four fixed points. The departure of the guide rails from straight lines and parallelism, and similar departures of the guides conventionally arranged on the car, gives rise to friction and influences the motion of the car in a prejudicial manner, which in turn may result in a considerable decrease in the efficiency of the equipment as a whole. Therefore, it has become a routine to break in new elevators by operating them prior to placing them in service.

The assembly according to the invention eliminates these shortcomings in a simple manner. An example of this aspect of the invention is shown in FIGS. 26, 27 and 28. The car guides cannot become jammed on the guide rails even when owing to inaccuracies of installation these depart from straight lines (FIG. 28) or are arranged intentionally askew.

The lower guides 1 of the car are connected in the conventional manner to the car and guide rails. On the other hand the upper guide elements 2 are fastened to an arm 4 that turns around a vertical shaft 3, and not directly to the car. The three-point grip of the car guarantees its stability. At the same time the self-aligning

guides 2 mounted on arm 4 follow the guide rails without stress.

The invention also permits, in case of an emergency (e.g. when a freight elevator is operated as an all-purpose car) that the car (between levels sufficiently far apart) can turn around its vertical axis by 90° or even 180°. The turn by 90° permits the elimination of a turntable inside the car when a truck running on rails has to be transported.

Resilient Guide Rail Brackets

A precondition of the noiseless, smooth operation of the car is its free clearance while running in the guide rails. The elevators with the known guiding systems do not satisfy this condition, because the car is in each case guided with a clearance on the guide rails even when the guiding elements are provided with springs. Not even in this case is the horizontal swing of the car eliminated. Another method suppresses the swing and thus secures noiseless and free-of-oscillation guidance when installation of carefully machined guide rails is carried out in a careful and extremely accurate way.

The guide rail bracket system according to the invention permits the use of guide rails of a circular cross section which guarantee the free-of-swing guidance of the car by a simple device.

According to the invention the car is attached to the guide rails, one of which is rigidly secured to the shaft wall, and the other elastically mounted, without clearance, so that the car is subjected to no horizontal displacements or vibrations whatever.

The guiding elements mounted on the car (slides or rollers) surround the guide rail of a circular cross section to the extent of about 80 per cent. Thus the centric arrangement of the elements of the gripping device in respect of the guide rail is guaranteed at any time.

The elastic guide rail brackets for this system of guidance are shown in FIGS. 29 and 30. The guide rails of a circular cross section 1 join the socket-type jointing elements 2 with a screw thread. The elements 2 are fastened to the bracket trunk 3 so as to be slidable in the vertical direction. The bracket trunk is horizontally movably attached partly to the rigid bracket sole 4 by fulcrum 7, and partly to bracket sole 5 between elastic inserts 6.

The system of guidance according to the invention therefore does not require the earlier extremely delicate installation work and skilled labor, nor machined guide rails. Even drawn tubes will suit the purpose.

With the differentiated guidance of the car as shown in FIGS. 26 and 28, for roller guidance the so-called shaft efficiency of the equipment will rise from the known approximately 70 per cent, to about 95 per cent.

In view of the foregoing disclosure, therefore, it will be evident that all of the initially recited objects of the present invention have been achieved.

Although the present invention has been described and illustrated in connection with preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the spirit of the invention, as those skilled in this art will readily understand. Such modifications and variations are considered to be within the purview and scope of the present invention as defined by the appended claims.

Having described our invention, we claim:

1. A bank of elevators having a common control system for receiving calls from elevator users and for directing an available elevator of said bank to stop at the floor from which a said call was placed, said bank of elevators having up and down calling buttons at each of a plurality of said floors, said control system comprising direction registers, and for each floor separate signal storages for the up and down directions and also a story tracer, first input terminals of said signal storages for the up and down directions corresponding to the same floor being connected with each other for each floor, second input terminals of said signal storages of the up direction for each floor being connected with the second input terminals of said signal storages of the up direction of each other floor, second input terminals of said signal storages of the down direction for each floor

being connected with the second input terminals of said signal storages of the down direction of each other floor, said storages having output contacts connected in parallel to said direction registers, both signal storages of the up and down directions corresponding to a selected floor having input contacts connected in parallel to their associated said calling buttons, said story tracers having series contacts for each floor which are connected with signal acceptance hindering terminals of said storages corresponding to the respective floors as well as to terminals of said signal storages for sensing the stored signals, each said story tracer having a sensing element with storage character connected both to said signal storages and to said direction registers.

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