Oct. 16, 1962 W. R. CAPUTO 3,058,546

ELECTRIC ELEVATOR SYSTEMS HAVING SERVICE-DEMAND DEVICES

Filed Dec. 22, 1958 3 Sheets-Sheet 1

Fig. 1

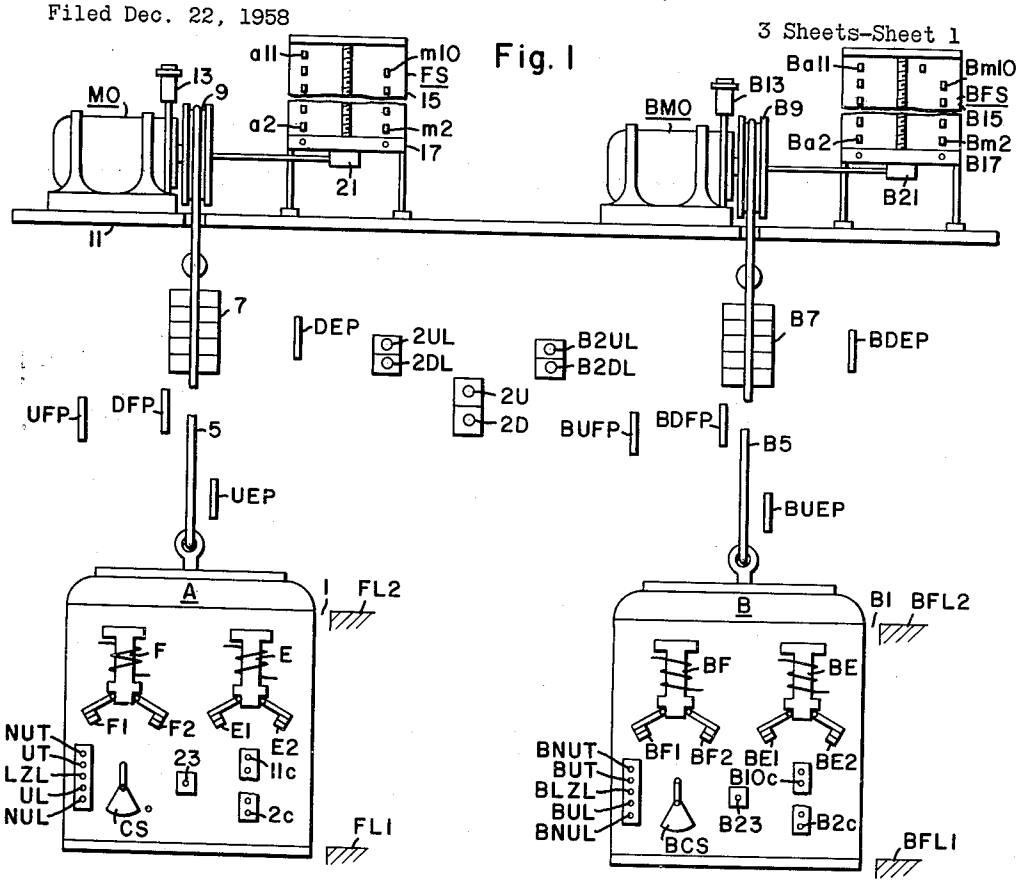


Fig. 2

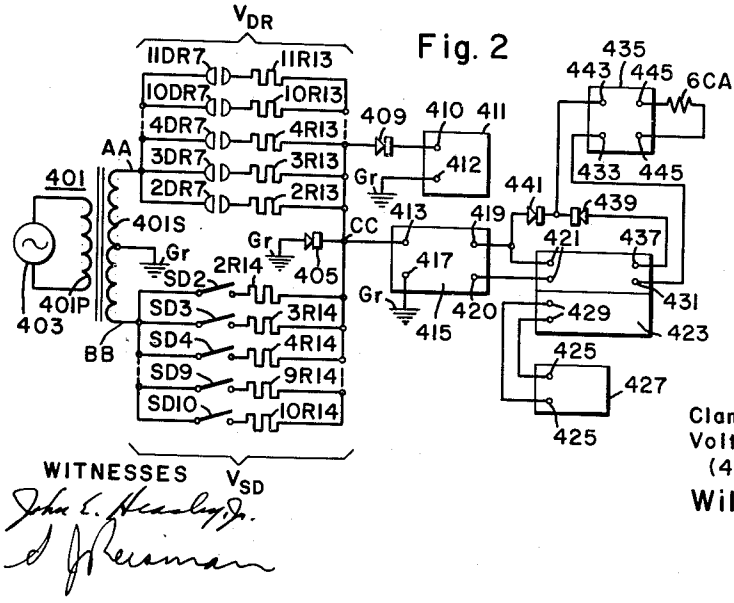
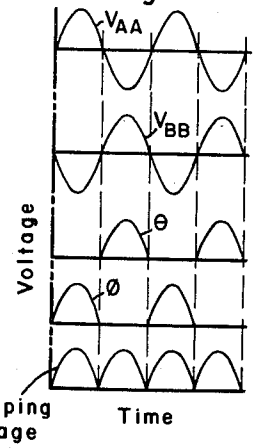


Fig. 3



WITNESSES

John E. Hanley Jr.

J. J. Kerman

INVENTOR

William R. Caputo

BY C. L. Freedman

ATTORNEY

Oct. 16, 1962 W. R. CAPUTO 3,058,546

ELECTRIC ELEVATOR SYSTEMS HAVING SERVICE-DEMAND DEVICES

Filed Dec. 22, 1958 3 Sheets-Sheet 2

Elevator Control System of Eames Patent 2,688,383 With Modifications

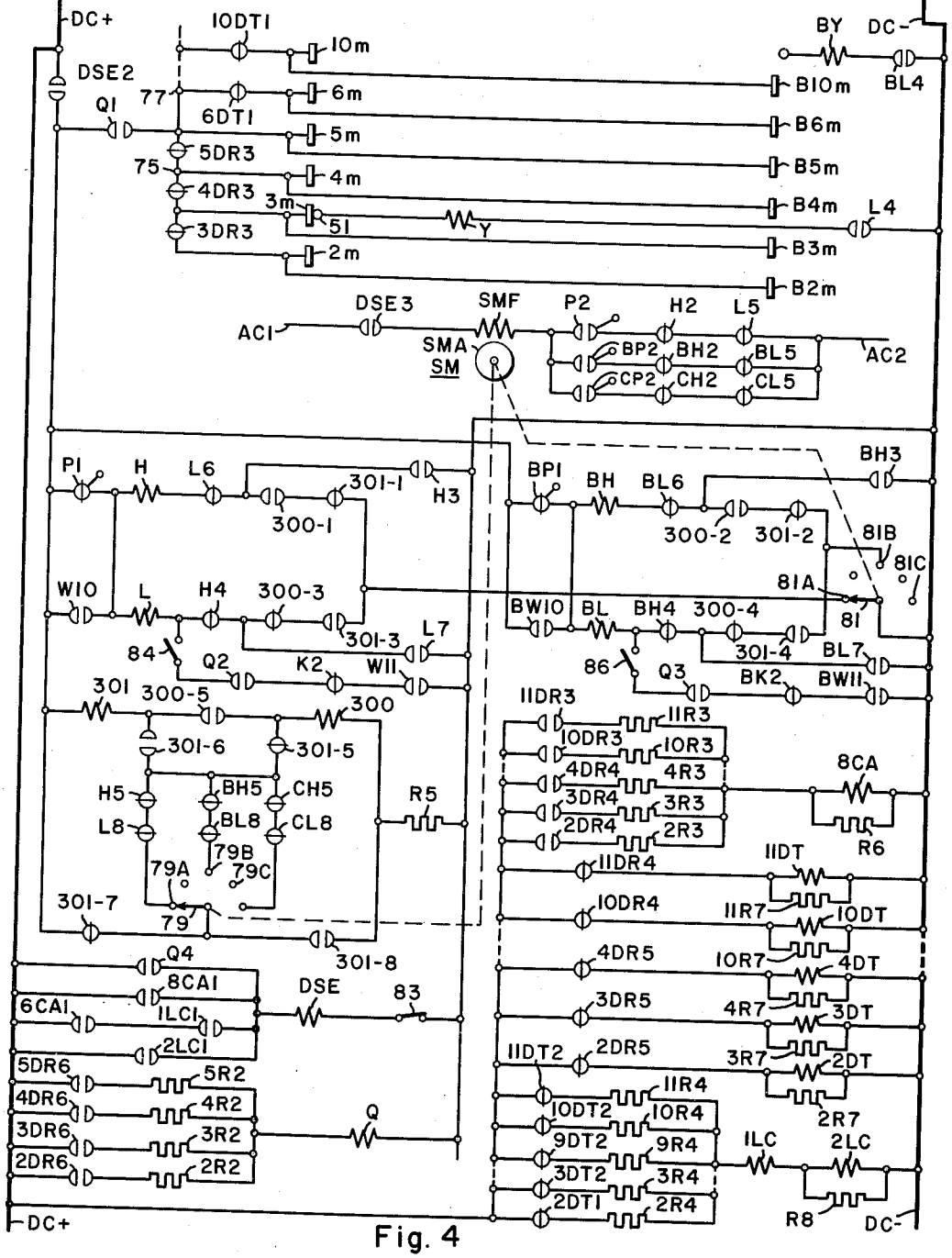


Fig. 4

Oct. 16, 1962 W. R. CAPUTO 3,058,546

ELECTRIC ELEVATOR SYSTEMS HAVING SERVICE-DEMAND DEVICES

Filed Dec. 22, 1958

3 Sheets-Sheet 3

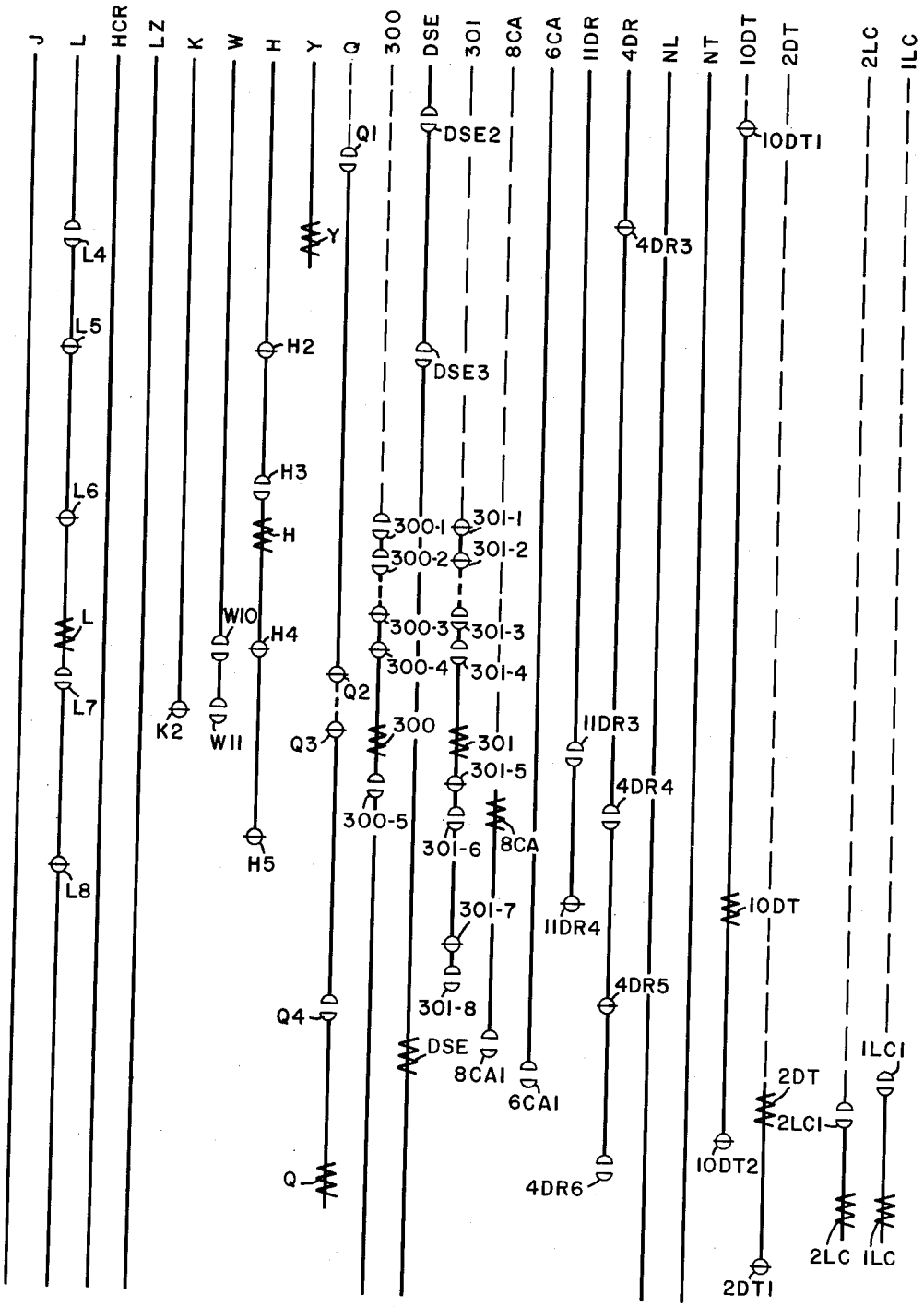


Fig. 4A

United States Patent Office 3,058,546
Patented Oct. 16, 1962

3,058,546

ELECTRIC ELEVATOR SYSTEMS HAVING SERVICE-DEMAND DEVICES

William R. Caputo, Jersey City, N.J., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Filed Dec. 22, 1958, Ser. No. 782,019
10 Claims. (Cl. 187—29)

This invention relates to counting devices and it has particular relation to elevator systems employing counting devices in the form of service demand circuits for controlling the operation of an elevator car.

Counting devices may be used to indicate the occurrence of a predetermined condition of a number of different conditions or events. For illustrative purposes, such devices in the form of service demand or of quota circuits may be employed in a multi-car elevator system installed in a building having a large number of floors to indicate the demand for elevator car service, which is subject to substantial fluctuation, and thereby to initiate a transfer of the elevator system from one mode of operation to another mode of operation in response to a predetermined service demand. Conveniently, the modes of operation which the elevator system must provide may be divided into three categories: "up-peak travel," "off-peak travel," and "down-peak travel." The aforementioned modes of operation are described in the Eames Patent 2,688,383 which issued September 7, 1954.

Up-peak travel occurs shortly before the start of a business day and at the close of the lunch period. During such a period a large number of people desire transportation substantially at the same time from the street floor to the higher floors of the building.

The up-peak period is followed by an off-peak period during which the travel in the two directions is substantially balanced.

Down-peak travel may occur at the start of the lunch period and also at the close of the business day. During such a period a large number of building occupants desire transportation from higher floors to the street floor at substantially the same time.

An elevator system may provide a distinctive service for each of the three peaks. Thus, in the aforesaid Eames patent quota and service-demand relays are employed to initiate transfer of the elevator system from one type of service to another. For example, in the Eames patent a particular service-demand relay is connected for energization by the sum of the currents flowing through make contacts of down floor-call registering relays, one of which is associated with each floor above the lower terminal floor served by the elevator cars. Each of these make contacts has in series therewith a current limiting resistor. Each of the make contacts with its associated resistor forms one arm of a parallel circuit supplying current to the service-demand relay. The service-demand relay may be designed to pick up when a predetermined number of down floor calls is registered. The remaining service-demand relays and the quota relay are energized in a similar manner.

According to the present invention, an elevator system service-demand indicating device is provided which is more sensitive and accurate than those devices heretofore in use. In a preferred embodiment of the invention, means are furnished for adjusting the device for response to any desired number of calls for elevator service. The device includes means responsive to the registration of calls for elevator service.

The device comprises an alternating current bridge circuit which conveniently is energized by a pair of alternating voltages of equal magnitude and opposite phase with respect to each other. The device includes means

for producing variable phase half-wave voltage; i.e., the last-named voltage upon the registration of a predetermined number of calls for elevator service is 180° out of phase with respect to that half-wave voltage which is produced in the absence of the predetermined number of such calls. It may be desirable to limit the half-wave voltage to a predetermined peak magnitude. In such instance, suitable voltage clamping means is provided.

The half-wave voltage produced by the device is employed to energize a phase sensitive member. Conveniently, the half-wave voltage may be utilized for input energization of a phase sensitive electrical static element which produces an output only upon input energization by that half-wave voltage of the device which signifies the occurrence of the predetermined service demand condition. The output of the static element is used in turn to effect energization of a service demand or quota relay for initiating a transfer of the elevator system from one mode of operation to another as previously mentioned.

It is, therefore, an object of the invention to provide, an improved counting device for indicating the occurrence of a predetermined condition of a plurality of different conditions.

It is a further object of the invention to provide an elevator system with an elevator car service-demand indicating device which is more sensitive and accurate than those devices heretofore in use.

It is another object of the invention to provide an elevator car service-demand indicating device having adjustable means for rendering the device responsive to any desired predetermined condition of a plurality of possible service-demand conditions.

It is an additional object of the invention to provide an elevator system with an elevator car service-demand indicating device which produces half-wave voltage whose phase is dependent upon the occurrence or non-occurrence of a predetermined service demand condition.

It is also an object of the invention to provide an elevator car service-demand indicating device as set forth in the preceding object wherein the half-wave voltage is utilized to drive a phase-sensitive member having an output only upon the occurrence of the predetermined service-demand condition.

Other objects of the invention will be apparent from the following discussion taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a view in elevation with parts broken away and parts schematically shown of an elevator system embodying the invention;

FIG. 2 is a detailed schematic view of a circuit embodying the invention;

FIG. 3 comprises voltage wave forms which serve to illustrate the operation of the invention;

FIG. 4 is a schematic view showing electrical circuits in straight-line form which may be incorporated in the elevator system of FIG. 1; and

FIG. 4A is a key representation of electromagnetic switches and relays employed in the circuits of FIG. 4. If FIG. 4A is placed in horizontal alignment with FIG. 4, it will be found that the corresponding contacts and coils shown in the two figures are substantially in horizontal alignment.

Features of the present invention may be employed in multi-car elevator systems which are designed to serve structures or buildings having various numbers of floors. The systems may include any desired number of elevator cars. In order to simplify the presentation, however, the invention will be described with reference to the system shown in the aforesaid Eames patent. Insofar as is possible, the conventions employed in the Eames patent will be adhered to in the present discussion. Components of the Eames system which are herein illustrated

will be identified by the same reference characters employed in the Eames patent.

FIG. 1 is identical to FIG. 1 of the Eames patent. FIG. 4 represents the elevator system of the Eames patent. The circuits shown in detail in FIG. 4 are identical to those in FIG. 6 of the Eames patent with the exception that a relay coil 6CA has been removed. As discussed below the relay 6CA in the present invention is energized by the circuit of FIG. 2. The similar components of the four figures operate in identical manner. For this reason, a detailed discussion of the components is believed unnecessary at this time. For convenience, however, the following components appearing in FIGS. 1 and 4 are listed:

Apparatus for Car A

E—slow-down inductor relay
F—stopping inductor relay
L—low-zone car relay
H—high-zone car relay
Y—auxiliary high floor-call relay (low-zone cars)

Apparatus Common to All Cars

Q—quota relay
300—first selection relay
301—second selection relay
DSE—down service relay
6CA—first service-demand relay
1LC—second service-demand relay
2LC—third service-demand relay
8CA—fourth service-demand relay
2DT through **11**DT—down floor-call timing relays
2C through **11**C—car call pushbuttons
1U through **10**U—up floor-call buttons
2D through **11**D—down floor-call buttons
2DR through **11**DR—down floor-call registering relays

In FIG. 1, the mechanical locations of various parts of the elevator system are illustrated. Only two elevator cars A and B are illustrated in FIG. 1, but it will be understood that additional cars if employed will be similarly associated with the building structure.

As shown in FIG. 1, the building structure includes a hoistway **1** within which the elevator car A is mounted for travel. Two floors FL1 and FL2 served by the elevator car are also illustrated.

It will be noted that the elevator car A is connected by a flexible rope or cable **5** to a counterweight **7**. The rope **5** passes around a traction sheave **9** which is secured to the shaft of a motor MO. In accordance with the conventional practice, the motor MO is mounted on a penthouse floor **11** which forms part of the building structure. A brake **13** of the conventional spring-applied electrically-released type is provided for stopping the elevator car.

Apparatus associated with the elevator car B is similar to that associated with the elevator car A. Each component for the car B is identified by the same reference character as employed for the corresponding component for the car A preceded by the letter B. For example, the hoistway for the car B is designated by the reference character B1.

To permit registration of calls for elevator car service, floor buttons are provided. Thus, at the second floor a floor button 2D is provided by which a call may be registered for elevator car service in the down direction. It will be understood that a similar floor button is provided for each of the floors requiring down service from the elevator cars. Each of these buttons is identified by the reference character D preceded by a numeral corresponding to the floor with which it is associated. The down floor-call buttons are common to all of the elevator cars.

Referring now to FIG. 2, a circuit embodying the invention is shown schematically therein. A transformer **401** has a primary winding **401**P connected for energization by a suitable alternating voltage source **403**. The transformer **401** has a secondary winding **401**S which is center tapped, the center tap being connected to ground Gr. One end AA of the secondary winding **401**S is connected to a plurality of make contacts of the down floor-call registering relays **2**DR through **11**DR. As is explained in the aforesaid Eames patent, each down floor-call registering relay is energized in response to the actuation of its associated floor-call button. For example, in response to the actuation of the down floor-call button 2D, the down floor-call registering relay **2**DR is energized, thereby closing its associated make contacts **2**DR7. Since the circuits for the various floors are similar, circuits are shown in FIG. 2 only for the floors **2**, **3**, **4**, **10** and **11**. The make contacts **2**DR7 through **11**DR7 have in series therewith respectively resistors **2**R13 through **11**R13. All of the resistors **2**R13 through **11**R13 are of substantially equal value.

Connected to the opposite end BB of the transformer secondary winding **401**S is a plurality of service-demand switches SD2 through SD10. In series with the switches SD2 through SD10 are resistors **2**R14 through **10**R14, respectively. Each of the resistors **2**R14 through **10**R14 is of substantially the same value as each of the resistors **2**R13 through **11**R13. One end of each of the resistors **2**R13 through **11**R13 and **2**R14 through **10**R14 is connected to a point CC.

One terminal of a control rectifier **405** is also connected to the point CC, the other terminal of the rectifier **405** being connected to ground Gr. In addition, one terminal of a clamping rectifier **409** is connected to the point CC. The other terminal of the rectifier **409** is connected to a positive terminal **410** of a direct voltage source **411**, a negative terminal **412** of which is connected to ground Gr. The rectifiers **405** and **409** may be of the semiconductor type such as silicon. These rectifiers conduct current in the directions pointed by their schematic representations in FIG. 2. For purpose of the present discussion, the rectifiers **405** and **409** have negligible voltage drop when conducting current in their current-conducting or forward directions and have substantially infinite impedance in their non-current-conducting or reverse directions.

An input terminal **413** of a phase-sensitive electrical element **415** is also connected to the point CC. A second input terminal **417** of the element **415** is connected to ground Gr. The element **415** has a pair of output terminals **419** and **420** to which are coupled input terminals **421** of a Memory element **423**. Output terminals **425** of a timer **427** are coupled to reset terminals **429** of the Memory element **423**. An output terminal **431** of the Memory element is conected to an input terminal **433** of an amplifier **435**. A second output terminal **437** of the Memory element is connected to one terminal of a rectifier **439**, the other terminal of the rectifier **439** being coupled to a like terminal of a rectifier **441**. The other terminal of the rectifier **441** is connected to the output terminal **419** of the element **415**. The junction of the rectifiers **439** and **441** is connected to an input terminal **443** of the amplifier **435**, which has a pair of output terminals **445** to which is coupled the coil of the first service-demand relay 6CA. The rectifiers **439** and **441** are similar to the rectifiers **405** and **409** heretofore described.

Operation of the circuit of FIG. 2 now will be described in detail with reference to FIG. 3. When the primary winding **401**P of the transformer **401** is energized by the alternating voltage source **403**, an alternating voltage of the same frequency will appear between the ends AA and BB of the secondary winding **401**S. The magnitude of the voltage AA to BB depends upon the turns ratio of the transformer windings, and it must be of a certain minimum value, as hereinafter explained. The voltage at the end AA with respect to ground Gr will be equal in magnitude and opposite in phase to the voltage at the end BB with

respect to ground. The wave forms of these voltages are illustrated in FIG. 3 as V_{AA} and V_{BB}, respectively.

Assume for a moment that the rectifiers **405** and **409** are removed from the circuit of FIG. 2. Also assume that one or more of the down floor-call registering relay make contacts **2DR7** through **11DR7** and that one or more of the service-demand switches SD2 through SD**10** are in closed condition, but that the number of closed make contacts is unequal to the number of closed switches. In such instance the following series circuit may be traced: AA, those parallel resistors **2R13** through **11R13** whose associated down floor-call registering relay make contacts are in closed condition, those parallel resistors **2R14** through **10R14** whose associated service-demand switches are in closed condition, BB, **40 1S**, AA. There will thus be an alternating voltage V_{DR} developed across those resistors **2R13** through **11R13** and an alternating voltage V_{SD} developed across those resistors **2R14** through **10R14** through which current is flowing. The relative magnitudes of the voltages V_{DR} and V_{SD} depend upon the relative magnitudes of the equivalent parallel resistances R_{DR} and R_{SD}, respectively, across which these voltages are developed. V_{DR} plus V_{SD} equals the total voltage across the transformer secondary winding **401S**.

At the point CC there will be an alternating voltage with respect to ground, V_{CC}, whose magnitude is equal to the difference between V_{AA} and V_{DR} (or between V_{BB} and V_{SD}). V_{CC} will be in phase with either V_{AA} or V_{BB}, again depending upon the relative magnitudes of R_{DR} and R_{SD}. For example, when R_{SD} is greater than R_{DR}, V_{CC} will be in phase with V_{AA}; and when R_{DR} is greater than R_{SD}, V_{CC} will be in phase with V_{BB}. (It is apparent that if R_{DR} equals R_{SD}, V_{CC} will be zero.)

It will be observed that the circuit as thus far described comprises one form of alternating current bridge, whose balance and direction of unbalance are controlled by the relative magnitudes of R_{DR} and R_{SD}.

If the control rectifier **405** now is replaced in the circuit, during those half cycles of V_{CC} when the point CC is positive with respect to ground G*r*, the rectifier **405** will block, i.e., it will conduct no current, and V_{CC} will have a magnitude depending on the conditions heretofore set forth; but during those half cycles when the point CC is negative with respect to ground, the rectifier **405** will conduct current, and, since the rectifier **405** has negligible forward voltage drop, V_{CC} will be substantially zero, or point CC effectively will be at ground. Thus, since V_{CC}, when the rectifier **405** is removed from the circuit, is an alternating phase-reversible voltage as aforementioned, V_{CC}, when the rectifier **405** is replaced in the circuit, is a half-wave unidirectional voltage whose phase is also changeable by 180°, as is clearly shown by the voltage wave forms θ and ϕ in FIG. 3. The θ phase of V_{CC} occurs when R_{SD} is less than R_{DR}, i.e., when the number of closed switches SD2 through SD**10** is greater than the number of closed relay contacts **2DR7** through **11DR7**, and the ϕ phase of V_{CC} occurs when R_{DR} is less than R_{SD}, i.e., when the number of closed relay contacts **2DR7** through **11DR7** is greater than the number of closed switches SD2 through SD**10**.

In order to illustrate operation of the circuit of FIG. 2 in the elevator system, let it be assumed that four service-demand switches, SD2 through SD5, are in closed condition. If 0, 1, 2 or 3 of the make contacts **2DR7** through **11DR7** of the down floor-call registering relays are in closed condition. (R_{SD} is less than R_{DR}), V_{CC} will be a half-wave voltage of the θ phase. If any four of these make contacts are in closed condition (R_{DR} equals R_{SD}), V_{CC} will be zero at all times. If any five or any greater number of these make contacts are in closed condition (R_{DR} is less than R_{SD}), V_{CC} will be a half-wave voltage of the ϕ phase. The circuit will operate in a similar manner when any other number of service-demand switches (including zero) is in closed condition. Thus, the phase of the voltage V_{CC}, ϕ, or θ is an indication, respectively, of whether or not a predetermined number of down floor calls (five, in the preceding example) has been registered, as determined by the number of service demand switches SD2 through SD**10** which is in closed condition. It will be observed further that the total number of service-demand switches required for the circuit of FIG. 2 is one less than the total number of down floor-call registering relay make contacts employed in the circuit, since the number of down floor-calls required for a change of V_{CC} to the ϕ phase is one greater than the number of service-demand switches in closed condition at a given time. In the circuit of FIG. 2, therefore, there are ten down floor-call registering relay make contacts and nine service-demand switches.

The circuit as thus far described may be used for energization of the first service-demand relay **6CA** in any suitable manner. In the embodiment shown in FIG. 2, the elements **415**, **423** and **435** and their associated components are employed for this purpose. As was noted heretofore, the electrical element **415** is of the phase-sensitive type. In this case, it is desirable that the element **415** produce an output at its output terminals **419** and **420** to initiate pickup of the relay **6CA** when and only when V_{CC}, and thus the voltage at the input terminals **413** and **417** of the element **415**, is of the ϕ phase. Such an element may be designated a one-input And element.

The Memory element **423**, also referred to as a "flip-flop," has a desired output at its output terminals **431** and **437** when the aforementioned output from the And element **415** (Memory element "on" input signal) is present at the input terminals **421**. The desired output of the Memory element is maintained even though its "on" input signal thereafter is discontinued. The Memory element may be reset and its desired output terminated in response to the application of a reset signal from the timer **427** to the reset terminals **429**. When both the "on" input signal from the And element **415** and the reset signal from the timer **427** are present at the input terminals **421** and at the reset terminals **429**, respectively, the Memory element has zero output at its output terminals **431** and **437**.

The output of the Memory element is fed to the input terminals **443** of the amplifier **435** through the rectifier **439**. In response to the desired output of the Memory element, the amplifier produces an output at its output terminals **445** to effect pickup of the relay **6CA**. Since the relay **6CA** must remain picked up as long as V_{CC} is of the ϕ phase, even though a reset signal from the timer **427** is applied to the Memory element's reset terminals **429** (in which case the Memory element has zero outut, as heretofore mentioned), means must be provided to effect such result. The rectifier **441** is provided for this purpose.

By virtue of the connections shown in FIG. 2, the output of the And element **415** is also fed, through the rectifier **441**, to the input terminals **433** and **443** of the amplifier **435**. Thus, when V_{CC} is of the ϕ phase, the output of the And element is effective to produce an output at the amplifier's output terminals **445** to energize the relay **6CA**. In the absence of a Memory element reset signal from the timer **427**, V_{CC} of the ϕ phase and the desired output of the Memory element resulting therefrom produce, by operation of the rectifiers **439** and **441**, a combined input signal at the amplifier's input terminals. In response thereto, the amplifier produces an output to energize the relay **6CA**. It will be seen, therefore, that when the predetermined number of down floor calls is registered, the relay **6CA** will be picked up, regardless of whether a reset signal from the timer **427** is present at the Memory element's reset terminals. The combination of the rectifiers **439** and **441** with the Memory element **423** is sometimes designated an "on-dominated" Memory element. The reason for this designation will be apparent from the foregoing explanation.

When V_{CC} changes to the θ phase or to zero, a reset signal applied to the reset terminals **429** from the timer **427**

is operative to terminate the desired output of the Memory element to effect dropout of the relay 6CA. The timer 427 may have an output at intervals of two minutes, for example, to reset the Memory element, provided no "on" input signal is present at the terminals 421. Such timers are well known.

If the Memory element has adequate sensitivity, the And element 415 may be eliminated from the circuit of FIG. 2, V_{CC} then driving the Memory element directly, operation of the circuit otherwise being the same as described above.

And and Memory elements are well known. Examples of such elements will be found in Paper No. CP–56–91, entitled "Magnetic Logic Circuits for Industrial Control Systems" by W. G. Evans, W. G. Hall and R. I. Van Nice, published by the American Institute of Electrical Engineers, 33 West 39th Street, New York City. Conveniently, the amplifier 435 may comprise two one-input And elements having their outputs tied togeher (terminals 445, FIG. 2). The input to one of these And elements serves as the input of the amplifier (terminals 433 and 443), the input to the other And element being the output of the first And element.

Depending upon the input voltage requirements of the And element 415 and the magnitude of V_{AA} and V_{BB}, it may be desirable to limit V_{CC} under all conditions of operation to a predetermined peak magnitude. For this purpose the clamping rectifier 409 and the direct voltage source 411 may be used. The source 411 has a full-wave rectified voltage output at its terminals 410 and 412, the terminal 410 being positive with respect to the terminal 412 as aforementioned. The wave form of this voltage, designated "clamping voltage," is shown in FIG. 3. The clamping voltage 411 has a peak magnitude equal to the peak magnitude of the rated input voltage of the element 415. By virtue of the connections in FIG. 2, the clamping voltage 411 biases the rectifier 409 in the reverse direction. The rectifier 409 conducts current as long as the instantaneous magnitude of V_{CC} attempts to exceed the instantaneous magnitude of the voltage 411. When the rectifier 409 conducts current, the instantaneous magnitude of V_{CC} is prevented from exceeding the instantaneous magnitude of the voltage 411, and the rated input voltage of the And element 415 cannot be exceeded.

It is desired, of course, that V_{CC}, upon registration of the predetermined number of calls for elevator service, have a magnitude sufficient to initiate pickup of the relay 6CA, regardless of such predetermined number. For example, in the circuit of FIG. 2, when the predetermined number is ten (all service-demand switches SD2 through SD10 in closed condition), V_{CC} must have a magnitude sufficient to initiate pickup of the relay 6CA upon the registration of ten down calls for elevator service (all contacts 2DR7 through 11DR7 in closed condition). Thus, the secondary voltage of the transformer 401 must have a magnitude which is great enough to enable the circuit to satisfy the foregoing reqirement. When this condition is met, V_{CC} also will have a magnitude sufficient to initiate pickup of the relay 6CA for any predetermined number of calls less than ten.

The relay 6CA picks up to control operation of the elevator system in the manner described in the aforesaid Eames patent. Thus, if the total down floor calls from all of the floors equals or exceeds the predetermined number, that is, if the total number of such calls is any number greater than the number of service-demand switches SD2 through SD10 in closed condition, the make contacts 6CA1 of FIG. 4 close to energize the down service relay DSE through the closed make contacts 1LC1, thereby transferring the elevator system to down-peak operation. When the registered down calls drop below the predetermined number, output from the And element 415 ceases. In order to minimize hunting of the system from one mode of operation to another, the relay 6CA may be of a type which has a predetermined dropout delay after termination of its energization.

A variable resistor may be substituted for the resistors 2R14 through 10R14. In such instance the variable resistor may have a dial calibrated with numerals corresponding to the predetermined number of down floor calls desired for instituting pickup of the relay 6CA. As the predetermined number is increased, that portion of the variable resistance remaining in the circuit is decreased. In like manner, the resistors 2R13 through 11R13 may be replaced by a variable resistor, the make contacts 2DR7 through 11DR7, upon actuation of their associated down floor-call registering relays, being operative to short out various portions of the variable resistor. Furthermore, for a given installation, the resistors 2R14 through 10R14 may be replaced by a single fixed resistor if no variation in the predetermined number is required for such installation.

The circuit of FIG. 2 may also be substituted for the circuit of the quota relay Q and for the circuits of the second, third and fourth service-demand relays 1LC, 2LC and 8CA, respectively, of FIG. 4 in the manner explained above for the relay 6CA. In addition, it will be appreciated that other well-known types of alternating current bridges having phase-reversible output may be substituted for the alternating current bridge illustrated in FIG. 2.

Although the invention has been described with reference to certain specific embodiments thereof, numerous modifications falling within the spirit and scope of the invention are possible.

I claim as my invention:

1. An alternating current bridge, first means responsive to a condition variable in a plurality of discrete steps for unbalancing the bridge in a first direction, second means selectively operable for unbalancing the bridge in a second direction, and detecting means responsive to unbalance of the bridge for producing a pulsating unidirectional output voltage of constant polarity, said output voltage when the bridge is unbalanced in the first direction being out of phase with said output voltage when the bridge is unbalanced in the second direction, the components of said bridge being proportioned to effect at least a predetermined minimum peak magnitude of said output voltage regardless of the extent of unbalance of said bridge.

2. An alternating current bridge, variable means for unbalancing the bridge in a first direction in a plurality of discrete steps, selectively adjustable means for unbalancing the bridge in a second direction in a plurality of discrete steps, means responsive to the variable means and the selectively adjustable means for producing alternating voltage having a phase dependent on the direction of unbalance of the bridge and a peak magnitude dependent upon the extent of such unbalance, in combination with half-wave rectifying means for converting said alternating voltage to a pulsating unidirectional voltage of constant polarity, said unidirectional voltage when the bridge is unbalanced in the first direction being 180 degrees out of phase with said unidirectional voltage when the bridge is unbalanced in the second direction, the components of said bridge being proportioned to effect at least a predetermined minimum peak magnitude of said unidirectional voltage regardless of the extent of unbalance of said bridge.

3. In a device for indicating the occurrence of a predetermined number of operations, an alternating current bridge, said bridge including first impedance means having an effective magnitude variable in a plurality of discrete steps each corresponding to a separate one of such operations, second impedance means having a magnitude corresponding to said predetermined number of said operations, said bridge producing output alternating voltage having a phase dependent upon the direction of unbalance of the magnitudes of said first and second impedance means and a peak magnitude dependent upon the extent of such unbalance, and half-wave rectifying means for converting said output alternating voltage to pulsating unidirectional voltage of constant polarity, said unidirectional voltage when the magnitudes of said first and second

impedance means are unbalanced in a first direction being 180 degrees out of phase with said unidirectional voltage when the magnitudes of said first and second impedance means are unbalanced in a second direction, the components of said bridge being proportioned for effecting at least a predetermined minimum peak magnitude of said unidirectional voltage regardless of the extent of unbalance of the magnitudes of said first and second impedance means.

4. In a device for indicating the occurrence of a predetermined number of operations, an alternating current bridge, said bridge including first impedance means having an effective magnitude variable in a plurality of discrete steps each corresponding to a separate one of such operations, second impedance means having a magnitude corresponding to said predetermined number of said operations, said bridge producing output alternating voltage having a phase dependent upon the direction of unbalance of the magnitudes of said first and second impedance means and a peak magnitude dependent upon the extent of said unbalance, half-wave rectifying means for converting said output alternating voltage to pulsating unidirectional voltage of constant polarity, said unidirectional voltage when the magnitudes of said first and second impedance means are unbalanced in a first direction being 180 degrees out of phase with said unidirectional voltage when the magnitudes of said first and second impedance means are unbalanced in a second direction, the components of said bridge being proportioned for effecting at least a predetermined minimum peak magnitude of said unidirectional voltage regardless of the extent of unbalance of the magnitudes of said first and second impedance means limiting means for limiting said unidirectional voltage to said predetermined peak magnitude regardless of the extent of unbalance of the magnitudes of said first and second impedance means, and means responsive to only one phase of said limited unidirectional voltage for indicating the occurrence of said predetermined number of operations.

5. In an elevator system, a structure having a plurality of floors to be served by an elevator car, an elevator car, means mounting the elevator car for movement in two directions relative to the structure to serve the floors, motive means for moving the elevator car relative to the structure, registering means for registering demand for elevator service, control means operable in cooperation with the registering means and the motive means for moving the elevator car relative to the structure and for stopping the elevator car at predetermined floors, and a service-demand device for effecting a modification in operation of said control means, said service demand device comprising variable means responsive to the registration of demand for service by the registering means, selectively adjustable means for selecting a predetermined demand for elevator service, means responsive to the variable means and the selectively adjustable means for producing alternating voltage having a phase dependent upon the direction of unbalance of the variable means and the selectively adjustable means, detecting means for said alternating voltage, and means responsive to the output of the detecting means for only one phase of said alternating voltage for initiating said modification upon the registration by said registering means of said predetermined demand for elevator service.

6. In an elevator system, a structure having a plurality of floors, a plurality of elevator cars, means mounting the elevator cars for movement in two directions relative to the structure to serve the floors, motive means for moving the elevator cars relative to the structure, control means for controlling the movement of the elevator cars by the motive means and the stopping of the elevator cars at predetermined floors, said control means comprising call means operable for registering calls for floors at which one of the elevator cars is desired to stop, and a service-demand device for effecting a modification in operation of said control means, said service demand device comprising an alternating current bridge, means responsive to call registration by the call means for unbalancing the bridge in a first direction, means operable to select a predetermined number of calls for unbalancing the bridge in a second direction, said bridge being unbalanced in said first direction upon the registration by said call means of said predetermined number of calls, half-wave rectifying means responsive to the direction of unbalance of the bridge for producing half-wave rectified direct voltage, said direct voltage when the bridge is unbalanced in the first direction being out of phase with said direct voltage when the bridge is unbalanced in the second direction, and means responsive only to the output of said rectifying means when the bridge is unbalanced in the first direction for initiating said modification upon the registration by said call means of said predetermined number of calls.

7. In a device for indicating the occurrence of a predetermined number of operations, an alternating current bridge, said bridge having a first arm comprising a first source of alternating voltage, a second arm comprising a second source of alternating voltage constantly equal in magnitude and opposite in phase to the voltage produced by said first source, a third arm comprising first impedance means having an effective magnitude variable in a plurality of discrete steps each corresponding to a separate one of said operations, and a fourth arm comprising second impedance means having a magnitude corresponding to said predetermined number of operations, said bridge producing output alternating voltage having a phase dependent upon the direction of unbalance of the magnitudes of said first and second impedance means and a peak magnitude dependent upon the extent of such unbalance, and half-wave rectifying means for converting said output alternating voltage to pulsating unidirectional voltage of constant polarity, said unidirectional voltage when the magnitudes of said first and second impedance means are unbalanced in a first direction being 180 degrees out of phase with said unidirectional voltage when the magnitudes of said first and second impedance means are unbalanced in a second direction.

8. In a device for indicating the occurrence of a predetermined number of operations, an alternating current bridge, said bridge having a first arm comprising a first source of alternating voltage, a second arm comprising a second source of alternating voltage constantly equal in magnitude and opposite in phase to the voltage produced by said first source, a third arm comprising first impedance means having an effective magnitude variable in a plurality of discrete steps each corresponding to a separate one of said operations, and a fourth arm comprising second impedance means having a magnitude corresponding to said predetermined number of operations, said bridge producing output alternating voltage having a phase dependent upon the direction of unbalance of the magnitudes of said first and second impedance means and a peak magnitude dependent upon the extent of such unbalance, and half-wave rectifying means for converting said output alternating voltage to pulsating unidirectional voltage of constant polarity, said unidirectional voltage when the magnitudes of said first and second impedance means are unbalanced in a first direction being 180 degrees out of phase with said unidirectional voltage when the magnitudes of said first and second impedance means are unbalanced in a second direction, said first and second impedance means and said alternating voltages being proportioned for effecting at least a predetermined minimum peak magnitude of said unidirectional voltage regardless of the extent of unbalance of the magnitudes of said first and second impedance means, limiting means for limiting said unidirectional voltage to said predetermined peak magnitude regardless of the extent of unbalance of the magnitudes of said first and second impedance means, and means responsive to only one phase of said

limited unidirectional voltage for indicating the occurrence of said predetermined number of operations.

9. In an elevator system, a structure having a plurality of floors, a plurality of elevator cars, means mounting the elevator cars for movement in two directions relative to the structure to serve the floors, motive means for moving the elevator cars relative to the structure, control means for controlling the movement of the elevator cars by the motive means and the stopping of the elevator cars at predetermined floors, said control means comprising call means operable for registering a call for each floor at which one of the elevator cars is desired to stop, and a service-demand device for effecting a modification in operation of said control means, said service-demand device comprising an alternating current bridge, said bridge having a first arm comprising a first source of alternating voltage, a second arm comprising a second source of alternating voltage constantly equal in magnitude and opposite in phase to the voltage produced by said first source, a third arm comprising first impedance means having an effective magnitude variable in a plurality of discrete steps each corresponding to a separate call registered by the call means for unbalancing the bridge in a first direction, and a fourth arm comprising second impedance means having a magnitude corresponding to the selection of a predetermined number of calls for unbalancing the bridge in a second direction, said bridge being unbalanced in said first direction upon registration by said call means of at least said predetermined number of calls and in said second direction upon registration by said call means of fewer than said predetermined number of calls, said bridge, when unbalanced, producing output alternating voltage, half-wave rectifying means for converting said output alternating voltage to pulsating unidirectional voltage of constant polarity, said unidirectional voltage when the magnitudes of said first and second impedance means are unbalanced in the first direction being 180 degrees out of phase with said unidirectional voltage when the magnitudes of said first and second impedance means are unbalanced in the second direction, and means responsive to energization by said unidirectional voltage only when the bridge is unbalanced in the first direction for initiating said modification.

10. In an elevator system, a structure having a plurality of floors, a plurality of elevator cars, means mounting the elevator cars for movement in two directions relative to the structure to serve the floors, motive means for moving the elevator cars relative to the structure, control means for controlling the movement of the elevator cars by the motive means and the stopping of the elevator cars at predetermined floors, said control means comprising call means operable for registering a call for each floor at which one of the elevator cars is desired to stop, and a service-demand device for effecting a modification in operation of said control means, said service-demand device comprising an alternating current bridge, said bridge having a first arm comprising a first source of alternating voltage, a second arm comprising a second source of alternating voltage constantly equal in magnitude and opposite in phase to the voltage produced by said first source, a third arm comprising a plurality of parallel branches each including a resistor and means responsive to registration of a call by said call means for a separate one of said floors for placing the associated resistor in operative condition in said bridge, said resistors being of substantially equal resistance whereby the magnitude of the effective resistance of said third arm is variable in discrete steps each corresponding to a separate call registered by the call means, and a fourth arm comprising resistance means having a magnitude which corresponds to the selection of a predetermined number of calls and which is an integral multiple of the resistance of each of said resistors, said bridge being unbalanced in a first direction upon registration by said call means of at least said predetermined number of calls and in a second direction upon registration by said call means of fewer than said predetermined number of calls, said bridge, when unbalanced, producing output alternating voltage, half-wave rectifying means connected for energization by said output alternating voltage for converting such voltage to pulsating unidirectional voltage of constant polarity, said unidirectional voltage when the magnitudes of said first and second impedance means are unbalanced in the first direction being 180 degrees out of phase with said unidirectional voltage when the magnitudes of said first and second impedance means are unbalanced in the second direction, a Memory element having an output dependent on the last of a plurality of inputs supplied thereto, means responsive to energization by said unidirectional voltage only when the bridge is unbalanced in the first direction for applying a first input to said Memory element to effect the production thereby of an output indicating the registration by said call means of at least said predetermined number of calls, means responsive to said output for initiating said modification, and means operable at predetermined intervals for applying a second input to said Memory element for resetting said Memory element to effect termination of said modification.

References Cited in the file of this patent

UNITED STATES PATENTS

2,454,776	Conant	Nov. 30, 1948
2,537,767	Langenwalter	Jan. 9, 1951
2,544,790	Hornfeck	Mar. 13, 1951

FOREIGN PATENTS

1,000,096	Germany	Jan. 3, 1957